Digital Technologies
in
New Zealand Secondary Schools

- a Case Study of an Auckland School

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Abstract

One of the most rapid and far-reaching developments in contemporary secondary schools in New Zealand is the adoption of recent curriculum innovations in the application of digital technologies across curriculum areas. Building on the New Zealand government's 2014 report, *Future-focused learning in connected communities*, came the revamping of *Technology Learning Areas* in 2017, along with the *Digital Visual Literacies* recommendations to be adopted across all learning areas. In light of these specific and far-reaching shifts in educational focus and delivery, this Master of Philosophy research investigates the extent to which secondary schools in New Zealand understand these changes, and are prepared for their introduction. Commensurate with the scope of Master's level undertakings, the research develops a 'snapshot' understanding, in the context of one Auckland low-decile secondary school, of how digital technologies are currently deployed across subject areas.

The thesis comprises six chapters, including an Introduction that establishes the research aims, and a Conclusion that reiterates the research journey and emphasises outcomes. Chapter Two engages literature relevant to the research field, placing particular emphasis on the Organisation for Economic Cooperation and Development (OECD) literature on digital technology developments in secondary education within international contexts. When we look at the New Zealand Ministry of Education (MOE) literature on twenty-first century learning, on new facilities design, and on digital literacies, it is clear the extent of influence of OECD policies on New Zealand education. Further literature includes international and national researchers in the educational field engaging questions of innovations in curricula, driven by digital technological change. Chapter Three engages with the thesis methodology. Within an interpretative phenomenological, qualitative approach, the research undertakes participant interviews of five secondary school educators from one Auckland school. The participants comprise four subject heads and a deputy-principal. Chapter Four presents the findings from the participant interviews. Interview data was coded and themed, with the aim of determining where themes have convergences and divergences, thereby defining, within terms developed from participant responses, how this case-study school is currently managing digital technology curriculum innovations.

Chapter Five comprises the discussion chapter, where findings from the empirical research are brought into conversation with understanding developed from the literature search. My research discussion finds there are clear gaps between understandings, expectations and readiness on the part of experienced secondary teachers, and current perspectives offered by the MOE or OECD. The thesis makes suggestions concerning how to address more directly secondary teacher needs. It also recognises that a larger study is required, with a broader range of schools, to consolidate the genuine needs that educators are facing with rapidly changing learning environments, driven by digital technology innovations.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Ethics

This work has been conducted in accordance with the Auckland University of Technology Ethics Committee (AUTEC) policy and procedures. This thesis was granted ethics approval by AUTEC on 28th August, 2018. The ethics approval number is 18/324 and the notification of approval is contained in Appendix A.

Chapter One

Introduction

Precipitating the research

Educational technologies have always (at least since I started school) been chasing technological advances. These advances are often devices or media already well accepted in everyday environments, as conduits or mediums for the betterment of learning. In commencing the Introduction to this thesis, I thought it valuable for the researcher to reflect on his own teaching and learning experiences with generic information and communication technologies (ICTs). We need to remember that ICTs might equally refer to the simple use of pencil and paper, as much as the most current social networking devices. I begin in the 1950s, with my own early schooling, in order to reflect, somewhat genealogically, on the successive developments of ICTs that I have encountered over the past sixty or so years.

The 1950s heralded the commencement of my primary schooling, an era of extremely limited Information and Communication Technologies. Once a week we listened avidly to a radio programme devoted to aspects of Social Studies, with a textbook supporting correlations between audio information from the radio and image and text references. Occasionally, we would gather in the school hall with other classes to see a film, projected on a 16mm projector.

Though limited, these were exciting intrusions from outside, into the routines of classroom teaching. Classrooms were ordered, with rows of desks, a single teacher delivering all curricula for the year. In secondary school during the 1960s, on a weekly basis, our science teacher would wheel in one of the school's television monitors for a government-funded series of television programmes on aspects of our Science curriculum. The television screen was small and the class large. Nonetheless, this was also a welcomed intrusion, breaking the routine of face-to-face teaching. At university in the 1970s, considerable use was made of slide carousel projectors, sometimes in tandem, to present an image-rich accompaniment to the habitual routine of a teacher standing and delivering a lecture. Television monitors were also used in the delivery of lectures, either from already recorded lectures on videocassettes, or, for very large classes, having a lecture delivered live in multiple lecture theatres, with the lecturer in one and monitor presentation in another.

During the 1970s and 80s, the computing industry rapidly developed (Ferguson, 2008). The main focus seemed to concentrate on software development, with telephone-line technology enabling remote access to computers. Computers became smaller with IBM dominating hardware and software sales. My initial foray in the design industry, having graduated from Auckland Technical Institute (later to become AUT University) with a Graphic Design Diploma, included working on a 'drawing board' where everything needed to be 'typeset'. When I started teaching in secondary schools, during the 1980s, huge advances were made on what was initially termed 'porta-pack video technology'—heavy and cumbersome ¾-inch U-matic—followed by more lightweight ½–inch VHS. After completing a Master of Fine Arts at Elam, University of Auckland, I re-entered the Graphic Design/Advertising industry at a time of prolific change in terms of computer design. It was assumed that design processes would take less time due to the complexity and efficiency of the software. In reality, this speed simply led to expectations of faster design outputs, increasing the tempo and stress of creative work. By the time I commenced teaching at university in Digital Design, a small revolution had occurred in ICTs, initially with the advent of the Personal Computer (PC) in the early 1990s, along with development of the internet and an explosion in software packages, from word-processing, to spread-sheets, graphic design and video editing.

With the graphic-user-interface (GUI) sophistication of Apple Macintosh, the introduction of laptops, and the conversions of differing delivery modes to a single device (for example, word-processing, graphic design, internet, social media, music, digital video editing) there was a paradigm shift in educational delivery. In the early 2000s, students were not permitted cell-phones or other devices during class. However, by 2019, this expectation has completely reversed with integration of internet-linked devices used by students in their learning environment. Cell-phones, tablets and laptops form essential accompaniments to students' capacities to learn. I lived through this revolution: as a child growing up in an educational environment devoid of digital technology and currently as a tertiary educator in the digital field. I recognise the extent to which curricula in schools and universities, along with physical facilities as spaces within which we learn, have responded to drivers that did not arise as a result of the needs of educators, they were simply a result of what was happening within this field.

Although these drivers or advances are 'external', they are integral to all of our lives. Traditionally, the New Zealand secondary education curriculum has lagged behind global technological innovations (Long, 2019a; 2019b). However, it appears that our current

Ministry of Education (MOE) in New Zealand is committed to the establishment and advancement of digital literacy for secondary educators and students. This research grew out of recognition of the significance of the new national digital technologies curriculum for New Zealand schools, especially from the vantage point of a tertiary educator in digital visualisation, who is keen to assess the genuine understanding of this initiative for secondary educators themselves. Are secondary teachers prepared for the delivery of this curriculum? What are their apprehensions and their aspirations? In developing a research project around this concern, I formulated a series of aims and objectives, as well as desired outcomes.

Background

The New Zealand Government's 2014 report, *Future-focused learning in connected communities*, suggested the potential and expectation for new and emerging technologies to change learning and teaching in the twenty-first century learning environment. A growing body of evidence points to "thoughtful integration of digital technologies with effective teaching practices, which can significantly improve learning outcomes" (Greaves, et al, 2010, p. 6). In 2017, the New Zealand Curriculum (NZC) and MOE suggested that adaptation and innovation are at the heart of technological practice, and that quality outcomes result from thinking and practices that are informed, critical, and creative (Ministry of Education, 2017a). However, ICTs across the curriculum are not addressed in depth within MOE documents, other than by way of a directive for schools to explore avenues that are able to supplement traditional ways of teaching. The MOE could see that ICT was capable of advancing the delivery of subject content but teachers demonstrated an unwillingness to become involved with this new technology, although it also suggests ICTs may open up new and different ways of learning (Savidan, 2003). Without explicit guidelines on how to integrate ICTs within curriculum objectives and enthuse and engage students in meaningful learning, evidence suggests that educators resort to fitting digital technologies into existing structures.

There are two aspects to the MOE's digital curriculum initiative. One is the revamping of the "Technology Learning Area," undertaken in 2017, placing new emphasis on in-depth engagements with basic understandings of digital technologies. The other is the broader adoption of specifically "Digital Visual Literacies" across all learning areas of a curriculum (Ministry of Education, 2017c). Hence, students engaged in science and in history might well use similar visualisation technologies when exploring or undertaking independent enquiry and presentation of such enquiry. This enhances opportunities for developing student-centred projects that work across, for example, science and history, combining research enquiry approaches via common digital visual techniques. The reorganised Technology Learning Area continues to have three strands: technological practice, technological knowledge, and nature of technology. This third arena itself includes four regions: designing and developing materials, processed and digital outcomes, design and visual communication, and computational thinking (Ministry of Education, 2017c).

The new content covers two key areas, Computational Thinking and Designing and Developing Digital Outcomes (Ministry of Education, 2017c). This content has been designed to be flexible, such that it can respond to new developments and technologies as they emerge. The MOE defines Computational Thinking as "understanding the computer science principles that underlie all digital technologies, and learning how to develop instructions, such as programming, to control these technologies" (Ministry of Education, 2017c). The MOE refers to Designing and Developing Digital Outcomes as:

> understanding that digital systems and applications are created for humans by humans, and developing knowledge and skills in using different digital technologies to create digital content across a range of digital media. This part of the curriculum also includes learning about the electronic components and techniques used to design digital devices. (Ministry of Education, 2017c, p. 1)

This research aims to develop a 'snapshot' understanding of the manner whereby one Auckland secondary school is implementing the new digital technologies curriculum innovations, with particular emphasis on how digital technologies are deployed across subject areas. It also aims to determine the extent to which these common deployments enhance the potentials for discipline divides to be broken down.

The thesis presents an analysis of the processes undertaken by a mid-decile Auckland secondary school in innovating its curricula. On the basis of its findings, the thesis aims to recognise and highlight requirements which can add to the MOE's body of knowledge which informs policy, such as explicit guidelines for the adoption of digital technologies across curriculum areas, as well as indicative approaches that schools might adopt to enhance holistic approaches to subject integration.

Research questions

The key research question is:

- How are New Zealand secondary schools currently implementing the digital technologies initiatives defined by the MOE?

The secondary questions are:

- To what extent has implementation of the digital technologies initiatives led to the breaking of silo discipline areas in secondary school teaching practices?

- To what extent has the MOE's initiatives in twenty-first century curriculum innovation, in school facilities design innovation and in digital technologies innovation been adopted by schools with perceived positive results?

The significance of the research provides an evaluative guide in one case-study school, to evaluate the success or otherwise of far-reaching digital technologies that are driving curriculum change. Hence, the research aims to provide an evaluation of the extent to which there is inertia or enthusiasm for change in particular discipline areas and within the school as a whole. The study is modest, though appropriate in scale for an M.Phil. It aims at preliminary investigation in order to develop a larger study, in the future, for PhD research.

The researcher, in his capacity as a university educator, has seen the slow development of digital technologies into various secondary curriculum offerings (as outlined in the opening paragraphs of this chapter). From the researcher's perspective and from anecdotal observations, this development has been slow, for a number of reasons. Firstly, the MOE has appeared to be reticence in understanding the impact of digital technology within the education field and in recognising that newly emerging learning areas, such as those related directly to ICT developments, need to be included in secondary education curricula. Secondly, there seems to have been slow realisation that teacher professional development in

this field is significantly under-realised and, therefore, underfunded. Teachers do not know how to teach nor integrate digital technologies within their subject areas, which seems to have caught the MOE unawares. This research sets out to ascertain the veracity of these anecdotal observations, for one Auckland secondary school.

Research methods

This Master of Philosophy thesis uses a number of methodological approaches, guided overall by an understanding of critical hermeneutics (Gadamer, 1975; Ramberg and Gjesdas, 2009). The research methods are 'critical', inasmuch as they aim to question the basic structures by which the conditions of possibility for the various agencies that come into play are determinable. The study is informed by depth engagement in current literature in the field of education curriculum, its innovation and application. The participant study uses a 'case-study' methodology, whose findings are to be compared and assessed in relation to the literature study.

Case study is an empirical inquiry that has "investigated a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p. 13). The frame of reference for this 'case' study is the implementation of digital technologies as enhancements of holistic approaches to education, to mark an emergent phenomenon in education. Under the more generalised category of case study exist several subdivisions, each of which is custom-selected for use, depending upon the goals or objectives of the researcher. I have chosen to use the 'critical instance case-study' (Gulsecen and Kubat, 2006), which examines one or more sites (in this case one site) for either the purpose of examining a situation of unique interest (digital technology adoption) with little to no interest in generalisation, or to call into question or challenge a highly generalised or universal assertion. A critical case is defined as having strategic importance in relation to the general problem, in this instance, the impact of the implementation of digital curricula. The critical instance approach favours fewer, not more, cases.

This research study is conducted primarily through dialogue with participants, and relies on their experiences, perceptions and views in the context of their professional practice. Case study provides a research strategy for exploring key areas of interest, in a defined context. Merriam & Tisdell (2016) advocated the use of case study to seek meaning and understanding of an issue, suggesting a distinct advantage over other research strategies for exploring phenomena that are embedded in everyday contexts (Yin, 2009). Its design aligns well with interpretive methodologies (Creswell, 2013; Merriam, 2009; Yin, 2009). Five participants (teaching staff) from a single Auckland secondary school were invited to respond to individual semi-structured interviews (of up to sixty minutes), eliciting experiences and perceptions on the adoption and integration of digital technologies. The interviews were recorded and later transcribed by transcription software. After the relevant data transcription was sent to each of the participants for verification, possible editing and approval, the researcher commenced with coding the data.

Data analysis

Seidel (1998) introduced a metaphor for the analytic process: he regarded data analysis as a symphony based on three elegant but simple notes—noticing, collecting, and thinking. Qualitative data analysis is the range of processes and procedures used to move from the

collection of qualitative data to its conversion into some form of explanation, understanding or interpretation of the people and situations being investigated (Denzin & Lincoln, 2000). The analytic challenge is thus to establish findings by reducing data, identifying categories and connections, and developing themes, so as to offer well-reasoned, reflective conclusions. Inspired by Seidel's symphonic metaphor, I see the process of analysis as iterative (repeating cycle), recursive (returning to previous point), and 'holographic' (understanding changes as the position and orientation of the viewing system changes and retains the same object of focus). Analysis is therefore an iterative process throughout the data collection, being frequently 'in conversation' with the data (Shank, 2002), to provide a transparent narrative of participants' voices. Miles and Huberman (1984) claim "words, especially organized into incidents or stories, have a concrete, vivid meaningful flavor" (p. 13). I made meaning of the data by valuing stories that narrate personal transformation within the context of the exemplar learning environments.

Thus, no pre-defined categories were used for qualitative data. An iterative coding approach was used for analysis:

(i) Beginning with identifying 'first-level' codes
(ii) Codes then grouped into 'pattern codes' identifying themes.
(iii) In a third moment codes are mapped (with data material) noting relations between them.
(iv) In a final step, networks of themes for the interview data corpora are compared to key findings from the literature.

Overview

Chapter Two introduces literature important for understanding recent developments in both pedagogical change and how digital technology is being introduced and assimilated into secondary school subject areas, as well as its development as a stand-alone subject area. It attempts to highlight the requirement for more than just infrastructure to make pedagogical change, as well as leadership issues related to such change. The literature chapter aims to address international literature on secondary school innovation, especially in relation to the use of digital technologies. This arises especially from the international body, the Organization for Economic Cooperation and Development (OECD). A range of OECD reports have impacted on the New Zealand government's understanding of education innovation. Hence, a further body of literature engages the MOE's own publications that clearly demonstrate influence from the OECD. Further literature, from academic research into education, both national and international, is engaged in order to bring critical depth to analysis.

Chapter Three develops the approaches to research methods undertaken in the thesis. The thesis develops understandings of participant experiences by centring on qualitative phenomenological hermeneutical research design. The methodological assumptions made and the progression to justify the use of the tools and methods selected is the initial focus. Issues of data collection and data analysis are included as well as the ethical considerations related to such research. The research methods centre around one case-study school. It is clearly recognised that a single school study limits the generalisation of research findings. However, this scope or scale of research is justified, initially in the context of a Master's project, and secondly, in that this research needs to be recognised as preliminary to a broader

study that will engage multiple schools. Much will be learnt from this limited study that will be applied to the larger project.

With Chapter Four, the results and findings of the research are presented. Having drawn the findings from the interviews, a thematic presentation has been presented based on the data analysis and coding process. The findings pertain primarily to the empirical component of the research: discoveries from the case-study school. The aim in this chapter is to have fidelity to the voices of the participants in the research, rather than engage in critical or interpretative analysis, which happens in the following chapter. Chapter Five establishes discussion around the findings from the research through interpretation in relation to the literature review, responding to the research question and sub-questions, which established themes and sub-themes within the findings. Discussion enables me to bring a critical engagement to significant issues emerging from respondents, issues that the MOE will need to address in terms of policy and funding levels for improved approaches to the adoption and integration of digital technologies. Chapter Six offers a brief summary of the thesis, its research questions, methods and outcomes. The chapter, thereby, offers insight into the reality of the findings, noting limitations to the study, arenas of contribution to the research field, and potentials for expanding the scope of research for future engagements.

Concluding comments

A research premise is that teachers' perspectives on the applicability of digital technology are perhaps fundamental for understanding digital technology integration. Hence, how teachers deal with implementation and challenges of integrating digital technologies into pedagogical initiatives may indicate the extent (or otherwise) of a gulf between the reality of this initiative and its framing within education documents, such as *The New Zealand Curriculum* (Ministry of Education, 2017g). Is the up-skilling of teachers in ICTs affective or ineffective? Do teachers want to integrate digital technologies into their subject areas, though perhaps feel unqualified and inexperienced to do so? Is the MOE planning carefully and prudently, providing sufficient time for professional development for digital technology? Do teachers feel equipped and empowered for digital technology integration into their pedagogies? In-depth discussion and defined outcomes for these concerns are vital for the success of education in the twenty-first century both in New Zealand and globally.

Chapter Two

Literature Review

Introduction

This chapter aims to provide a systematic overview of international and New Zealand-focused literature that informs my research into current frameworks within secondary education that support the integration of digital technologies into teaching curricula. This review of key literature also aims at a comparative analysis of overseas trends and national priorities in digital-technologies integration. Key literature globally emphasises the overwhelming influence of Information and Communication Technologies (ICTs) in contemporary educational practices at all levels of the education sector, and particularly emphasises, globally, the need for increasing ICT integration within education. In establishing a necessary contextual framework for this research's field of study, this review of literature places special emphasis on the role of the Organisation for Economic Cooperation and Development (OECD) in establishing global benchmarking for educational development at curriculum and facilities levels, along with the role of ICTs in mediating educational delivery. Further emphasis is given to New Zealand Ministry of Education (MOE) policy documents with respect to curriculum renovation, facilities design and the integration of ICTs in secondary education.

The chapter is developed in four sections. The initial one introduces the role of technology and technological change as drivers in educational delivery. The second places focus on the role of the OECD in pedagogical change. The third shifts focus to New Zealand contexts for pedagogical change. And the fourth addresses, specifically, the introduction of digital technologies in New Zealand school contexts. Hence, the review of literature develops an overview of international literature concerning emerging global trends in digital technologies in OECD countries, and the implications of these trends for pedagogy. The review then moves to New Zealand's place within this field, and implications that bear on the growth of technology training at secondary levels in New Zealand schools and concomitant expertise levels that flow into industry sectors.

1. Technological progress: Implications for change

Technological Transformation

Our contemporary world is continually undergoing change, whose driving force is dominated by ongoing processes of globalisation and technological innovation. The ways whereby we live, think and produce are influenced by the pervasive presence of ICTs. Our social is now one constructed by and subsisting in social-media platforms (OECD, 2019b). Hence ICTs refer to technologies that provide access to information through telecommunications, focussing primarily on communication technologies, including the Internet, wireless networks, cell phones, and ubiquitous global social-media platforms such as Google, Facebook and Twitter. The world has accelerated its digital transformations in recent years, and the rate of change and higher global levels of education contribute to its increasing complexity (O'Halloran, 2015). The OECD, which spans thirty-six member countries, from North and South America to Europe and the Asia-Pacific region as well as emerging countries like Mexico, Chile and Turkey, was established in 1960 to stimulate economic development, cooperation and world trade. Research undertaken by OECD countries aims to increase connectivity and education worldwide by examining the future of education in the context of major global trends (OECD, 2019a).

A Brave new world: Technology and education (2018c), an authoritative OECD report of information on the state of global education, notes that ICTs are geared, over the next decade, to replace the labour power of white collar employment, replicating industrial displacements of manual and blue-collar labour during the twentieth century. It is estimated that:

> Computers have the ability to complete literacy, numeracy and problem-solving tasks utilised today by many workers, particularly in Chile (over 50% of the workforce), Greece and the US. This is predicted to be the case across all OECD countries by 2026, with an impact ranging from nearly 50% of the workforce in Japan and Turkey and up to 70% in Chile, Ireland, Northern Ireland (UK) and the US. (p. 3)

These predictions do not necessarily account for the complexity of skills that white-collar employment entails, or the complexity by which these skills attributes are activated in novel problem-solving situations. The report states that rapid technological advances will impact

personal, social and professional development. Because of this, we should see expanding possibilities for teaching and learning with an increased demand for changes in knowledge and skills. The increasing sophistication of robots, artificial intelligence, big data and the Internet of things generate anxieties about the automation of existing jobs (OECD, 2018c). The growing demand for industrial robots worldwide, over the past decade, has seen the Asian region as the main driver of such a trend (OECD, 2018b). Scientific literature on technological development concurs that advances in artificial intelligence, computer-vision and robotic-movement capabilities will impact on the kinds of tasks to be carried out in the future by the majority of workers in currently existing occupations (Elliott, 2017). The OECD report also emphasises: "The increasing sophistication of robots, artificial intelligence, big data and the Internet … leads to uncertainty about the monotony of existing jobs" (2018b, p. 3).

Deming (2015) notes: "If skills demand was to continue at the rate current estimates imply, it would fall on workers to continuously adjust their skill set over their working lives" (p. 3). This highlights not only the importance of developing workers' adaptive capacity, leading to considerable complications in the workforce, but also the creation of sound education systems for continued learning. The escalation of digital technologies is creating new opportunities and solutions that enrich our lives while, at the same time, fuelling disruptive waves of change in every sector. Unprecedented innovation in science and technology, especially in biotechnology and artificial intelligence, raises fundamental questions about what it is to be human, and how to create new economic, social and institutional models that pursue better lives for all. Furthermore, data is being created, used and shared on a vast scale, holding out the promise of expansion, growth and improved efficiency while posing new problems of cyber-security and privacy protection. Social challenges, resulting from a growing global population, affect migration, urbanisation and increasing social and cultural diversity. These are now powerful forces in reshaping nation-states and their communities and are drivers for exponential change in the workforce, education and society as a whole (Nicolopoulou, et al, 2011).

Recognition of these powerful forces leads to concerns about the global directions of digital innovation, driven by science and technology, along with the rapidity of its effects on social inequity, social fragmentation and resource depletion. For the OECD, implications for education "underscore the importance of building students' adaptive capacity and developing robust systems for lifelong learning" (OECD, 2018b, p.5). How are curriculum innovations driving digital technologies in the twenty-first century? The OECD notes: "The demands on learners and thus education systems are evolving fast" (OECD, 2015a, p. 3). The implication of this is that schools have a responsibility to prepare students by instilling abilities to engage technologies within a world of rapid economic and social change. Education in ICT "has the potential to open doors and reshape the future of our global world" (OECD, 2018b, p. 6). It must evolve to achieve its mission of better access to learning and knowledge, in a complex and rapidly changing global world. With this in mind, what predominant change is being made in the education systems of OECD countries, to develop the knowledge, skills, attitudes and values that enable citizens to contribute-to and benefit from an inclusive and sustainable future? As Williams (2012) notes: "Educational philosophy is generally slow to change, but society is in a continual state of flux. Given that education is a product of social demands, social changes then represent a challenge to existing educational philosophies" (p. 19). The emergence of technology as a core component of the curriculum reflects social demands and

the changing technological nature of society. Technology education is the responsive philosophical change to this social phenomenon, but it represents a challenge to prevailing technical education philosophies.

In 2018, OECD launched a radical project. The far-reaching framework, *The future of education and skills: Education 2030*, was established as "a space in which to exchange ideas, compare proven and promising practices, discover cutting edge research and contribute to a new ecosystem of learning (OECD, 2018c, p. 1). This document also addresses the United Nations 2030 Global Goals for Sustainable Development (SDGs), aiming to ensure the sustainability of people, profit, planet and peace, through partnership (p. 1). By addressing the rapid advance of science and technology, which may "widen inequities, exacerbate social fragmentation and accelerate resource depletion," its intention is to act as a catalyst for "a global effort for education change" (p. 7). The underlying message emphasises the necessity for curriculum innovations to drive utilisation of new ICTs in order to meet these needs. For this purpose, policy makers, academic experts, school networks, teachers, education leaders, students and social partners from OECD countries, contributed to finalise the framework by the end of 2018. In 2019, exploration has commenced involving the translation of the framework into pedagogy, assessment and the design of an instructional system.

From this perspective, what predominant change is being made in the education systems of OECD countries, to develop the knowledge, skills, attitudes and values that enable citizens to contribute-to and benefit from an inclusive and sustainable future? "The class of 2030 and life-ready learning," is how the OECD couched its response, via a comprehensive document, *The Technology Imperative*, a summary report which drew on multiple sources, including surveys of 2,000 students and 2,000 teachers across Canada, Singapore, the United Kingdom and the United States. This report provides an in-depth review of 150 outcomes of research on how society can help prepare "the class of 2030" to thrive in work and in life. Interviews with 70 leaders, including educators, researchers, policy makers, and technologists contributed to the research, which aligns with other international literature, indicating the increasingly critical, though complementary, role of technology in student learning. It also emphasizes the crucial support of educators in the increasing requirement for deeper cognitive skills, the core skills used to think, read, learn, remember, reason, and pay attention, in priority areas, such as creativity and problem solving (Microsoft Education, 2018). The framework of the OECD's *The future of education and skills: Education 2030* (2018b) acknowledges the integration of present and future digital technologies. OECD member nations were asked to find answers to two far-reaching questions:

- What knowledge, skills, attitudes and values will today's students need to thrive and shape their world?
- How can instructional systems develop these knowledge, skills, attitudes and values effectively? (2018b, p. 2)

Five common challenges were identified in the framework, including curriculum overload, gaps between learning intent and outcome, quality and equity of content, effective planning and alignment of implementation, which all have a bearing on the implementation of future digital technology applications. In response to these challenges, working group members and partners have co-created design principles for changes in curricula and education systems, with particular relevance to different countries over time.

Recommendations for curriculum innovation include a focus on concept, content and topic design, divided into key areas, all of which incorporate digital technologies:

Student Agency	The curriculum should be designed around students' prior learning and needs.
Rigour	Topics should be challenging and support deep thinking and reflection.
Focus	A relatively small number of topics, which may overlap, should be introduced in each grade to ensure the depth and quality of students' learning.
Coherence	Topics should be sequenced logically, enabling progression from basic to more advanced concepts through stages and age levels.
Alignment	The curriculum should be well aligned with teaching and assessment practices. While the technologies to assess many of the desired outcomes do not yet exist, different assessment practices might be needed for different purposes. New assessment methods should be developed that value student outcomes and actions that cannot always be measured.
Transferability	Higher priority should be given to knowledge, skills, attitudes and values that can be learned in one context and transferred to others.
Choice	Students should be offered a diverse range of topic and project options in order to make well-informed choices. (OECD 2018b, pp. 6-7)

As well as recognition of the need for urgent action for the integration of digital technologies in all curriculum areas, *The future of education and skills: Education 2030* acknowledges the significant role of quality of learning in future outcomes. Technology alone does not enhance learning. Though, carefully integrating technologies into effective teaching practices opens new doors to learners and teachers. To this end, the framework emphasizes the importance of:

Process Design	Teachers should feel empowered to use their professional knowledge, skills and expertise to deliver the curriculum effectively.
Authenticity	Learners should be able to link their learning experiences to the real world and have a sense of purpose in their learning. This requires interdisciplinary and collaborative learning alongside mastery of discipline-based knowledge.
Inter-relation	Learners should be given opportunities to discover how a topic or concept can link and connect to other topics or concepts within and across disciplines, and with real life outside of school.
Flexibility	The concept of 'curriculum' should be developed from 'predetermined and static' to 'adaptable and dynamic'. Schools and teachers should be able to update and align the curriculum to reflect evolving societal requirements as well as individual learning needs.
Engagement	Teachers, students and other relevant stakeholders should be involved early in the development of the curriculum, to ensure their ownership for implementation. (p. 7)

Schools within OECD member nations are recognised as facing escalating demands to prepare students for increasing economic, environmental and social change, for jobs that have not yet been generated, for technologies that have not yet been created, and to solve social problems that have not yet been predicted (OECD, 2018b). The radical OECD project, *The future of education and skills: Education 2030*, seeks to address curriculum innovation

to meet these issues, partly on the demographic basis of children who enter school in 2018 and who will be young adults in 2030. Radical change is imminent.

Pedagogical drivers

Barlex (2012) emphasises the role of curriculum development in meeting expectations driven by technological changes: "The rapid pace of technological developments in the world outside school inevitably challenges the teaching of technology in schools to reflect these changes. Through curriculum development that such challenge is addressed" (Barlex, 2012, p. 226). The multitude of approaches and philosophies in consideration of the technology curriculum often results in confusion in learning and application. This points to the paramount importance of teachers needing to up-skill rapidly and become mentors to both students and colleagues in the use of technologies. Okojie (2011) advises that they also need to be able to track technological changes and evaluate those changes to determine the most effective use of technologies in their classrooms. With the desirability for New Zealand to be technologically competitive with other OECD countries, how do teachers reorganise common teaching practices and re-evaluate their roles in the classroom?

According to Loveland (2012), teachers can enhance their digitally aware students' learning opportunities "by facilitating interaction with technology and each other in innovative ways. This may include use of online discussion forums, virtual group projects and multimedia" (p. 119). However, the implication of the context where fifty-nine percent of teachers within OECD member nations report either moderate or high-level needs for professional development in ICT-implementation in teaching, calls for major changes to teaching practice in the learning environment (OECD, 2015a). This reinforces the need for a radical new approach to learning and the teaching of subjects. Blended pedagogies, bringing together online and offline instruction, for example the 'flipped classroom', are increasingly used (OECD, 2018b). Interesting developments in gamification are also emerging. Constructivism is a means for students to learn actively constructing knowledge, with teachers acting as facilitators in the learning process (Shelly, Gunter, and Gunter, 2010; Strangman and Hall, 2003). Central strategies in constructivism include "guided discovery learning, use of collaborative learning models, authentic settings for learning, learner reflection and learner ownership of learning activities; processes enhanced by student access to digital technologies" (Loveland, 2012, p. 120). The key is finding the right interplay of the different elements that influence student learning, including the learning goals, specific technologies available, students' prior knowledge and learning needs, teacher's professional competence and the context in which teaching and learning develop (Paniagua and Instance, 2018). However, the actual use that teachers make of technology and their ability to integrate it into their teaching, to further their learning goals, is what counts (Comi, et al., 2016). Levels of confidence in teachers' and students' digital skills capacities in using ICTs are crucial. Competence and confidence in technologies require time for day-to-day trial-error practices as no-one becomes expert in the application of digital tools overnight (Harris, Mishra and Koehler, 2009). Teachers need to be equipped with sound pedagogical understanding and technology know-how, in order to support more personalised and engaged learning in ICTs. However, professional development needs to target an overall school culture, rather than piece-meal and limited interventions. This helps to foster an expectation of teachers to understand that up-skilling is an ongoing process, allowing provision for professional practice, collaboration, and acknowledgement of what works and doesn't work. According to Davies and West (2014), effective strategies for OECD countries should include:

1) teacher training programmes focusing on skills development
2) increased teacher collaboration
3) peer mentoring (p. 11)

However, to what degree do teachers have the inclination to up-skill or become familiarised with current technologies incorporated in their subject area? How can teachers develop digital resilience—technical, emotional, and critical-thinking skills—for themselves and their students, while concurrently managing the risks? There needs to be convergence of pedagogical strategies, technological practices and knowledge content, in order to address the particularities of students and learning contexts (Harris, Mishra, and Koehler, 2009). In other words, teachers need flexibility and capability to be effective educators in the digital classroom, aligning with the OECD's framework in *The future of education and skills: Education 2030*. Effectiveness of ICTs in the classroom depends, essentially, on implementation and not simply potential or capacity. The actual use that teachers make of technologies and their abilities at integrating them into effective learning—to further learning goals—is paramount (OECD, 2017). Having access to them is not, in itself, sufficient. In addition, as the pace of technological development accelerates, educators need to inculcate skills for the future by developing higher-order thinking and social and emotional skills that a digitalised and automated world requires (OECD, 2018c). International literature suggests that, increasingly, technology-rich classroom environments are leading to inevitable and radical changes in the ways that students learn and the ways that teachers engage their students in learning OECD, 2018c). Technology applications at times mirror, and sometimes magnify, the risks we face in comprehending and living in our world. These applications enable us equally to recognise opportunities before us. Building resilience to the former and grasping the benefits of the latter are among the fundamental challenges education faces today (OECD, 2017).

Finally, and importantly, the disposition of teachers to technology is crucial. The perception that ICTs will be of any benefit, during the course of instruction, is intimately linked to their adoption and use (Ertmer and Ottenbreit-Leftwich, 2010). That being said, "Flexible delivery modes utilizing ICT may increase academic workloads, particularly in the development phase" (Samarawickrema and Stacey 2007, p. 33). This increased workload becomes problematic for already time-poor teachers who feel reticent or pressured to adopt and integrate digital technologies into their learning environment.

2. Digital technologies in OECD countries: Pedagogies and approaches

Digital technology: Principles

In response to the ubiquitous nature of ICTs in economic and social life, processes are now in place across OECD countries to promote ICT innovation in schools. Restructuring of many of the standard characteristics of education is a result of ongoing research and recommendations. For example, Samarawickrema and Stacey (2007) report that where students were expected to take a good deal of responsibility for their own learning, the mere presence of ICTs produced strong motivation and meta-cognitive skills: "The improved quality of presentation with digital technologies, the ability to find new material, and the

possibility of self-paced work seemed to contribute to increased motivation and self-esteem for weaker learners" (2007, p. 24). The adaptability of ICTs instigated worthwhile learning experiences for students at different levels, which suggested they could be especially valuable for differentiated learning experiences, and for students of different levels. This has significance for differentiated learning in mixed-ability classrooms. ICTs are now present in more and more classrooms across OECD countries in an increasing variety of forms. However, less than forty percent of OECD teachers report using any form of digital technology for students' projects or class work. This is less than twenty percent in Finland and ten percent in Japan, both PISA (Programme for International Student Assessment) high-performing countries (OECD, 2017).

From OECD findings, it is suggested that the most technologically 'successful' countries are those in which educational policies foster the development of children's digital skills and provide training in ICTs for teachers, as well as supporting the integration of technologies into school curricula (Venezky & Mulkeen, 2002, p. 12). For example, since 2009, both the Republic of Korea and Singapore have initiated educational policies involving massive investments in the so-called "Smart Education Initiative" (OECD, 2015a). Furthermore, "In thirty percent of all OECD countries, primary teachers have received targeted training in software education and those certified to teach technology received further training by the end of 2018" (OECD, 2017, p. 3). Outcomes, in Scandinavia, of such new directions or approaches to ICTs has meant that students in Denmark can use the Internet while taking particular school examinations, while in Norway, all students have to take a national digital skills evaluation test (UNESCO, 2017).

Other countries have adapted educational policies that go beyond teaching children basic technical skills by providing them with "twenty-first century skills" driven by digital fluency and competence. For example, coding is now part of children's compulsory education in the United Kingdom as well as in New Zealand. This involves equipping students with problem-solving skills or computational thinking, which involves breaking larger tasks into logical sequences of smaller steps, diagnosing errors and coming up with new approaches when necessary. It provides students with the ability to develop their own websites, apps and computer software. Yet, "such fundamental change to the curriculum provides challenges for teachers who may, themselves, be new to programming" (Dredge, 2014, p. 1).

Emerging trends

OECD countries also benefit from an emerging trend of open educational resources (OER), where more and more digital learning resources are available on the Internet, openly and without cost. Researchers, Istance and Kools (2013) note that OER activities are spread much more widely across all educational sectors, with primary, lower secondary and upper secondary education becoming as involved as the tertiary sector (p. 46). They suggest that more and more institutions, as well as individuals, are sharing digital learning resources over the Internet as OERs. These free and openly-licensed educational materials, developed for teaching, learning and research, have an ethical inference that the world's knowledge is a public good and that technology in general, and the Web in particular, provide extraordinary opportunities for everyone to share, use, and reuse knowledge. Redesigning learning environments is a way for digital-technologies innovations to promote twenty-first century pedagogy. In addition, more recent OECD analyses of educational patents shows that there

has been a clear rise over the past twenty years in the production of innovative educational technologies by businesses, typically building on advances in ICT (Foray and Raffo, 2012).

However, in spite of emerging trends in greater investment and availability of technology resources in OECD member nations' schools, strong limitations are apparent in their teaching and learning. Schools find effective integration of these advances into the teaching and learning process challenging. The OECD's Programme for International Student Assessment (PISA) reported on an initial assessment of digital skills findings, leading to the conclusion that schools have not yet addressed sufficiently the potentials of technologies for the classroom, for the empowerment of students. Overall evidence shows little, if any, effects from an increase in access to equipment and educational software in schools (Escueta, Quan, Nickow and Oreopoulos, 2017). I have already mentioned the limited uptake in, for example, Japan and Finland. Correspondingly, there has been no noticeable improvement in students' performance in PISA results for reading, mathematics or science. Perhaps this is due to "the pedagogy of technology application rather than technology itself that makes a difference" (OECD, 2017). Critical to the integration of technology, even in well-resourced learning environments, is teacher knowledge, competence and beliefs. However, PISA reports that only fifty-nine percent of teachers report either a moderate or high-level need for professional development in using ICTs for teaching (OECD, 2017. This suggests the need for better future-orientated and adaptable approaches with significantly more complex thinking involving knowing, doing, and being, as well as a reconsideration of ideas concerning resources, organisation, and support for our learning systems.

Istance and Kools (2013) focus on another issue. They claim that much of the work on technology in OECD learning environments has too strong a focus on micro-level learning experiences by small groups or individuals, without paying attention to what they term "a more holistic" understanding, concerning the efficacy of the immediate technology-enhanced learning activities, to fit into learning environments: "The result tends to be the presentation of fragments of teaching and learning possibilities that technology can contribute to without locating that in more convincing wholes that include going well beyond the innovative episodes" (p. 47). They contend that, rather than learning institutions simply adapting more adequately to available digital technologies, ICTs should be fully exploited in well-designed learning environments. They propose a more holistic focus on learning environments with a view to analysing ways in which "digital technology can be integrated into education as a design framework" (p. 53). New Zealand could well follow their lead.

If learning environments in OECD countries are to keep pace with technological advancements, the search for impacts on teaching and learning must be pursued continually with the same diversity and breadth. Biesta (2013) suggests that education always involves a risk, which is there because students should not be seen as objects to be moulded and disciplined, but rather as subjects of action and responsibility. He maintains that if we take the risk out of education, there is a real chance that we take out education entirely. As classrooms become increasingly technology-rich, there is necessity for radical transformations in the nexus of learning and teaching. These are fundamental challenges to the technological pedagogies and approaches in OECD countries today, which will be explored in greater detail in the following section, discussing New Zealand contexts. The New Zealand Ministry of Education has taken note of the PISA findings and has moved to revise the positioning of digital technologies in the New Zealand curriculum. By the start of the 2020 school year,

New Zealand schools will be expected to have completed integration of revised learning areas into their curriculum (Ministry of Education, 2017b). This is further discussed below.

3. Digital technologies in New Zealand schools: Pedagogies and approaches

Digital technologies implications: New Zealand

From the international literature cited above, it is apparent that the speed of advanced technology adoption is overwhelming education, both globally and in New Zealand. According to Loveland (2012):

> One of the skills employers are looking for in their future employees is the ability to problem solve technological problems without direct supervision. In addition, the ability to think critically is expected in the work world. (p. 126)

An entirely new world is literally being opened rapidly for today's students in all education sectors. In some cases, this has dramatically changed the way education is provided and received. For some time, there has been awareness of the role of ICTs in education, for New Zealand schools. Hekia Parata, New Zealand National Education Minister in 2011, labelled it as:

> One of the fastest growing sectors in New Zealand, with a demand for skilled graduates. The increased awareness (of the necessity to integrate digital technology into the school curriculum areas) will support young people to develop skills, confidence and interest in digital technologies and lead them to opportunities across the diverse and growing IT sector. (Barback, 2016, p. 1).

New Zealand's Tertiary Education Commission (TEC) has been heavily influenced by the Education Policy Outlook series, an analytical observatory which monitors the evolution of policy priorities and policy developments from early childhood education to adult education, mainly among OECD education systems, to provide a comparative understanding of how policies are evolving, and how they can be best implemented or improved over time. These reports build on the OECD's knowledge-base, developed from substantial member-nation comparisons, along with sectorial policy comparisons. The series presents biannual comparative analyses of education policies and reforms across all OECD countries. TEC has developed a comparative outlook on education policy in a two-stage process. TEC provides an analysis of individual countries' educational context, challenges and policies (education policy profiles) as well as analysis of international trends. It also develops comparative insight on policies and reforms on selected topics (Pont, 2013). Designed for policy makers, analysts and practitioners who seek information and analysis of education policy, taking into account the importance of national contexts, the country policy profiles offer constructive analysis of education policy in a comparative format. Each profile reviews the current context and situation of a country's education system, and examines its challenges and policy responses, according to six policy levers that support improvement. Improvement is itself defined through five reference points:

(1) equity and quality
(2) preparing students for the future
(3) raising quality through school improvement
(4) evaluation and assessment
(5) organisation for delivering education policy in terms of governance and funding (OECD, 2013).

Curriculum development

Since 2014, New Zealand government initiatives, via the Ministry of Education (MOE) have enhanced the use of digital technologies in schools. This includes the 2017 implementation of a new curriculum initiative in digital technologies, which aims to work across all subject areas. The intention of these initiatives is to reformulate the siloes of individual subject areas, developing a holistic approach to education. Digitization, as ICT innovation, is seen as a means, across discipline areas, to enhance the potentials for such holistic integration. In an attempt to future-proof the national education system, to position New Zealand as a global leader in education and to ensure students are equipped to succeed in a digital world, the MOE developed a broader and deeper approach to the curriculum with the document *Enabling e-learning: Ministry initiatives*, that centres on the integration of digital technologies within learning environments (2017f). This is a result of close Ministry consultation with a range of key agents, including leaders in the education sector and digital technologies industries. The Ministry also considered international experience and New Zealand-based research, working further with the education sector, the wider community and economic-interests, to refine the content. As part of this refinement, the MOE is developing new content at Curriculum Levels 1 to 5, and revising content at Curriculum Levels 6 to 8, in Digital Technologies/Hangarau Matihiko (Ministry of Education, 2017c). The MOE is also reviewing Digital Technologies NCEA achievement standards and assessment resources. Alongside these will be a suite of resources for teachers/kaiako, schools/kura and Communities of Learning/Kāhui Ako, to support them to deliver rich, relevant digital technologies learning experiences.

The current digital technologies matrix of standards has been compared with the draft Digital Technologies/Hangarau Matihiko curriculum progressions, and a draft reviewed Level 1 matrix and achievement standards has been developed using draft 'outcome statements' at Years 10 and 13. These outcome statements identify what students ought to have learned by the end of compulsory learning in Digital Technologies/Hangarau Matihiko through to Year 10, and elective learning through to Year 13 (MacManus, 2017). The New Achievement Standards in 2017, mandatory in 2020, include five strands of Digital Technologies, namely: Digital Information, Digital Infrastructure, Digital Media, Electronics, and Programming and Computer Science. The frameworks for their implementation comprise:

1. The five areas of Digital Technologies (as above) are recognised as five distinct and complete disciplines in their own right.
2. Each of these disciplines will have rigorous, sound, relevant, and academically challenging assessments that prepare students for further study and careers in their respective areas.
3. Each of these disciplines will have separate scholarship opportunities for the students.
4. Each of these disciplines will have sufficient associated Achievement Standards (A/S) so that enough standards are available at level 1, 2 and 3 to run an entire course in any of the five disciplines.
5. Each of these disciplines will be approved subjects for University Entrance. A course can be constructed using standards across any of the disciplines. (NZACDITT, 2012, paragraph 7).

This model is already operational in curriculum areas such as Classical Studies, Geography, History, Accounting, Business Studies and Economics in the Social Sciences; Painting, Printmaking, Photography, Sculpture and Design in the Visual Arts; Calculus and Statistics in the Mathematical Sciences; and Chinese, Latin, French, German, Japanese, Samoan and both Te Reo Māori and Te Reo Rangatira in the Language Arts; and Physics, Chemistry, and Biology in the Sciences, where each is recognised as a complete and valid discipline. (Te Kete Ipurangi, 2018). The five technological strands in the revised technology-learning document are expected to straddle all curriculum areas, also mandatory in 2020. These include:

- Designing and developing materials outcomes
- Designing and developed processed outcomes
- Design and visual communication
- Computational thinking for digital technologies
- Designing and developing digital outcomes (NZACDITT, 2012, paragraph 6).

"The new content has been designed to be flexible, so it can respond to new developments and technologies as they emerge," stated Nikki Kaye, Minister of Education in 2017. (Ministry of Education, 2017f, p. 1). This aligns with international OECD literature, which states the importance of flexible instructional systems developing knowledge, skills, attitudes and values effectively (OECD, 2017). Furthermore, the new curriculum's intention is to prepare students "to be work ready for a world with digital skills that are increasingly valuable to the economy and wider society" (Ministry of Education, 2017f, p.1). This also supports a key intention of the OECD project, *The future of education and skills: Education 2030*, to ensure "the sustainability of people, profit, planet and peace, through partnership" (OECD, 2018c). The MOE acknowledges the importance of empowering students with an understanding of computer science principles that drive digital technologies and for students "to learn how to design their own digital solutions and become creators of, not just users of, digital technologies" (Hipkins, 2018). This concurs with international literature. *The future of education and skills: Education 2030* recognises authenticity in learning where:

> … students will need to apply their knowledge in unknown and evolving circumstances. For this, they will need a broad range of skills, including cognitive and meta-cognitive skills … and practical and physical skills, e.g., using new information and communication technology devices. (OECD, 2018c, p. 6)

The new curriculum emphasises the development of "digitally-capable thinkers, those who understand the computer science principles that underlie digital technologies" (Ministry of Education, 2017c, p. 82). In this, the MOE recognises the need for students to be equipped with the skills for working in environments of unprecedented change. These skills include securing communication teamwork and ethical awareness (Te Kete Ipurangi, 2018). These parallel recommendations that can be found in international literature, that emphasise transferability in digital technologies, where skills, attitudes and values are transferrable from one context to another. However, what seems striking is that, for the first time, in New Zealand schools: "Learning in digital technologies will link to learning across all Learning Areas which will lead to significant changes in the classroom" (Te Kete Ipurangi, 2018, p. 1). The expectation for digital technologies is that they "will be integrated with other learning areas of the curriculum—so students might learn about programming in the context of mathematics, science or art" (Ministry of Education, 2017a, p. 4). This research project investigates these assertions, by exploring the outcome of the proposed integration of digital

technologies, along with their alignment with OECD recommendations, across the curriculum in an Auckland secondary learning environment.

Integrated curriculum

Many questions are emerging about the nature of the integration of digital technologies in the curriculum. Loveland (2012) claims:

> While new trends toward engineering and mathematics (STEM) and integration have taken center stage in research and publication in the field of technology education, collaboration with other subject areas has been ongoing for some time. Technology is a natural place to apply language arts, science, mathematics, arts, and even foreign language content around an engaging technological project. (p. 129)

The need for a broader perspective on integrating digital technologies has heralded new frameworks for envisioning teacher knowledge. Different models of knowledge or proficiency underlie the "Technological, Pedagogical and Content Knowledge" frameworks and the "Structuring Features of Classroom Practice" framework (Ruthven, 2013). Technological, pedagogical, and content knowledge (TPCK) was initially suggested as the interconnection and intersection of content, pedagogy—teacher and student learning—and technology (Niess, 2011). Over time, the acronym of TPCK was reformatted to TPACK, a term which integrates technology, pedagogy, and content knowledge (Niess, 2011). This framework was presented to draw attention to the way in which new technological resources reshape pedagogical knowledge, content knowledge and pedagogical content knowledge. According to Niess (2011):

> TPACK is viewed as a dynamic framework describing the knowledge that teachers must rely on to design and implement curriculum and instruction while guiding their students' thinking and learning with digital technologies in various subjects. (p. 301)

TPACK directs attention to the integration or intersection of three disciplinary arenas: content, digital technology and teaching and learning. From the perspective of Angeli and Valaindes (2009), as cited in Niess (2013), as teachers teach with digital technologies, they draw upon knowledge of students' content-related difficulties, as well as the intricacies of the relevant context—what works and does not work in their classrooms—and how they believe they need to teach to facilitate students' learning. Research has indicated that teachers who improve their knowledge and skills with instructional technology, improve their teaching and collaboration with school colleagues (Knezek & Nilenhauser, 2011). Increased student learning can result from collaboration with other content-area teachers, in a situation where students are engaged by educational technologies in multiple classes that could be integrated through technology-based projects. This collaboration assists students in making connections between the multiple content areas they are exposed to each day in school.

Loveland (2012) lists interdisciplinary examples using digital technology, provided by the International Society for Technology (IST):

- having students design and develop a digital learning game
- creating and publishing an online gallery of technology projects that demonstrates an understanding of differing historical periods, cultures and countries
- identify a complex global issue, develop a systematic plan to address the issue, and communicate a sustainable solution using educational technologies

- Create media-rich presentations to class on the appropriate and ethical use of digital tools and resources. This last assignment could be a presentation showing manipulated images that lead to a critical thinking discussion about the ethical role of digital technologies in the current media age (p.130).

The result of integrating digital technologies across the curriculum shifts learning from teacher-centeredness to learning-centeredness. It enables students to utilise and understand technology in the technologically-infused world in which we live, by creating real-world situations in which students must use critical thinking and analytical skills.

Curriculum support: Government

To support implementation of the new curriculum initiatives, the government has made considerable investment in schools. Funding in excess of $700 million has been made available to finance digital infrastructure, that includes ultra-fast broadband and the development of a variety of resources (Ministry of Education, 2017e). The MOE asserts that its investment in ICT education is evident in New Zealand's strong performance in ICT-related subject areas. Participation and expenditure fall into "the top third in the benchmark of OECD countries" (OECD, 2017, p. 88). In fact, New Zealand falls below the OECD average in per-student investment. However, in relation to measures of national wealth, investment in education is high as a percentage of overall gross domestic product (GDP). It also remains one of the highest as a percentage in the OECD of total public expenditure. New Zealand teachers' statutory salaries start lower than the OECD average, but tend to increase more quickly than their OECD counterparts. There is concern with teacher-qualifications, with teachers being under-qualified, as many do not have a Master's qualification, a requirement in most OECD countries. On this basis, New Zealand teachers have higher salaries relative to their qualification-levels than do their OECD partners. New Zealand has the highest OECD rate (sixty-eight percent) of participation in formal or non-formal education. Another benchmark consideration is that the proportion of New Zealand students wanting to study overseas is much less than the number of students coming to study in New Zealand.

As a result of the new curriculum directives, all New Zealand teachers and schools have included digital technologies into their teaching programs from 2018. There are two new technological areas: firstly, *Computational thinking for digital technologies*, where students will understand the underlying principles of computer science. They will become creators of digital technology by learning core-programming concepts. Secondly, *Designing and developing digital outcomes*, engages students in fit-for-purpose digital solutions (Te Kete Ipurangi, 2018, p. 1). The Education Review Office (ERO) is responsible for assessment of implementation of the new curriculum content for digital technologies from 2020. The purpose of internal and external evaluations developed by the ERO is to progress education outcomes and to confirm that schools are accountable for application of the new learning areas in digital technologies, and to ensure that there are ongoing processes of evaluation and improvement. Schools are also expected to report on the achievements of their students, their priorities for improvement, and the actions they plan to take through an annual reporting process (Te Kete Ipurangi, 2018).

4. New Zealand industry views: Digital technologies and learning environments

Digital technologies: Industry and economy implication

NZ Tech, is a New Zealand not-for-profit organisation, with membership composed of representation from local technology-firms, multinationals, universities and banks, that work closely with the digital technology sector and government, to generate economic growth and provide recommendations for curriculum development within the education sector. Its role is also to stimulate an environment where technology provides important productivity and economic benefits for New Zealand. CEO, Graeme Muller, cites the importance of technology in New Zealand industry as "the fastest growing segment of our economy generating eight percent of our GDP and nine percent of our exports" (Strang, 2017, p. 1). Muller notes: "In just over a decade, our contributions to GDP growth have been higher than any other OECD country" (cited in Parr, Kubiak, Pambudi and Reilly, 2016, p. 8). General manager, James Scollay, of MYOB NZ, a leading provider of business management solutions in New Zealand and Australia, sees New Zealand's future prosperity as linked to digital technology's pedagogy. He holds that the real importance of the education curriculum should lie in its ability to teach young people how to think creatively and function effectively in the digital world (Education Central, 2016). This points to the need for a strong focus on curriculum approaches to digital technologies in an increasingly digital world, where demand for skills significantly outstrips supply. Undoubtedly, the speed at which New Zealand industries are adopting digital technologies implies that demand for advanced digital skills is growing. NZ Tech argues that a shortage of skills has the potential to slow economic growth, as industry delays investment in new efficiency-boosting technologies. Maintaining a supply of high quality digital skills within an economy could "effectively act as a catalyst to continued growth and improved social prosperity" (New Zealand Digital Skills Forum, 2018, p. 9). As a result of this, the ICT industry faces significant challenges recruiting people with the right skills to drive digital innovation and strengthen New Zealand's potential for economic growth (Ministry of Education, 2017c).

More students need to leave school having attained valuable digital skills to keep abreast of the changing times. For this reason, the MOE has reorganised the *Technical Learning Area* to incorporate "Digital Technologies" into the curriculum. As stated in *Digital technologies/ Hangarau matihiko* (2017c), the curriculum content in the existing technological areas is built around:

- Designing and developing materials outcomes
- Designing and developing processed outcomes
- Design and visual communication (Ministry of Education, 2017c, paragraph 4).

The eight levels within these areas are split into three Achievement Objectives: Technological Practice, Technological Knowledge, and Nature of Technology, all with individual outcomes:

> Technical Practice: Planning for practice, Brief development, and Outcome development and evaluation.
>
> Technical Knowledge: Technological modelling, Technological products, and Technological systems.
>
> Nature of Technology: characteristics of technology, and Characteristics of technical outcomes. (Ministry of Education, 2017c, paragraph 6).

Digital skills: Industry recommendations

Significant international research indicates that university-industry collaboration (UIC) is a powerful source of innovation. For example, *The world bank annual report* (2013) found that UIC is critical for skills development, generation, adoption of knowledge, and promoting entrepreneurship. Similarly, Nielsen (2017) found that UIC is a critical for the development of knowledge economies and societies.

However, according to the OECD's latest "Skills Strategy for New Zealand," reference is specifically to digitisation (Maclennan, 2019):

> The country has important imbalances between the skills of workers and the skills needs of the labour market. As digitalisation has been increasing the demand for high- skilled workers, employment is gradually shifting towards high-skilled occupations.
>
> New Zealand is also among the bottom 20-40% in regards to the alignment of skills with the labour market, and the use of skills at work is not improving much over time.
>
> New Zealand could benefit from a renewal of its strategic vision for the future to ensure that all of its people have the skills to respond to the challenges and opportunities of a complex and rapidly changing world. A whole-of government approach and effective stakeholder engagement will be essential for achieving this aim. (paragraphs 1-3)

During August and September 2017, the Digital Skills Forum, a coalition of industry and government organisations working together to identify key issues across ICTs, surveyed the digital technology sector to find evidence for and insights on skills needed for digital technology application. In part, the intention of the Digital Skills Forum included forecasting skills in demand in the short-to-medium term, to better inform education. The New Zealand Digital Skills Survey was targeted at the most senior person in 142 digital technologies organisations and details were sought, relevant to an organisation's current employee base and its planned or future needs. The survey was complemented with data from the Government IT and Digital Skills survey and analysis of LinkedIn data of 90,000 New Zealand IT workers and surrounding recruitment trends. For the organisations that responded, sixty-eight percent of employees worked in advanced digital skills roles, with the main skills group being software developers. Future forecast requirements suggested an additional 3,248 digitally skilled employees within the next two years (New Zealand Digital Skills Forum, 2018). There was a perceived lack of investment in reskilling and upskilling current staff, and a requirement for more investment focus on developing a strong domestic pipeline of highly skilled capacity (New Zealand Digital Skills Forum, 2018).

The review revealed a significant skills shortage in the New Zealand digital technologies workforce, which most recognised as a national issue. The findings provided valuable insight and suggestions for educational focus within New Zealand. According to industry seniors, there is a necessity for more emphasis on developing sound skills in digital technologies in our education system and a need for better alignment of tertiary education with future demands of the sector (New Zealand Digital Skills Forum, 2018). The study highlighted the insufficient number of tertiary students studying computer science or information technology for industry, and the difficulty of graduates transitioning into roles following graduation. The

review suggested that further attention should be given to growing the number of students, as well as supporting placement of tertiary graduates, including internships.

There was overwhelming agreement on the importance of improving pathways into technology roles, with the option of including methods for upskilling or reskilling, for high demand areas, nationally (New Zealand Digital Skills Forum, 2018). After reviewing the study of industry perspectives, in 2018, members of the Digital Skills Forum, NZ Tech, NZ Rise and IT Professionals NZ committed to continue collaboration with the government to address the digital skills shortage, with recommendations for digital technologies pedagogical initiatives, including exposing every New Zealand child to digital technologies, and ensuring their understanding of the importance of digital skills from an early age (New Zealand Digital Skills Forum, 2018). These recommendations align with the intentions of TEC policy, which aims to address skills shortages in areas like information and communications technology, which are considered as skills needed for innovation and economic growth (New Zealand Digital Skills Forum, 2018.)

Government and industry collaboration

In light of industry concerns and recommendations about digital technologies in the learning environment, the question needs to be asked concerning what actions are taking place in New Zealand to address these. Government, whether National or Labour, is well aware of industry concerns and the significant challenges in recruiting people with the right skills, crucial for driving digital innovation and strengthening New Zealand's potential for economic growth.

> Accessing digital skills has become an equity issue and New Zealand must act to keep pace. While some positive change is underway, vision and scale is lacking. True transformational change is required in what and how we teach our kids about technology. The pace of this change must also be significantly accelerated. (NZ Tech, et al., 2017, p. 17)

Appropriate transformational change is required, in what and how we teach students about technology. Government needs to embrace the urgent need for such change, through the introduction and integration of "Digital Technologies" throughout the education system, and invest in the necessary resources and tools to achieve this goal by 2020.

In an initiative to close the gap between need and demand in digital technologies industries, the government's Business Growth Agenda for 2016-2019 nominated three ICT Graduate Schools as pilot initiatives in Auckland and Wellington, and one in New Zealand's South Island. This was after a stringent selection process. These schools were created with the objective of closing the gap between the ICT industry and educational providers, with an aim to involve employers in the design and delivery of programmes of study, in order to equip graduates with high-level skills and knowledge required by ICT industries (The New Zealand Government, 2017). This is recognised as an investment in those responsible for driving future innovation as the objectives are to produce graduates with work-relevant and business-focussed skills, provide more direct pathways from education into employment, and help grow New Zealand's ICT capacity. The programme funds education, research and collaboration in the chosen ICT Graduate Schools, each of which is linked to local industry innovation precincts or technology hubs. The programme also involves the development of more broadly applicable ICT education initiatives that can be delivered through affiliated education providers throughout New Zealand (The New Zealand Government, 2017).

Coincident with this, collaboration between the University of Auckland and the University of Waikato was also developed, to meet the increasing demand for industry-ready ICT graduates. This collaboration aims to fulfil the demand of the growing ICT sector with two postgraduate programmes, developing industry-ready ICT graduates. The Master of Information Technology (MinfoTech), and the Post Graduate Certificate in Information Technology (PGCertInfoTech) aim to produce graduates with the ideal combination of technology skills, critical thinking and business understanding, to drive innovation in New Zealand (Tertiary Education Commission, 2017). At the same time, ICT students are encouraged to have close contact with business mentors and advisers to develop a better understanding of the use of technology within industry, facilitating future innovation. Students are also given opportunities to deliver industry talks and engage with industry advisory groups. They are offered placements for internships, and a chance to mentor and recruit the next generation of ICT professionals (Auckland ICT Graduate School, 2019). Along with connections between the universities, a strong partnership between New Zealand's tertiary and business sectors is being developed, as a result of long-established links with some of New Zealand's largest and most well-established companies. These companies are from multiple sectors, though have in common the need for input from the next generation of rising ICT professionals (Auckland ICT Graduate School, 2019).

While government collaboration with industry leaders and the wider economy has led to the design of the revised New Zealand curriculum for digital technologies, and further educational initiatives, both government and industry have ongoing roles to play. NZ Tech's *New Zealand's digital future: 2017 manifesto* (NZ Tech, et al., 2017) advised the government to continue to acknowledge the pressing need to increase the number of students leaving secondary school with appropriate digital technologies skills, in order to facilitate innovation and support emerging industry infrastructures. It stressed the importance of the MOE to continue to embrace the urgent need for transformational change through the introduction and integration of "Digital Technologies" throughout the education system It also needs to provide investment in the necessary resources and tools to achieve this goal by 2020. This includes giving "Digital Technologies" significant focus, profile and role as a core and central component of the New Zealand Curriculum, and on every child's education pathway. As well as investing in more teaching resources, professional development and support needs to be given for the teaching of "Digital Technologies" in schools. The MOE needs to ensure that every school not only teaches, but also reports on the "Digital Technologies" curriculum up to Year 10, and all schools provides "Digital Technologies" at years 11-13 (NZ Tech, et al., 2017).

Digital skills: Into the future

Amalgamation between education and industry should continue to have positive implications for industry. NZ Tech has also partnered with government on multiple initiatives in the past year (2018-2019), including supporting the introduction of the Digital Technology Curriculum in schools. Muller (CEO of NZ Tech) holds that digital technology in New Zealand industry was very fragmented eight years ago However, he is positive about the new initiatives in digital technologies education, and sees them having potential for far reaching impacts on New Zealand's prosperity (NZ Tech et al, 2017). As national and international literature has emphasised, the key catalyst for success within the technology sector is a sustainable supply of skilled labour. In this light, New Zealand must continue to improve its education system and to further develop important skills in digital technologies. To achieve

this, there must be ongoing (and increased) investment in the support of secondary school and tertiary educators, in the transition to twenty-first century teaching models (OECD, 2018c).

Responsibility for preparing students from an early age for a technology-focussed future should be addressed through "the early introduction of computational thinking and digital technologies" (NZ Tech, et al., 2017, p. 7). At the same time, the gap between education and digital industries must continue to be bridged, to improve the development of work-ready graduates (New Zealand Technology Industry Association, 2016). A main focus of this review of salient literature is recognition of the increasing development and integration of ICT data into curriculum strategy within educational structures broadly in OECD countries, and locally in the New Zealand context. Classrooms have become increasingly technology-rich environments. This necessitates a transformation in the way teachers teach and the way students learn. This transformation cannot be an easy transition for classroom teachers trained primarily in pre-digital education environments. In order for positive curriculum advances, much development needs to be achieved before radical change happens. Intensive work needs to be done in upskilling and changing the way teachers operate and students learn in the digital technologies learning environments. The empirical research I have undertaken in an Auckland secondary school aims to correlate these key literature positions. Do teachers in schools need significant professional training and up-skilling in digital competencies? Are schools successfully integrating digital technologies, or keeping them in siloed learning areas? The next chapter will outline the methodology and research design that is employed in this study, addressing literature review methods, and the empirical study.

Chapter Three

Methodology

Introduction

This study is guided by the following research question: *Do current education frameworks support the integration of digital technology pedagogies in the secondary school system?* The primary aim of this research is to provide critical perspectives on the phenomenon of the integration of technology into pedagogical content, through investigation and analysis of experiences of teachers and a school leader. This chapter details the methodological approaches I have developed to gain an understanding of the experiences and approaches of educators in a New Zealand secondary school. The research methods take into consideration interpretative approaches to the coalescing and analysis of key literature, along with empirical approaches to the development of data from participant interviews, the analysis of that data and the producing of findings. The overall approach is qualitative phenomenological in its methods, which necessitates engagement with data, and its interpretation, supported by a proven research approach.

The research design aimed at focusing on participants who could offer perspectives and insight into current digital technologies pedagogy. Thus, my research design included examination of an applicable learning environment as a case study, with in-depth interviews.

Engagement with an underlying phenomenological paradigm ensured a means to gain understanding and provide sensitive engagement with the real-life experiences of participants. A qualitative phenomenological approach was also adopted for analysis of key literature, and developing findings from that literature survey. This implied a hermeneutical approach to engaging literature, a circular iterative process of interpretation that initially accounts for the factuality of the literature surveyed. Secondly, there is analysis in the form of an understanding of that factuality, in light of the contexts and circumstances of this research project. Thirdly, there is return to that literature in light of the research contexts, to elucidate literature findings. This methodology chapter is in three broad sections. The first, "Qualitative Research," outlines and explains the reasons for the methodological approach and methods engaged in this research. The second section, "Research Design," discusses the design of the empirical case study, undertaken to elicit new data and findings with respect to the research question. The third section, "Data Analysis," provides clarification as to how the research process moves from collecting participant responses to elucidating findings from those responses.

1. Qualitative research

Qualitative research methods

The preferred methodology for this study engages a qualitative research method (QRM). QRM involves close observation and analysis of non-numerical data. With this research, data is generated through interviews. This method affords recognition of the socio-cultural embeddedness of research, thereby acknowledging the nuanced nature of an already established environment into which the researcher enters (Myers, 2018). As Loveless and Williamson (2013) suggest:

> Education and technology are constituted by societal (economic, political and cultural) and technical components, and completed by the biological components of their embodied human users. That is, technology and education consist of a 'socio-technical' system. The term 'socio-technical' recognizes that technologies and society are mutually constitutive; technology influences social relations, while social relations influence the development and take-up of technologies. (p, 2)

As qualitative research is used to gain an understanding of underlying reasons, opinions, and motivations, as outlined by Loveless and Williamson, this process should be appropriate for gathering data. The rationale of alignment results from findings in the literature review, which uncovered issues relating to international and national pressures for the implementation of digital technologies in secondary education. The research also questioned teachers' understanding or resistance to the growing importance of the integration of digital technologies into their curriculum, while noting a lack of resources for up-skilling in this area. QRM is the preferred method to investigate teacher attitudes and the role of teacher professional development, as these are understood by the participants. This methodology will determine and better define nuances and tensions in relation to the study. It is crucial to hear and respond to teachers' opinions and experiences in the search for effective frameworks. With QRM, findings are not established by statistical methods or other means of quantification (Richie & Lewis, 2003), thereby preserving, in subtle ways, the lived relations of participants within data and, thus, within findings. Hence, this research proceeded on the basis of in-depth interviews with school and curriculum leadership in an Auckland secondary

school, culminating in data gathering, listening to participants, in order to establish empathetic relations (Bogdan and Biklen, 2003). This research design requires the presentation of data in a descriptive and narrative form, such that a research audience is able to understand, clearly, findings and explanations (Creswell, 2013).

Core features of qualitative research

Denzin and Lincoln (2000) cite qualitative research as "a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that makes the world visible" (p. 3). They see such practices as transforming the world through "a series of representations, including field notes, interviews, conversations, photographs, recordings and memos to the self" (p. 3). In other words, qualitative research leads to a holistic, interpretative approach to the world by encountering *situations* in their everyday settings. Thus, the research method involves *positionality*. This is to be understood in relation to how a questioner, a question, a respondent *and* the situation of that dialogue find their relationality. Hence, questions are dialogical—concerned with the eliciting of *something to know*— in their relation to, on the one hand, the production of knowledge and, on the other hand, the manner in which the knower comes to understand knowledge so gained. As defined by Rhoads, positionality is "the social position of the knower" where "the knower is not removed from the knowledge, but fundamentally a part of knowledge construction" (Rhoads, 2015, p. 10). In other words, in order to understand aspects of participants' daily lives, a researcher is able to enter their world. This is especially contingent on the researcher developing an empathetic alliance with participants.

Madison emphasizes the importance of forming a relationship between researcher and participants, through "a deep and abiding dialogue with the other" (Madison, 2005, p. 8). In this way, the researcher will be able to "speak of the writer's voice from the standpoint of researchers committed to the vocation of using all we can of our imperfect human capacities to experience and communicate something of others' lives" (Charmaz and Mitchell, 1997, p. 194). In order to create a platform for interviewees to consider and relate their experiences, in relation to the integration of digital technologies into their curriculum (or subject) areas, the generating of data comprised individual semi-structured interviews with each of the participants. A series of prompt-questions were formulated with consideration given to digital technology curriculum design, its teaching and student learning. With prompt-questions, eliciting discussion rather than closed response, the intention is to create a situation implying interviewees as co-researchers. As the phenomenology methods theorist, Max van Manen (2017), suggests: "The process of investigating the understanding of the pedagogical experience with interviewee can be a crucial step in the examination of meanings" (p. 27).

Limitations within this process can arise from perceived relationships of the interviewer and participants, which may impact on responses or dialogue relating to experiences relevant to discussion, such as personal pedagogical practices. Evidence suggests that teachers (among other professionals) are often reticent to relate experiences of their practice due to personal perspectives, deep-seated values and sentiments (Voogt et al, 2013). This necessitates inviting participants to articulate their specific narratives, deviating at times from a more established approach of asking participants to generalise about their overall practices (Brinkmann and Kvale, 2009; Langdridge, 2007). Qualitative research involves complex and insightful interpretation, ensuring all-inclusive dispositions and perspectives. With respect to my case-study research, I was cognisant of engaging practicing teachers who were unknown to me

through my ongoing involvement in secondary schools. I was also aware of the potential perception by participants of myself as a tertiary 'expert' in digital technology education. This awareness enabled me to allay possible anxiety on the part of respondents as to their potential sense of being 'judged' by the interviewer.

Phenomenology

Phenomenological research attempts to recognise the inevitability of 'bias' in interpretative research settings. It does this by ignoring preconceived, or fixed normative, expectations concerning human experiences, feelings and responses to a given situation. Developed at the turn of the twentieth century by Edmund Husserl, his intention was to provide an account of experience and the phenomenal world inextricably formed as human experience *of* those phenomena. Hermeneutic phenomenology seeks to *interpret* experiences phenomenologically adduced (Langdridge, 2007; Laverty, 2003). Its primary claim is that self-analysis constitutes *the* position out of which understanding is to be sought and analysed, implying three key issues: (i) All interpretations are informed by one's previous experiences, world-view and personal history; (ii) New insights and understandings lead to new considerations and the creation of meaning; which (iii) Further influences a person's beliefs (Ramberg and Gjesdal, 2009; Weinsheimer, 1985). Hermeneutic phenomenology, with its emphasis on the self as moment of analysis, is to be opposed to methodological procedures developed from the physical sciences, which pose an objectively knowable world, divorced from the interpretative perspectives of an existing human self. This research differs from the precepts of research methods based on, or derived from the physical sciences, including those tailored for the human sciences. Rather, the research is based on a critical phenomenological position. Participants reflect on and discuss their experiences in relation to the pedagogies of digital technologies, within the situatedness of their secondary school. Through processes of interaction and interpretation, researchers and interviewees are interconnected in the creation of discoveries and new knowledge.

2. Research design

Introduction

"Research Design" discusses the procedures required for this case study approach. Discussion unfolds in seven stages. Initially, discussion turns to the reasons for adopting a case study approach, surveying a single metropolitan secondary school, addressing how generalization of findings subtends from the limited scope implied by a single 'case'. As the research involved participants, it was mandatory to consider ethical implications and gain ethics approval from my academic institution. This is discussed in the second stage. The three following stages address field engagements, in the gaining of access to a school, consent from participants and interview protocols. The final two stages of discussion provide definition of the school and participants in detail.

Case study

Traditionally associated with qualitative research methods, Wilbur Schramm (1971) notes, concerning case-study approaches: "The essence of a case study, the central tendency among all types of case studies, is that it tries to illuminate a *decision* or set of decisions: why they were taken, how they were implemented, and with what result" (p. 43). Gerring (2007) notes:

"'Case' connotes a spatially delimited phenomenon (a unit) observed in a single point in time or over some period of time, while the notion of 'study' attempts to explain the behaviour of individuals" (p. 19). A case study approach defines a delimited field or context, thereby providing a research process that itself defines—for investigation—the most salient arenas wherein the researcher is *directly* involved in processes of data collection and analysis in a defined context. The intention of the researcher is to "understand how the actors, the people being studied, see things" (Stake, 1994, p. 236). The ultimate goal of a researcher is to maintain the views and perspectives of interviewees, by offering an insightful *interpretation* of their experiences.

Precision in formulating questions that are most significant for a topic requires much preparation. Yin (2009) notes the importance of a thorough literature survey in connection with determining respondent questions: "One way is to review the literature on the topic" (p. 9). A literature review is essential for developing perceptive and insightful questions about the topic, prior to defining the actual 'case' of the case study. The distinct advantage of case study design is that *it does not* focus on finding answers to questions such as "how much" or "how many," questions that implicate quantitative and objective measure more associated with methods derived from the physical sciences. Rather, "case study concerns situations where 'how' or 'why' questions are asked concerning the contemporaneity of events" (Yin, 2009, p. 9). The investigator has little or no control over the outcome of these questions, thus gaining valuable *insight* and perspective into interviewees' unique experiences. As previously outlines, my research aimed to examine frameworks that support the integration of digital pedagogies in the New Zealand secondary school system. As my research was at Master's level, its scale, scope and complexity was limited to expectations associated with the depth of findings associated with Master's research. This required locating a secondary school with which I had no prior involvement, either with individual staff or the school more generally. My role in tertiary digital technology education has resulted in engagement with a number of Auckland's secondary schools, in programmes that aim to transition students from secondary technology arenas into tertiary programmes. Hence my special interest in secondary education and concern with locating a case study school with whom I have had no previous involvement.

To this end, it was desirable to locate a school with a definite focus on developing a digital technological presence across its curricula. After discussion with colleagues and the establishment of a 'short list' of schools, the decision was made to undertake the research project in a government-funded, rather than private school. The reasons for this decision were many and complex, relating in part to exclusivity of education in some private school arenas, with skewed funding in comparison to government school budgets, through to issues of compliance with MOE curriculum directives, and incentives for schools in the government sector to embrace MOE aspirations for integrated and expanded adoption of digital technology education (Te Kete Ipurangi, n.d). I strategically aimed for a low-decile school, meaning one that was identified as serving low-income and disadvantaged communities. Funding that goes to low-decile schools has attached to it accountability by way of addressing positive pedagogical outcomes, in this case outcomes relating to integrated digital curricula. Participant selection within the chosen school was based on purposeful sampling, a technique widely used in qualitative research for the identification and selection of participants for the most effective use of limited resources (Patton, 2002a). With purposeful sampling, individuals are identified and selected if they are especially knowledgeable about or experienced in a

phenomenon of interest (Cresswell and Plano Clark, 2011). Bernard (2002) and Spradley (1979) see the importance of availability and willingness to participate, in addition to knowledge and experience, as well as the ability to outline experiences and thoughts in a reflective, articulate, and expressive way.

Ethics

The Auckland University of Technology Ethics Committee granted approval for my study in November 2018. Ethics is based on standards of right and wrong, advocating human behaviour. Miller, Birch, Mauthner and Jessop (2012) note: "Ethics approval processes scrutinise the familiar ethical principles of protection, informed consent, confidentiality and anonymity across the research design that in turn provide new ways to justify and judge the integrity and quality of social research" (p. 44). The complexity of encountering the life of research participants, and then placing that life with research reporting within the public domain, raises multiple ethical and social issues for the researcher. As the arena of qualitative research continues to change, with researchers facing new issues when producing new findings, the increasing significance of ethical frameworks is now emphasised with respect to the use of data for interpretive and analytical processes. Increased regulation can be seen, in part, as a response to the growth in new technologies, along with attempts to oversee the use of these technologies within social research (Miller, et al, 2012). In fact, the increasing use of digital technologies in participant research is a significant issue.

As a qualitative researcher, it is important to acknowledge the impossibility of complete transparency and impartiality at all times. However, it is imperative that my conduct towards participants is recognised as impartial and transparent as possible in the gathering and analysing of the views of the participants, as ethical issues arise when a study is based on accounts of the experiences and perspectives of others. Concerns with unwarranted participant identification, with deception and exploitation of participant data all relate to the protection of the participants. Informed consent was required. Anonymity of respondents and the school was maintained through nondisclosure of identifiable content, including interviewee identities and their place of work. Actual names and workplace were replaced with pseudonyms. However, it was recognised and made clear to participants that, given the nature of the research, and the kinds of responses elicited, it may be possible for those informed about digital technology curricula in Auckland secondary schools could 'second-guess' the school and therefore the participants who each coordinate an identified curriculum area. I had no prior communication with any of the school participants who volunteered to participate in the case study. In the recount of the interviewees' narratives, I have given special attention to maintaining research integrity, outlined in my ethics application, and in the research approach as described above. The ethics application, participant information sheet and consent form proformas are included in this thesis as an appendix.

Engaging the field

Having researched various schools, and through discussion with academic colleagues, it was decided one particular school would be appropriate for the purposes of this research. The chosen school satisfied the selection criteria, based on the school's interest to integrate technology into its pedagogical content. I made sure I had no prior knowledge of the school's systems, or previous interaction with the staff. After initial approach to the school, via its Principal and ensuing discussion as to the aims, scope and potential benefits of the research, there was unreserved agreement, in principle, from the Assistant Principal who was to be one

of the respondents. After sending him pertinent details, including the relevant curriculum areas for investigation, and after a period of deliberation, he followed up with nominated staff and their subject areas that included the four key areas I wanted to cover in terms of digital technology integration: History, Geography, Health, and Visual Communication. The Assistant Principal also agreed to be interviewed, in order to discuss the current position and future strategies for the integration of digital technologies within his school. For the scope of this Master's research, Sunnyvale High School was considered adequate in providing sufficient data to allow me to understand the processes undertaken by each interviewee in order to integrate Digital Technologies into their subject areas and across disciplines. Participant selection within the chosen school was, thus, purposive inasmuch as sampling using the purposive approach is a non-probability sample, selected on characteristics of a population (Miles, Huberman, & Saldana, 2014).

Access and consent

It was important for me to obtain a range of participants, each potentially having different objectives, career spans and experiences pertinent to my topic. The design of the study suggested five key participants, whom I considered would deliver competent data in order for me to deduce credible findings. These included:

One school leader
Criteria included: One Deputy Principal from the Leadership team

Four school teachers
Criteria included: Four Heads of Departments who were involved in integrating Digital Technologies into their curriculum areas.

It was necessary for the selected teachers to have several years of teaching experience, each in their different learning areas. Teaching experience was important. I was keen to interview teachers who were curriculum leaders prior to the development and implementation of the new Digital Technologies strategy. Importance was placed in this research on teacher experience of curriculum change, especially where that change presents challenges to the paradigm by which teachers have understood their role. I invited participants via an e-mail with a letter of introduction and description of the research project. They were given the opportunity to respond to the invitation and upon doing so, were sent a Participant Information Sheet (PIS) and Consent Form (see Appendix). A digital voice recorder was used to record the interviews, and this data was securely stored on the researcher's password-protected computer.

Interviews

Interviews are used extensively as a data collection process by qualitative researchers (Yin, 2009). Individual semi-structured (or prompt-based) interviews with teachers and the school leader were the primary data source in this research. Interviewee perspectives or viewpoints on issues are able to be confirmed or may in fact transform during the course of an interview (Yin, 2013). To facilitate this possibility, interviews were conducted as conversations, rather than in a form of fact-finding or 'inquisition' (Yin, 2009). Advantages of interview as a data collection tool in research include:

- *Insight:*
  The researcher is likely to gain valuable insight based on the depth of information gathered and the wisdom of "key informants."

- *Equipment:*
  Interviews require only simple equipment and build on conversation skills which researchers already have.

- *Information Priorities:*
  Interviews are a good method for producing data based on informant's priorities, opinions and ideas. Informants have the opportunity to expand their ideas, explain their views and identify what regard as their crucial factors.

- *Flexibility:*
  Interviews are more flexible as a method of data collection. During the process, adjustments to the line of inquiry can be made.

- *Validity:*
  Direct contact at the point of the interview means that data can be checked for accuracy and relevance as they are collected.

- *High response rate:*
  Interviews are generally pre-arranged and scheduled for a convenient time and location, ensuring a relatively high response rate.

- *Therapeutic:*
  Interviews can be a rewarding experience for the informant, compared with questionnaires, observation and experiments, as there is a more personal element to the method and people tend to enjoy the infrequent opportunity to talk about their ideas at length to a person whose purpose is to listen and record the ideas without bias. (Lu, Elliott, Majowicz and Perlman, 2017, p. 1)

Interview participants were grouped as follows:

- One senior leader, in this case a Deputy Principal, who was interviewed during school time within a one-hour time frame.

- Four senior teachers, each with responsibility for a different subject area, with individual one-hour face-to-face interviews and follow-up email exchanges, for clarification on data.

As a means to stimulate conversation, allowing participants to discuss easily their experiences with digital technologies in their specific curriculum areas, a list of prompt questions was used as guides in the semi-structured interviews (see Appendix). The prompt questions were tactical, aiming for enabling critical evaluation of views and perspectives, as well as exploration of how participants make sense of their world, along with experiences they have in the world (Merriam, 2009). Specifically, for this research, the prompts allowed-for respondent interpretations of how a digital technological integration was being included and adapted into school curricula. This enabled me to explore participant *positionality* and *emotion*, while allowing me to critically evaluate views and perspectives. I was interested in how teachers were critically involved with their subject 'world' and how experiences in developing

digital technological integration were affecting them. Semi-structured interviews allowed me to achieve this.

Description of the school

In the 1920s, the region or suburb that now encompasses Sunnyvale High School, was promoted for urban development in terms of it being a convenient commuting suburb, to down-town Auckland, some fifty minutes away by rail. It was equally promoted as rural or semi-rural, affording a life-style of uncrowded living. In the aftermath of World War Two, many returning servicemen bought land, as established farms came up for subdivision. The population grew considerably between the 1950s and 1960s, establishing a need for further land subdivision and additional services. Sunnyvale High School, which opened in 1960, is now one of the largest secondary schools in New Zealand, with an enrolment of over two thousand students. It is a highly diverse, multi-cultural school, with forty-seven percent Pacifica students, twenty-four percent Māori, sixteen percent Asian students, and only eleven percent New Zealand European/Pākehā. A further two percent of students represent a broad range of ethnicities, including Australian, Dutch, French, French Polynesian, Indian, Iranian, Iraqi, Irish, New Caledonian, Niue, Polynesian, South African, Sri Lankan, and Syrian.

As a 'Decile 1' school, its decile measures the extent to which the school's students live in low socio-economic or disadvantaged communities. Decile 1 schools are the ten percent of New Zealand schools with the highest proportion of students from low socio-economic communities. Sunnyvale High School is also notable as the only major secondary school in New Zealand with a large pool of resources dedicated to the education of blind and visually impaired students. This is coordinated through the Royal New Zealand Foundation for the Blind, in association with their major education facility, Homai College for the Blind, which is within walking distance of Sunnyvale High School. Blind and visually impaired students are placed in normal classroom environments and are assisted through the provision of specialized equipment and resources, such as Braille versions of textbooks, along with staff specially trained to meet their special needs. However, this did not arise in the interviews, perhaps because interviewees did not think it pertinent to the visual aspect of the digital technologies under investigation. However, this has the potential for a separate research project concerning digital technologies and the sight-impaired. The high proportion of Pasifika and Maori students (approximately seventy percent) was discussed in relation to the community aspect of kaitiaki, whose approach to collaborative and community projects have encouraged enthusiasm and active involvement in the Pasifika and Maori cohort in all subject areas.

Multiculturalism has great benefits in preparing students for a future world where multicultural complexities create opportunities and pathways for growth. Cultural difference is recognised and celebrated, enabling students to participate fully in school curricula without any sense of ethnic segregation. The school's size and diversity benefits students in other ways. Students recognise they are part of a school that always has cause for celebration. Sunnyvale performs with high achievement in all of its programmes, whether academic, sporting, music, the arts, dance and drama. Perceived student motivation is strong, in part through commitment and dedication of a caring and professional staff. The school recognises strongly the significant role that parents play in supporting their sons and daughters through their secondary school years. There are well-designed programmes that aim to build and sustain long-term caring relations between the school and the communities it serves.

The Participants in Detail

The Senior Leader

When contacted, one of the Deputy Principals (of two) agreed to suggest pertinent staff to approach as interviewees, and also agreed to be interviewed in his capacity as a leader of the school. This was especially pleasing as one of his roles is overseeing the integration of Digital Technologies into the school curriculum. The Deputy Principal has a Science background and has been in several teaching positions, over the last twenty years, before taking on the present role. He has held the DP position for just over two years, which is positive due to the probability of implementing a new vision in many areas of the school. The interview took place during the school's regular hours of operation, and covered the future strategic direction of curriculum, with a special interest in the integration of Digital Technologies across the school.

Senior Leader from Sunnyvale High School

Pseudonym	Larry
Position	Deputy Principal
Department	Leadership Team

The Senior Teachers

When I contacted the Deputy Principal, I asked permission to contact the Heads of Geography, History, Science, and Visual Communication. He suggested the Head of the Health Academy instead of Science, as this would then give four Heads of Departments who were involved in the integration of Digital Technologies into their curriculum areas. In addition, the teachers were chosen for their previous experience and variation in their learning area specialisations, ensuring different foci. Their experience would also encompass their teaching histories, with earlier curriculum development experience, along with former curriculum design models. This history provides valuable insight into the progression of the integration of digital technologies in the learning environment.

Teacher participants from Sunnyvale High School:

Pseudonym	Alice
Position	Senior Teacher
Department	Health Academy

Pseudonym	Jack
Position	Senior Teacher
Department	Geography

Pseudonym	Sam
Position	Senior Teacher
Department	History

Pseudonym	Richard
Position	Senior Teacher
Department	Visual Communications

3. Data analysis

Qualitative data analysis

As this research engages a qualitative case study methodology, its range of methods concentrate on a comprehensive understanding of the situation and the meaning elicited from those involved in the research (Merriam, 2009). Crucial in this process, is the movement from respondent statement as data to findings. This involves systematic analysis of respondent data, in order to elucidate cogent, reliable and consistent understandings. The technique of Content Analysis formed the basis of data analysis, the aim of which is "the process of categorizing verbal or behavioural data to classify, summarize and tabulate the data" (Dudovskiy, 2018, p.1). This method of analysis is valuable in organizational research because it allows researchers to determine and analyse the subtleties of behaviour, perceptions, and societal trends (Duriau, Reger and Pfarrer, 2007). It enables researchers to recover and analyse socio-cognitive and perceptual nuances, that are problematic to study via traditional quantitative methods (Duriau et al, 2007).

According to Clarke and Braun (2012), content analysis can be classified into four main approaches:

1. *Thematic Analysis*: Historically the terms "content analysis," "qualitative content analysis" and "thematic analysis" have been used interchangeably to refer to very similar approaches to qualitative data analysis. the term "thematic analysis" is essentially a method for identifying and analysing patterns in qualitative data

2. *Conventional Content Analysis (CCA)*: Also known as the inductive approach. It is utilised where knowledge about a phenomenon is limited.

3. *Summative Content Analysis (SCA)*: This approach is employed where there is lack of clarity about the context. The keywords are treated as codes, which are counted and compared for interpretation and understanding of the latent context.

4. *Directed Content Analysis (DCA)*: Also referred to as deductive content analysis. It helps in testing established theories at different intervals or different situations (Hyde, 2000). In addition, it is utilised to test or investigate further an established hypothesis. (p. 54)

Individual interviews of the five participants resulted in the collection of data, via audio recording, relating to their concerns, perspectives and dispositions, within their education-work environment, after which transcriptions were created from the audio recordings into text. Bazeley (2007), Bogdan and Biklen (2003) and Byman & Kansanen (2008) advocate verbatim transcription of all interviews, due to the influences of various personal nuances of emphasis or inference. For this reason, the interviews were transcribed in their entirety. Participants had been informed that they were able to withdraw from the research at any time up to ten days after they had received their transcriptions for validation. After participant endorsements, familiarization was established by reading the transcription texts several times. Coherent categories were summarized from discrete material arising from the interviews, within overarching themes of 'learning', 'pedagogy', and 'issues'. In this way, data

collation and its analysis operated as an integrated process. An initial coding of data was tabulated using an inductive analysis approach (CCA), with occasional clarifications being made, concerning various points or issues, directly by returning to participants' data.

Methodology considerations

Siedel (1998) regards data analysis metaphorically as a symphony of noticing, collecting and thinking. The analytic challenge is to establish findings by reducing data, identifying categories and connections and developing themes, in order to propose coherent, insightful conclusions. Merriam advocates all research is concerned with making valid and reliable knowledge in an ethical manner (Merriam, 2009). He emphasises the importance of the dependability of research results in applied fields, such as teaching and learning. Byman claims that structured interviews strengthen validity, noting that this method contributes to conciseness of data and reduction of researcher bias (Byman & Kansanen, 2008). On the other hand, semi-structured interviews *reduce* the chance of reliability and validity. Research is worthless without precision and meticulousness. Hence, reliability and validity play an important role in all research methods. With this research, I was cognisant of this risk and aimed to balance the semi-structured openness with careful consideration and preparation in the design of interview questions, enabling participant spontaneity of response. Importance was also placed on not 'leading' the interviews, and giving participants the latitude to direct the dialogue. This facilitated the collection of authentic data, in a semi-structured manner, thus aiming at improving validity and reliability of data.

While reliability and validity are generally considered the 'keystone' in quantitative research, they actually have less relevance in qualitative research, where these notions are *superseded* by the prominence given to good judgement and responsible (ethical) principles, along with the examination of findings for evidence of precision, trustworthiness, credibility and authenticity (Berg, 2007; Denzin and Lincoln, 2000; Patton, 2002a). Grix, (2004) outlined some common criticisms of data analysis in qualitative research, relating to the perception of 'anecdotalism' that raises questions concerning the characterisation and generality of data, prompting questions about reliability. The implications here are twofold. When compiling experiences and insights of interviewees, it is important that the initial question design was relevant, allowing provision for depth of knowledge. As well, there is vital necessity to recognise the differences between quantitative and qualitative research, the notions of validity and reliability attached to each, and therefore issues of generality or specificity of findings. These issues will be further discussed in the concluding chapter of this thesis, under limitations to the findings.

Data analysis for this study is based on defining *common themes* that emerged from the interviews. The researcher looked for relevant generalisations and commonalities to create themes concerning digital technologies pedagogy (See Table 1 below). The sample was relatively small, with four secondary school teachers and a school leader, and the question design was structured in a neutral manner, enabling easy identification of practical implications. In allowing respondents to 'take the lead' in conversation, the interviews are of unequal length, even though all respondents had a similar range of prompts. Some individuals discuss things in more (or less) depth, and find conversation easy (or not). Opportunities were given to participants to provide further or follow-up information or perspectives about their teaching practice and curriculum expectations. The researcher delved continually into meanings and perspectives from within and beneath the surface of

the interviewees' dialogue, and attempted to find commonality and differences through comparison of comments. Consideration was given to the moral obligation of the use of accepted forms of data analysis, to ensure an *accurate* portrayal of participants' dialogues, and to present emergent themes about the integration of digital technologies in school curricula. In seeking findings within research, it is imperative for *the researcher* to be aware of pre-existing knowledge and perceptions, which may be taken directly into the research process in an unreflective way. As a former secondary school teacher and currently a tertiary educator, this researcher is mindful of his pre-existing knowledge and perceptions of digital technologies in the secondary school environment. This issue of researcher expectation or perspective will be further explored in Chapter Six, the "Discussion" chapter of the thesis.

Initial coding strategy

A researcher can be alerted to a difference in response, by seeing that a code, leading to a commonality within a dataset, may apply to one respondent but not another. In addition, the classification of patterns, where codes do and do not appear, can assist the research inasmuch as this establishes a variation that leads to exploring relations that subtend that variation. In other words, coding helps examine commonality, differences and relations. With this in mind, after completion of interviews and checks of data confirmation, the first step in my data analysis was to develop and apply a series of codes. A *thematic* strategy was employed to coalesce the data loosely into a meaningful or topic-converging schema. The schema was then organised into a table. Table 1 is a modified version of Lincoln and Guba's (2000) coding strategy, which I have adopted for my systematic analysis of the collected data:

REALITY		STAGES OF DATA ANALYSIS				
Data collection	Immersion	Understanding	Abstraction	Synthesis and theme development	Illumination and illustration of phenomenon	Integration and critique findings
Participant interviews Teachers Leader	Organisation of data into texts Repetitive reading of texts Initial interpretation of texts to enable coding	Identification of first order (participant) ideas Coding of data with column based table system	Identification of second order (researcher) ideas Categorisation of second order ideas into sub-themes	Grouping sub-themes into themes Further explanation of themes Comparison of themes across sub-discipline groups	Correlation of literature with identified themes Reconstruction of interpretations into stories	Critique of the themes Report of final explanation of the research findings

Table 1: Systematic stages of analysis (after Lincoln & Guba, 2000).

As Huberman and Miles (1994) emphasise: "Valid analysis is immensely aided by data displays that are focused enough to permit viewing of a full data set in one location and are systematically arranged to answer the research question at hand" (p. 432). This method of coding, with classification and summary of responses, enabled me to clarify and determine meanings of the collected data.

Shaping findings

While this chapter provides a methodological and methodical overview of the research process, the more detailed strategies for collection of data and elucidating of findings is addressed in the following chapter, devoted to "Findings." In general, the three steps for the

development of data analysis from interviews constitute: listening, transcribing, and analysing. Each is addressed below. Attention should be paid to recording the spoken word, including care with operation of the recording appliance and determining an optimal volume. To ensure interviews were not lost or 'corrupted' once obtained, they were transferred to two other devices for backup. During interviews, it was important for me to establish a relaxed atmosphere, as quickly as possible, to encourage fluidity in conversation. The interview time, though scheduled for an hour, averaged thirty-five minutes, shorter than anticipated. This had implications for expected depth of discussion, far shorter than realised depth, and was not anticipated by the researcher who had anticipated there would be more advanced integration of digital technologies into subject fields. However, the knowledge gained from each interview enabled the researcher to develop an acceptable understanding of current pedagogical integration. After interview completion, and prior to transcription, I listened to the interviews a number of times, in part to get a sense of what was said, but also for the cadence of what was said, a mood or nuance only recognised in the inflexion of a voice, rather than in the transcribable word. As well, as I completed each interview, I quickly compiled notes, in order to gain an overview of the 'tenor' of the conversation and the salience of what transpired.

Data transcribing was the next phase in this process. Having contacted several colleagues at AUT, I had limited success in finding a way forward for transcription and was faced with the daunting task of doing it myself. However, a colleague suggested a digital transcription service, "TranscribeMe," which proved successful, with only minor corrections required for final usable transcripts. The next stage was data coding. To gain an initial understanding of the analysis process, I commenced with comparative analysis of the first two transcriptions of teachers' responses, in order to elicit a first schema of key themes, derived from repetitions of key concepts or terms. Hence, developing a coding, or lexicon of key notions, progressed inductively from raw data to recognised repetitions, and then nuanced differences between repetitions, to build the vocabulary (codes) by which thematic schema would be developed. The remainder of the responses were treated in a similar fashion, correlating with, as well as complicating and contradicting initial coding, and thus building a complex array of themes from which findings could be adduced. Working with this approach enabled more rapid comparison and understanding of the interviews, which required iterative reading, planning, and formulating of ideas.

I subsequently found it advantageous to correlate and compare teacher responses to each question, acknowledging that the questions themselves, though intended as conversational prompts, substantively developed responses subtending from the question itself as thematically driven. In this respect, responses were correlated doubly with implied themes suggested by the questions themselves, along with the open range of responses that at times elicited other themes, at variance with those suggested by the actual questions. Questions were developed in order to ask teachers and the school leader to consider benefits and challenges of integrating digital technologies into an existing curriculum and attempts were made to maintain focus on this arena as much as possible. Analysis of data to determine the main codes was subsequently *implicated by* the questions posed to respondents. Topics were refined into categories and themes were created to shape the findings from the case study contexts. This aspect of data analysis will be revisited in the conclusion, under "Limitations to the findings." The following chapter discusses the participants, questions, data analysis and findings of the research in more detail.

Chapter Four

Findings

Introduction

In the previous chapter, I described in outline and discussed the methods for my empirical design to examine and scrutinize the outcomes of the proposed integration of digital technologies across the curriculum in a secondary learning environment. I outlined the initial process of selecting participants, through to interview protocols, data transcription, coding and theming. I noted that the interview structure was based on a series of open-ended prompt questions about the philosophies, experiences and aspirations of each of the secondary school teachers and school leader, associated with the assimilation of digital technologies within their learning environments. Presented in this "Findings" chapter are the conversations in each interview, which were guided by the theme addressed in each prompt, and which secured issues I considered vital to cover.

With this chapter, I initially discuss more fully the background to each participant and school leader, after which I discuss the themes that emerged, correlating with the eight prompt questions. These themes address ways in which teachers are deploying digital technologies, their strengths and weaknesses, along with how teachers are integrating digital technologies

into their various subject areas. This addresses opportunities and challenges such integration brings to the classroom. Differences in perspective, as well as multiple-perspectives, are also examined. The findings extend to recommendations by teachers regarding how best to integrate digital technologies in teaching and learning. These trends, recommendations, similarities and differences, distended from the data set, will be further considered in the "Discussion" chapter of the thesis.

Participants and their backgrounds

All participants were interviewed in March 2019, and all were given pseudonyms to conceal their true identity.

Participant A: Larry (Deputy Principal, Leadership Team)
Masters in Educational Leadership, Dip Teaching. 21 years teaching.

Participant B: Alice (Senior Teacher, Health Academy)
Bachelor of Science, Master of Science, Post Grad Cert in Forensics. Dip Teaching. 10 years teaching.

Participant C: Jack (Senior Teacher, Geography)
Bachelor of Arts, Dip Teaching. 10 years teaching.

Participant D: Sam (Senior Teacher, History)
Bachelor of Arts, Dip Teaching. 6 years teaching

Participant E: Richard (Senior Teacher, Visual Communications)
Bachelor of Fine Arts, Grad Dip in Secondary Teaching. 9 years teaching.

Overall, varied responses were gained in the participant interviews about participant involvement with digital technologies in their respective subject areas, notwithstanding my comment towards the close of the previous chapter concerning the length of interviews. The quality of data from one participant was compromised, in that he organised to be interviewed during class. While I recognised this was not ideal, I was not in the position to ask for rescheduling or another location. All participants presented the view that digital technologies were vital as tools or instruments in learning and teaching. Each acknowledged that these tools or instruments were already integrated, to various degrees, into their classroom programmes. A common and crucial theme that emerged from the overall participant group was the conviction that digital technologies are to become integral to every aspect of school life in the near future, heralding significant changes to traditional teaching and learning processes.

Emerging themes

The data provided a platform for a range of themes and sub-themes. This platform has been construed phenomenologically from the interview transcripts; hence the resulting discussion is elicited hermeneutically from the data. The aim of this chapter is to present relevant citations from interviews, with the purpose of presenting participant statements, upon which research interpretations are based. As mentioned previously, while the larger themes

correlate with the prompt questions, sub-themes develop within the larger blocks that adduce individual respondent approaches to issues. These sub-themes are significant for the depth and breadth they are able to bring to the findings, and are further engaged in the following discussion chapter. However, not every theme resulted in sub-themes. Where no sub-themes emerged, there was either a resonance in experiences and views for all participants, or convergence of responses to a particular prompt. Where there are multiple sub-themes, there is divergence of response and interpretative openness to a thematic issue.

The chapter contains eight themes correlated to the eight prompt questions:

Question 1	*Can you tell me how you understand the term 'Digital Technologies'?*
Question 2	*Are such technologies currently being used in your subject area?*
Question 3	*Are digital technologies being used as well as they could? Is there room for improvement here?*
Question 4	*Do such technologies lend themselves to bringing different subject areas into closer proximity?*
Question 5	*Do you consider that new and emerging digital technologies open the possibility for changing or developing learning environments overall?*
Question 6	*Can such technologies become drivers for 21st century curriculum and learning environment innovations?*
Question 7	*How are such technologies being promoted in New Zealand? What are the curriculum initiatives?*
Question 8	*Can such potential innovations open to new understandings of work, leisure and civic responsibility?*

The eight themes that emerged are:

- Thematic characterisations of the participants' understanding of the term 'Digital Technologies'. These characterisations were quite broad across the subject areas and the responses revealed the perceived immensity of digital technologies
- Examination of the extent of usage within each teacher's specific curriculum area with most curriculum areas actually crossing over and collaborating
- Evaluations of the use of digital technologies in learning environments and perceptions about potential developments and improvements
- Perspectives and experiences about the integration of digital technologies across different disciplines
- Utilisation of digital technologies as a change agency where the development of 'flipped classrooms' was a future reality
- The promotion of digital technologies in the new Ministry of Education curriculum initiatives
- Perspectives about future curriculum and learning environment innovations
- Potential innovations in the 'real world' outside the school in terms of work, leisure and social responsibility

1. Digital technologies

I asked participants the following question:
Can you tell me how you understand the term 'digital technologies'?

The five participants discussed their understandings of digital technologies, with those understandings converging around the agency of computers. The over-riding theme when amalgamating the themes was: computers are everywhere. Hence, digital technologies included any technology enabling research, image presentation or construction, or a series of images to be displayed or manipulated in some way through a computer. Alice defined such technologies as:

> Any technology that enables an image or series of images to be displayed or manipulated in some way through a computer or screen.

An emerging theme was the enormity of the scope or range and impact of digital technologies, and their potential applications for teaching and learning. Participants discussed 'creating' digital technological assets, rather than simply integrating what was currently available through 'use' and 'management'. These assets varied depending on the subject area from historical reconstructions to scientific visualisations of chemical equations. This wider view of the data can be analysed as incorporating 'design', 'development', and 'evaluation' in creating resources for learning, generating effective materials and conditions for learning. Aesthetic, scientific, engineering, psychological, procedural, or systemic tools can be employed. Effective learning materials, such as web-based learning (websites), hypermedia (digital documents which include text, audio and video) and mobile media (focussing on the visual outcome of their projects) are already deployed in classrooms. Collaborative and active approaches to learning appear to be increasing for students and their teachers. Students can create a multitude of projects such as multimedia slideshows or animations, wherein they need to exhibit complex skills to combine text, sound and images, as cited by Richard:

> Most technology uses many digital forms. Most of the technologies now are highly visual, not complex. You recognise icons and symbols that represent a function and a tool for you to move forward in the project without having to create the coding necessary to achieve this.

It is interesting to note that this fits into the new technological benchmarks in the new curriculum.

Larry viewed digital technology within the school from a leadership perspective:

> Digital technology is being able to express some creativity in a digital form. Within the context of our school and in terms of what we do within this environment, it could involve students producing artwork, images or code that involves some sort of digitizing.

2. Curriculum usage of digital technologies

I asked participants the following question:
Are such technologies currently being used in your subject area?

All teachers confirmed that digital technologies are currently being used in their subject areas to some degree, with every teacher viewing it as a growth area. This question led to the participants considering the main goal for digital technologies, which was the facilitation of higher value and more effective education in a short time period. A common theme was recognition of the value of its use in their subject areas. They also recognised that the main digital technological tool in secondary schools was *the Internet*. The strengths and weaknesses of the Internet became a focal point in discussion of its integration into teaching and learning processes. The participants all agreed that classroom environments still appear generally as teacher-centred, but learning became more student-centred when and where digital technologies were deployed. Khine & Fisher (2003) suggest this approach to learning leads to a more student-centred learning environment, enabling new ways of learning, thinking and acting in the education system. In addition to this, the new technological student-centred learning environment enables collaborative project work across several subject areas.

Jack, Richard and Alice noted that digital technologies are used frequently by teachers and students in Social Sciences, Geography, Visual Communications and Science classes, where students can see a multiplicity of viewpoints on a single issue or subject. Often there are various resolutions to a problem and these answers can be viewed visually, critically examined, discussed and then resolved. This open-ended approach enables learning processes whereby teachers guide students to think more critically about information, develop new ways of assessing it, while forming evaluation skills and intellectual enquiry. Regular use of digital technologies in students' learning creates the potential for empowerment with new ways of thinking, being, and acting in the world, and the expectations of achieving learning goals, especially if they are using it as a design tool. While Alice mentioned they no longer use textbooks, Jack talked about 'a wealth of information online' by using digital technologies including Google Cardboard and iPod Touches with apps such as BBC Civilizations, to enable students to experience ancient artefacts in the classroom. Richard's language embodied the new curriculum, with his discussion concerning the requirements for visual representations of evidence, requiring the frequent use of 'software and digital tools, such as cameras and data projectors':

> Learning also happens by creating our own digital content in the framework of computational thinking and the new designing and developing digital outcomes.

However, all participants agreed that an overriding obstacle to effective implementation of digital technologies in the classroom is a lack of resources. Frustrations were aired about inability to access information and ideas, availability of digital technologies resources in learning and teaching and affordability of software. Several interviewees mentioned seeking advice and guidance from more experienced colleagues, from recent graduates more versed in digital technologies, and from the Ministry of Education. In some subject areas, where

adequate resources were unavailable, they researched models of effective practice for teaching and learning. Sam offered the perspective that the use of digital technologies is deficient in Social Sciences and History, due to lack of resources. He aired his frustration:

> There have been projects where digital visual technologies could be used to enhance learning, but at the moment that's not being initiated fully due to lack of scope in resources.

A common theme among all participants was that these teachers and school leader were not resistant to new media; they want to incorporate it into their learning environments to such an extent that they are complaining about the lack of it. This challenges the idea that teachers are the main obstacle to the digital curriculum, because of so-called 'technophobia'.

Another overriding obstacle to curriculum usage of digital technologies are restrictions due to NCEA, again highlighting perspectives from teachers, that obstacles are largely structural. In this case, the 'structure' was the necessity for giving priority to assist students to gain credits for NCEA (National Certificate of Educational Achievement). Alice indicated the skewed importance of this priority. Failure to pass NCEA impacted "their career opportunities, opportunity to go to university or to get into a particular course." Jack agreed that teachers are under pressure to ensure students pass NCEA and "experimenting with something new could potentially cause problems for our students, with negative impacts on future pathways through minimization of career or university opportunities."

NCEA was also 'blamed' for restricting teaching content. All participants discussed the restrictions instituted by NCEA assessment requirements, regarding freedom for creativity and innovative teaching, without the restrictions of external assessment. Their opinion is that the students of their school do much better in internal assessments than under the pressure of exams. In other words, relevant projects with assessment objectives are far more suitable for the students' learning processes and achievement outcomes.

3. Evaluating the use of digital technologies

I asked participants this question:
Are digital technologies being used as well as they could? Is there room for improvement here?

All participants had definite opinions about areas of concern in the integration of digital technologies in learning and teaching. For example, a recurring theme was the fact that there was an absence of or limited access to professional development to enable up-skilling. This meant that they were limited in their ability to develop, comprehensively, projects using digital technologies. As Richard said:

> We are quite limited in the extent to which students can take their projects, because it is often dependent on teachers' individual knowledge.

Jack agreed with these sentiments:

> The lack of professional development, in other words, my knowledge of digital technologies, hampers student progression and the depth they can go into in their projects.

These concerns reflected those of their professional association, the Post Primary Teacher's Association (PPTA), which has been vocal on the perceived difficulties in digital technologies curriculum implementation. The PPTA noted that although the curriculum itself looked good, it would bring "enormous workforce challenges" (Kenny, 2018, p. 7). Despite promises for professional development and support, the PPTA noted that the performance of the Ministry to effectively implement policy is generally very poor. The participants' views are similar, in that they felt that it is better to integrate digital technologies slowly and properly, to ensure that they can be sustainable, iterative, and able to improve educational outcomes. That is not to say they are unwilling or lack enthusiasm for implementation and integration.

Sub-theme 1 Professional Development

A common concern with participants is that they have insufficient digital technology Professional Development (PD), or they lack what they perceive as the 'right kinds' of digital technology PD. This perceived need to be re-centred as teachers must occur before they can become de-centred or work as facilitators for learning within the classroom. The result is that teachers don't see *how* digital technology can fit into (or change) teaching practices, nor *why* (or *if*) it should. If they do, they cannot actually do what they want to do, or want their students to do. They voiced a critical need for the up-skilling of all teachers to provide them with the ability to direct their students to areas of research or enhance their projects with digital visual components. Alice saw the lack of teacher-expertise as a concern, and talked about 'a huge skill requirement to know how to teach digital technologies'. She admitted that her students knew more about digital technologies than she did. From a leadership perspective, Larry acknowledged the importance of professional development and talked about an ideal future for teachers that included 'ongoing learning, and becoming part of a culture of being able to be better risk takers'. He wanted to see teachers as learners and recognized the importance of ensuring facilities and practices are in place to 'feed them the knowledge sets as necessary'.

A common theme arising from the study was the belief in the importance of student and teacher engagement and the dichotomy of skills between the two groups. It appears that students use digital technologies in the classroom readily and enthusiastically, with many holding a far more advanced skill-set than their teachers. They seem to relish the ability to quickly find research for projects, and the ability to learn to produce quite complicated structures through on-line tutorials. Jack felt the success and extent of integrating digital technologies were dependent on student engagement:

> If you've got a group of kids who are self-motivated and they've got good self-management, then potentially, you can give them more scope.

However, many participants voiced concern about the unwillingness of some teachers to integrate any digital technologies into their learning environments and unwillingness to undertake professional development in this area. This was attributed to staff concerns about their ability to learn, as well as time constraints associated with learning a digital technology approach for their classrooms. Richard viewed teacher-commitment as problematic and

claimed that the question should be: "When should technology not be used?" He suggested that not all teachers see the advantage of implementing digital technologies into the curriculum, where teachers can teach collaboratively across subject areas, so students 'can actually have the advantage of double-dipping or even triple-dipping'. Participants considered that the enthusiasm of a teacher plays an equally important role in engaging student interest. The unusual paradox here is that teachers believe that students are motivated to use new media, but become demotivated if they feel inexperienced as technology role models. Larry maintained the success of the integration of digital technologies is not about the abilities of teachers, but more about their eagerness and passion to inspire their students:

> As long as you can enthuse the kids, I reckon there's a greater chance of being able to bring them into a space whereby they are able to think, problem-solve, and be critical. If the teacher can enthuse the kid, I reckon we've won the battle.

However, ironically in our modern technological society, a common concern for participants and professional development in digital technologies was the pressure of time. This included time to up-skill and time to formulate classroom content, in order to implement the integration of digital technologies into curricula. Sam emphasized the 'incredibly time consuming' nature of learning and implementing something new, while Jack also viewed time as a major issue, as the integration of digital technologies cannot be done in 'hour blocks'. He also acknowledged that the education sector is reluctant to change traditional timetabling structures, which have been in existence for decades. Any changes to timetabling in schools, allowing for more effective integration of digital technologies, will require 'innovation, creativity and forward-thinking'.

A common theme emerging among the participants was also the impediment of financial restraints. Alice was desperate to move more into AR (augmented reality) and VR (virtual reality) in her classroom teaching, but cited cost as a huge barrier, causing an impact on her teaching. Funding for property upgrades, network provisions, and support personnel is critical for success in implementing new approaches for teaching. The processes of funding options for most schools has led to the gradual integration of hardware and software, so that more digital technological approaches can be integrated into teaching.

Sub-theme 2 The Role of Primary Schools

All participants noted that primary schools seem to have a superior approach to digital technologies within their teaching content, assisted by lack of restrictions brought about by requirements for student grading. Constraints as a result of mandatory assessment within the secondary curriculum are viewed as problematic in the implementation of digital technologies. Alice held that primary schools play an important role in scaffolding students in digital technologies for high school and insisted: 'primary schools are better than we are'. Sam noted the importance of primary schools to ensure enthusiasm for secondary school subjects, integrated with digital technologies. He argued they are in a better place than high schools and universities to begin scaffolding for future learning. He lamented the fact that by the time many students get to Year 9, 'they've lost a lot of their enthusiasm, that sort of creativity'. The implication is that primary schools have a crucial and pivotal responsibility to ensure positivity and resourcefulness in their students for future learning pathways.

4. Cross disciplines

I asked participants this question:
Do such technologies lend themselves to bringing different subject areas into closer proximity?

Respondents were aware of broad debates in education around curriculum integration, and the best methods for making this viable and relevant. They recognized the changing nature of classroom teaching and the necessity for longer stretches of time with collaborative subject projects, rather than the traditional time constraint of fifty or fifty-five minute classes. While there may be contention as to the best forms of curriculum integration, integration proponents consider it integral to twenty-first century teaching and learning models, explicitly addressing accelerating technological change. Similarly, curriculum integration is seen as a means of better meeting the vision of the New Zealand Curriculum, by preparing students to be confident, connected, actively involved life-long learners as well as developing key competencies in a more meaningful context (Jellyman, 2015).

A theme emerging from all participants was the mutual agreement that the integration of subject areas was definitely the desired way forward for implementing an innovative learning environment. They viewed cross-curricular work as offering a creative way to develop student understanding, skills and critical competency, while motivating them to learn through stimulating, interconnected topics. Integration also provides teachers with opportunities to encourage active enquiry, taking the initiative, and discussion and debate by students. Links between subjects need to be real and not contrived. Genuine connectivity between subject areas needs to be made, where they occur logically, and where connections make compelling sense to students. Sam clarified the importance of cross-curricular development by noting that students 'struggle to learn when things are detached, and when they don't see that things are intertwined within their education'. He cited, as an example, an art teacher at Sunnyvale High who used digital visual technologies to consider portrayals of Maui, creating possible images of Maui. This was followed by digitally analysing the portraits of historical figures, all of which could be completely intertwined with the history curriculum, and the examination of historical figures. He saw this as a situation where subjects could be blended, seemingly effortlessly, with striking and relevant learning outcomes.

Sam also argued that some students overlook the skills associated with History, as a subject area. This may happen less frequently if students were aware of the ability to apply historical understandings in other curriculum areas. In other words, as Sam commented, if students developed an awareness of the transferability of digital technologies skills, 'this would allow them to see the value in them and how they could apply to whatever career or study or walk of life they do eventually go into'. Alice reiterated the success of integrated learning environments for the present and future, which equip students with the ability for reflection and creative application, positioning them as 'future leaders of tomorrow'.

Sub-theme 1 Kaitiaki (Guardianship of the Environment)

The Treaty of Waitangi principle puts students at the centre of teaching and learning, asserting that they should experience a curriculum that engages and challenges them, is

forward-looking and inclusive, and affirms New Zealand's unique identity. This is definitely the case at Sunnyvale High which has adopted kaitiaki, a New Zealand Māori term for the concept of guardianship for the sky, the sea, and the land. The prefix 'kai' means someone who carries out an action and a 'kaitiaki' is a person, group or being who acts as a care-giver, a guardian, protector and conserver. The gods of the natural world were considered to be the original kaitiaki. Many hapu (sub-tribes) and whanau (families) care for a place, such as a river, lake or forest and work to conserve its natural heritage, addressing environmental problems and reclaiming traditional knowledge. Kaitiaki is exercised at Sunnyvale High in students' work on environmental projects with consistent use of digital technologies. Richard has involved his students with local waterways, integrating digital technologies into finding solutions to environmental or ecological problems, such as water contamination, inappropriate vegetation, or loss of native species. Richard noted that if there is no problem, 'they have to problematize it and make an engaging or useful website using that content from the community problem'.

Alice emphasised the valuable links between kaitiaki and real-world experiences. Her Health Academy now has one hundred and eleven students across five classes as a result of the new kaitiaki programme that allows for vertical teaching, with students from Years 9 to 13. Alice held strongly to the value of hands-on, real world learning, which integrates cross-disciplinary practices. Although she has been in Science for many years, she recognised that these learning opportunities expose students to more than she has ever personally experienced. She saw many positive outcomes in linking cross disciplines:

> Integrated learning is rich, real, about the connections, and about linking the real world. The students are not just doing Science, or Biology, they're doing Technology, Digital, planning, presenting and commentaries as well. They are learning the entire process from start to finish.

Sam also mentioned his aspirations for enhancing student connections with the environment, by instigating projects using digital technologies to recreate aspects inherently intertwined with the history of the community. By giving back to the community a sense of its historical developments, he hoped not only to strengthen community bonds, but also strengthen connections of the school to its region:

> We've got the new and emerging visual technologies here, but we need to consider their openings to the possibility for developing new learning environments.

Sub-theme 2 *Digital Technologies and the Real World*

All participants agreed that no teacher should forget what they are really preparing their students for—that students need to be prepared for the 'real' world, the one that they live in each day and in which they will build their lives and careers. The future is not *digital*, it is real and tangible and all around us. Digital technology is only a component of that whole. That is the reason Sunnyvale High involves the community as much as it can, in real life projects, which will hopefully make a difference. Alice offered an example of a real-world project, which she developed with another teacher, co-creating across curricula standards while simultaneously meeting the requirements of both subject areas:

> You might have a Social Science or an Environmental standard that you can get credits for that is looking at an environmental issue or a social issue, and they might be able to get the credits in digital technologies.

Jack's notion of what he termed 'the promised land of where education should be' was one in which students *and* teachers are bound by the project they are interested in, rather than bound by the structure of 'traditional subjects'. He suggested:

> You would have a central project that brought in elements from all sorts of different traditional subjects. In this way, the students are actually getting involved in the world around them in a real project and developing skills and collecting evidence along the way.

5 Digital technologies as change agency & 6. Future curriculum and environment

I asked the following questions:
Do you consider that new and emerging digital technologies open the possibility for changing or developing learning environments overall?

Can such technologies become drivers for 21st century curriculum and learning environment innovations?
(The answers to the questions were so similar, they have been combined).

The New Zealand Government has developed a 'vision' or aspirational framework for all New Zealanders to be thriving in a digital world. This has had huge implications for curriculum change in schools from 2018, when the new policy began its implementation. Government suggests that digital technologies concern more than the improvement of IT systems and processes. In the broadest sense, it means approaching things differently in an increasingly connected world, requiring new mindsets, skillsets, technologies and data to benefit people, government and the economy. Their belief is that acceleration of the curriculum changes in digital technologies will help students become an integral part of a rapidly changing world: "The digital curriculum is about teaching children how to design their own digital solutions and become creators of, not just users of, digital technologies, to prepare them for the modern workforce" (Hipkins, 2018, p. 1).

Sub-theme 1 The Changing Role of Teachers and Schools

Traditionally, secondary schools taught subjects in separate, siloed curriculum domains. With the innovations of the New Zealand Curriculum, students in many schools are given the choice of what, how, and sometimes where, they will study. This approach combines several subjects in the one project and replaces the one-hour lessons with 'workshops' that students can opt into. There is concern as to how this new approach can be assessed, an arena of investigation for schools. The basic premise, however, is seen as having pedagogical merit. This approach, enabling immersion of students in supposed state-of-the-art processes, was evident in discussion with Alice, who viewed digital technologies as having 'a revolutionary

impact on learning'. She described this via a recently purchased AR (augmented reality) suite in Health Science, which gave students 'the amazing ability to put their cell-phones over their organs and see them in 3D'. She also mentioned a pedagogical shift in the teaching of digital technologies as intrinsic to all education:

> Students are so used to interacting with technology, if you take it away, they're no longer engaged. I think there's a pedagogical shift parallel to the increase in technology.

Richard also emphasised the importance of innovation: 'You've got to keep on learning new things—innovate or stagnate'.

A common theme emerging among the participants was a firm belief of the importance of the transferability of skills associated with the integration of digital technologies. They all emphasised the ability for students to be able to work across a range of subjects, with the appropriate digital technological skills. Sam noted the importance of students understanding the transferability of their digital technological skills, emphasizing the need for building key proficiencies expected in History. This meant understanding perspectives, being able to identify, explain and analyse causes and consequences, and being able to critique opinions on aspects intertwined with other subjects. Ideally, Sam would like students to be able to make connections across subjects by asking themselves:

> In what ways can I apply these skills that I need to show for a standard to this project that I'm doing for another class or another subject?

All participants acknowledged that the role of the teacher is not only changing, but needs to change dramatically. Their contention is that if education does not keep up with the changing times, and if this is accepted as a truism, then teachers are not preparing students for today's world, and certainly not for tomorrow's world. Sam stated that 'the biggest thing' is for teachers to accept ultimately that the role of the teacher has changed and is changing in the digital age. He accentuated the importance of the teacher's role that has shifted from 'being the oracle of knowledge, the fountain of knowledge', to one which 'facilitates kids and their learning'. Alice concurred with the changing role of the teacher as a facilitator. For Alice, this parallels the changing role of students, as they take more control of their learning:

> If the students don't know how to do something, they will research it and get the tutorials and figure out how to use it.

Sam agreed with Alice's perspective, and stated his ideal would be to see subjects becoming something "where teachers work more around skills and then facilitate students through the content applicable to the subject(s)." In this way, students could make active choices about their learning.

Because many students are more digitally knowledgeable than their teachers, Larry suggested the potential of a symbiotic relationship between teacher and student, where each could learn from the other. He admitted that this would place teachers in a vulnerable position as learners, but maintained that this would empower both teachers and students alike, as long as teachers directed the learning, and requirements were achieved. Alice suggested that the

impact of digital technologies would result in schools becoming less of a focus in a student's life. She viewed a future in which students do not need 'to actually physically have to come to school' due to digital interaction and remote learning.

The role of creativity in the integration of digital technologies is paramount, with governments, academics, school leaders and teachers recognizing a surge of interest in creativity within classrooms. This is partly driven by a growing belief that in a fast-paced global economy, workers will be required with flexibility of mind to adapt to constant change, rather than following a traditional career path (Davies, 2015). Jack contended that creativity is responsible for new scientific breakthroughs and future problem solving. In other words, creative ability is at the heart of new research. All participants agreed that the collaboration between subject areas enhances and benefits the students' creativity and enthusiasm in learning. This is also reflected in gaming, which can be beneficial to teaching content and raising student enthusiasm and engagement. Sam has started experimenting successfully with Minecraft in his Social Studies classroom. A recent project involved exploring the cultural significance of landmarks including pyramids in Egypt, Sky Tower in Auckland, New Zealand, and the church of Saint Sava in Serbia. He was extremely positive about the 'incredible' feedback from students, which highlighted the value of the visual nature of digital technologies and games. Sam noted that this ensured 'great buy-in from students who were on-task every lesson'.

Another concept arising from interviews with the participants is that of the 'flipped classroom'. Taking an advanced view of classroom delivery, the interviewees all talked about the notion of a 'flipped classroom', which they utilised in their own ways. Larry viewed this innovative approach as a way forward for the future and cited teachers who have adopted it wholeheartedly. He advocated its ability to make learning available around the clock, as well as an approach enabling teachers to place work online, with links to websites for student investigation before class. On the other hand, he noted disadvantages to the flipped classroom:

> Social realities mean a lack of accessibility to the Internet at home for some students, and reticence of some teachers in the school to accept the flipped classroom approach.

Larry discussed the 'digital divide', which refers to the inequality in access to technology existing between communities, particularly socio-economic groups. He also commented on the importance of digital technologies in 'closing the gap' between privileged and underprivileged students, by giving students new experiences. He said that it was vital for teachers to help bridge the digital divide so that students can acquire the technological skills they need to be successful as adults and viewed it 'as an opportunity to level the playing field'.

Real-world projects also play a valuable role in the integration of digital technologies within the curriculum. Teachers valued the pathways of digital technologies into 'real-world' projects enabling community involvement from experts and mentors. Alice stated the importance of expert mentoring and funding, emphasizing the value of her students doing real-world projects with scientists, delivering real-world results. For example, at the moment, as a result of funded initiatives and an imperative for government science agencies to collaborate with schools, her class is involved in a real-world project with scientists, to create

an e-bike. Alice also noted the value of mentoring with companies like Fisher and Paykel Healthcare, who come in once a fortnight and help students plan a project and implement it.

Also emerging from the study was the idea of schools serving as research centres. Sunnyvale High, through its Kaitiaki principles, is endeavouring to involve itself with its community. This is happening more and more through real-life projects across several subject areas. Once this can be established as an ongoing practice, the school itself will be seen as a hub and even a research centre, where local industry and the community can work through problem-fields that involve them all. Larry viewed schools as having the potential to act as research hubs, serving the community by finding ways, for example, to produce free solar energy or create sustainable or community farms, involving 'the highest level of thinking associated with Mathematics, Physics and Social Sciences'.

The integration of digital technologies also calls for reviewed thinking around management systems within schools, in terms of teacher collaboration and timetabling. With the combination of digital technologies and different subjects, many students work in groups on 'real-world' projects, requiring larger blocks of time within a day. All participants recognised the necessity for change to the structure of classes in order to achieve pedagogical progress. Larry identified time allocation as critical, stating that this is an area in which teachers have confidence to debate approaches to rationalising optimal scheduling. To this end, this year they have introduced paired-learning areas. For example, time allocations of three periods of Maths and three periods of Science are given to teachers who work with 50 or 60 students in special Collab spaces. The four participants involved in this process, which enables two and sometimes three teachers to collaborate and direct integrated student learning, were vociferous in their enthusiasm. They believed that students benefit profoundly from the skill sets of two-to-three teachers, responsible for a wide-ranging or 'real-world' project, rather than facing the limitations of an individual subject area. All participants agreed that the extra time allowance makes for more meaningful learning with improved outcomes.

This move to teaching collaborative subjects also suggests a move away from traditional forms of assessment and reconsideration of assessment regimes. From a leadership point of view, Larry acknowledged that the integration of digital technologies, and the associated increase in combined-subject project work, calls for new approaches to assessment. He intimated that a student could drive this process and 'put themselves forward to be judged' at different stages of the project when they were ready, where software could potentially grade the outcome.

Sub-theme 2 Partnership with Industry

Recognising the need for relevant knowledge about future pathways to achieve easy transition between secondary school and post-secondary destinations, the New Zealand government has introduced a collaborative new programme connecting schools with tertiary education organisations and industry partners. Sunnyvale is privileged to be one of the first schools to be chosen to take part in this collaboration, called P-TECH, or 'Pathways in Technology'. Larry emphasized the value of industry involvement and funding as a result of the partnership with organisations such as Noel Leeming, Cyclone, Finance Now and Debit Success, as well as grants from ASB, which have allowed the school to purchase digital hardware for students, when students or their families are unable to afford it. This process has also enabled changes in pedagogy and classroom practice and created enablers for teachers to practice or change

the pedagogy that enables flip-learning to take place. The participants agreed that this new approach to pedagogy, with its community and industry involvement, is of real value to the students because they see more relevance and meaning to their learning.

Another programme Sunnyvale is linked to is 'Education Perfect', a team of curriculum designers, educators, technology 'gurus', and service providers, who sit at the intersection of leading pedagogy development and progressive technology design, creating transformative teaching and learning experiences in the everyday classroom. The aim of 'Education Perfect' is to ensure students acquire basic digital technology skills, via a skills-based programme, after which they begin acquiring "critical-analysis, critical-thinking and problem-solving" (Larry).

7. Ministry of education initiatives

I asked participants this question:
How are such technologies being promoted in New Zealand? What are the curriculum initiatives?

By 2020 all schools are expected to address the New Zealand Curriculum to include two Digital Technologies areas. These two areas are: 'Computational thinking for Digital Technologies' and 'Designing and developing digital outcomes'. The new curriculum's aim is for students to learn how to design their own digital solutions to become creators of, not just users of, digital technologies. The interview participants were in agreement with this initiative, although all showed concern with lack of teacher readiness and resources, as well as priority given to existing NCEA Achievement Standards, as has been mentioned above. Alice identified concerns about teacher readiness to teach the new curriculum:

> Not having expertise particularly in a digital technology subject, that's quite a big ask.

The Government's intention is to provide schools with affordable, modern and safe learning environments that support twenty-first century education, and improve outcomes for young people (Ministry of Education, 2018). However, there are conflicting arguments as to how the government is actually resourcing changes within schools. From a leadership perspective, Larry noted that the Ministry has invested positively in promoting digital technologies in the new initiative and stated that resourcing has been favourable:

> I think there is a commitment from the highest levels to put money into the space here.

8. Outside the school

I asked the participants the following question:
Can such potential innovations open to new understandings of work, leisure and civic responsibility?

Sunnyvale High offers an extensive range of co-curricular activities that enable students to work together in a community of learning, outside scheduled classes. These activities bring students and their projects into contact with their broader community, where they are proud to be a part of a living process, which affects their lives directly.

The participants recognised the ability of digital technologies to be used for a huge variety of curriculum areas in making the world accessible. Richard mentioned endless possibilities for integration across disciplines. For example, in Health Sciences, students could work on a collaborative project on Science and Mathematics by calculating the number of calories for a particular athlete to complete his daily exercise programme in preparation for a competition. Undoubtedly, technology has heralded innovative, interesting and diverse materials for the learning environment. The new reality is that students have easy access to vast amounts of information with the rapid evolution of the World Wide Web. Alice remarked on the ability of digital technologies to excite students with a virtual experience of the world. She saw it as opening up new worlds that students have not previously experienced, accessing international sites through 3D maps and exploring cities on 3D devices. She described it as 'enriching lives and making them fuller'.

The integration of digital technologies within Sunnyvale also has implications for industry. In line with its commitment to the philosophy of Kaitiaki, the school has definite links with industry, which it is endeavouring to promote within its community. Sunnyvale's dedication to partnership with industry is evident in the appointment of a dedicated staff member whose role it is to build links with industry. Jack emphasised the uniqueness of the role and was unaware of any other school with a similar appointment. However, in spite of this, he expressed frustration at his perception of industry's lack of reciprocal involvement, and claimed that there needs to be an understanding from New Zealand industry that if they want more proficient school leavers, they should be more prepared to liaise with schools, adopting a 'philanthropic attitude'. As well as links to industry, the school also recognises the importance of civic responsibility. A common thread among the participants was the belief that students should have an understanding that their actions affect the whole community, affects that could be interpreted either positively or negatively. Larry and Alice emphasised the dimension of civic responsibility for educators, in the world of digital technologies, to instil students with responsibility and positive values. Larry contended the need for teachers to be mindful of the power of adverse influences within this technological environment. He remarked on the important responsibility and challenge of the present generation of educators to ensure that students are taught appropriate values, in order to become responsible future civic leaders. He emphasised that as long as there are 'brave people to take this forward', there is 'a positive and exciting future for our country'.

Conclusion

Teachers in the study agreed on the importance of students learning a range of digital technologies skills in order to keep pace with the rapidly changing world. However, they identified challenges to its integration in their pedagogy, including teacher expertise, time constraints, and finance constraints, and the pressure for students to meet expected NCEA achievements. The findings suggested teachers understand scope for quite extraordinary changes to education and its delivery happening in the near future. In the following chapter, I examine both current literature and empirical findings and review themes of existing challenges and potential futures.

Chapter Five

Discussion

Introduction

This chapter aims to bring together material presented thus far in the thesis, so as to bring analysis and a critical dimension to both the key literature, outlined in Chapter Two, and the findings from the case-study, outlined in the previous chapter. From the vantage point of my research question, concerning the implementation and integration of digital technologies in New Zealand secondary schools, I want especially to bring the scope of literature, the government policy and approaches of the Ministry of Education, and the perspectives developed from practicing teachers into a common view. To what extent does the key literature account for the experiences of classroom teachers, whose role it is to achieve frameworks of learning for a technology-driven future? In what ways are Ministry prescriptions, directions and goals realistic from the vantage point of schools struggling to maintain resources and equip teaching staff with the knowledge base to deliver this technology-saturated future? Are suburban-school teachers aware of global perspectives and drivers, issuing from OECD documents, that predominantly influence national priorities? Are industry drivers and aspirations coincident with the goals of educators, concerned with educational equity, rapidly changing school cultures and growing porosity of school-industry environments?

Important themes and probing questions, extending from this research, are addressed in this chapter. These relate to technology transformations within global (OECD) and New Zealand learning environments, the integration of digital technologies into the classroom and beyond, and comparisons with OECD and New Zealand MOE expectations. This chapter summarises positions offered by the teachers and school leader in the case study. This summary relates their experiences of digital technologies integration, offering, at times, far-reaching implications for the potentials of or even the continued existence of schooling as we understand it. Industry involvement and expectations are also considered, alongside connections of digital technologies with real-world understandings, future-proofing and technology 'colonisation' and 'decolonisation'. This discussion is brought into perspective with respect to international and national literature on digital technology advancements in education.

Hence this chapter is structured into three discrete sections, which interrelate. The first presents a summary overview of the salient literature for the study, divided more or less according to the key themes developed in Chapter Two, commencing with international research, dominated by OECD studies, moving then to New Zealand research, dominated by Ministry documents, and finally to literature concerning an industry/education nexus. The second section presents a summary of key findings, again more or less sectioned according to the key themes elicited from Chapter Four. The third, and longest, section offers the discussion proper, where I aim to bring critical consideration to correlations between international and national studies, governmental policies and school-based teaching and learning practices. I conclude this discussion with commentary on perspectives I have gleaned from this study, perspectives that have asked me, as a tertiary educator, and former secondary teacher, to rethink the future of secondary education in the wake of a technology revolution, wrought by the influx of digital technologies in schools.

1. The big picture

Technology transformations: The OECD

Globalisation and technological change dominate and constantly shape modern lives, influencing the way we live, think and function. A rapid rate of change and higher global levels of education have contributed to this complexity (O'Halloran, 2015). The majority of employment opportunities are now determined—in the balance—by digital technologies, necessitating continuous adjustment of worker skills, leading to questions about the global direction of digital technological changes and its implication for education. On the near horizon is AI (Artificial Intelligence) which is set to eliminate a broad range of administrative functions, currently undertaken by well-educated and literate citizens. The education sector, in fact, may well be (ironically) a target for job elimination.

One implication for educators is the necessity for sound pedagogical and technological knowledge to impart to their students in a technologically dominated world. This requires *professional development* targeting a whole-school culture, to ensure the up-skilling of teachers and encourage increased teacher-collaboration and peer-mentoring. Teachers require flexibility and capability to be effective teachers of digital technologies, affording their integration into classrooms. Furthermore, educators need to develop the ability to inculcate higher-order thinking and social and emotional skills for learners, required by a digitalized

world. However, the attitudes of teachers to integration of digital technologies are pivotal to its successful adoption and use (Etmer and Ottenbreit-Leftwich, 2010).

Digital technologies are now present in an increasing number of classrooms globally (OECD, 2018a). Ongoing research *and* collaboration between OECD countries have led to the restructuring of many of the standard frameworks of education delivery, that have led to the development of digital technologies. According to *The OECD Innovation Strategy – 2015 Revision* (OECD, 2015f), the mere presence of digital technologies within the classroom, where students were expected to take responsibility for their own learning, produced strong motivation and meta-cognitive skills. Indeed, technologically successful countries are those that embrace educational policies fostering the development of children's digital skills. For example, the Republic of Korea and Singapore have injected massive investments into the initiation of educational policies of digital technologies. Students in Denmark have the ability to use the Internet while taking school examinations. Norway has introduced a national digital skills evaluation test for all students (UNESCO, 2018). New Zealand and the United Kingdom have introduced coding, involving problem-solving skills or computational thinking, as part of compulsory education.

There is an emerging trend in OECD countries of an increasing number and variety of educational resources, openly availability for students. OECD literature emphasises powerful trends in knowledge-sharing, leading to opportunities globally, associated with digital learning resources. It is therefore astonishing to note the findings from the OECD's *Programme for International Student Assessment*, which concluded that schools have not yet addressed effectively the potential of digital technologies in learning environments, with less than forty percent of OECD teachers using digital technologies within their schools (OECD, 2017). Furthermore, according to Durak et al, in the *European Journal of Education Studies* (2017), schools face challenges associated with curriculum overload, lack of alignment between learning intent and outcome, quality and equity of content, effective planning and resonance with implementation (Durak, Cankaya, Yunkul and Ozturk, 2017). This points to alarming discrepancies between OECD research outcomes and policies, and the reality of teaching practices. These discrepancies and an understanding of the role of the OECD in global education is further developed in the third section of this chapter.

New Zealand schools

Design of new curriculum content allows for flexibility to respond to emerging developments and technologies, aligning with OECD research, stating the importance of flexible instructional systems (OECD 2018c). Two new technological areas include *Computational thinking for digital technologies* and *Designing and developing digital outcomes*. The former promotes understanding of computer science principles, with students learning core programming concepts. The latter encourages fit-for-purpose digital solutions. However, more radical change has been heralded by the 2020 mandatory inclusion of the five strands of Digital Technologies. From 2020, Digital Information, Digital Infrastructure, Digital Media, Digital Electronics and Programming and Computer Science will be recognized as five distinct disciplines in their own right. They will also provide scholarship opportunities. All five are 'approved subjects' for University Entrance.

The intention of the new curriculum content is to equip students with skills for success in a world of unprecedented change. This aims at developing digital-capable thinkers, who

understand computer-science principles that *underlie* all digital technologies (Ministry of Education, 2017c, p. 1). Furthermore, there is now a *new* expectation that digital technologies will be integrated within other learning areas of the curriculum. To this end, the New Zealand government has allocated over $700 million, financing digital infrastructure, including ultra-fast broadband and hardware resources. This is one of the highest OECD allocations, as a percentage of total public expenditure (Education Review Office, 2019). The Education Review Office has responsibility for assessment of the new curriculum initiatives, to ensure effective implementation. There is also an expectation for schools to report on student achievement, priorities for improvement and planned actions.

From an economic perspective, a shortage of digital skills has the potential to slow economic growth, while a supply of high-quality digital skills may effectively contribute to a growing economy and improved national prosperity (New Zealand Digital Skills Forum, 2018). The implication for the ICT industry is the challenge of recruiting people with the correct range of skills to drive digital innovation and strengthen New Zealand's potential for growth (Ministry of Education, 2017c). For this to happen, more students need to leave school with a digital skill-set geared for future innovation. This implicates the role of digital technologies' pedagogy in the future prosperity of New Zealand, and points to the need for a strong focus on curriculum approaches in an increasingly digital world, where demand for skills significantly outstrips supply.

During August and September 2017, a coalition of industry and government organisations worked together to identify key issues across the area of digital technologies. The purpose was to find evidence and perspectives of skills, alongside forecasting skills in demand for the short-to-medium future, to better inform education. Its findings emphasised the necessity for closer alignment of the tertiary education system's courses with future demands of the sector, as well as the importance of improving pathways into technology roles through upskilling or reskilling (New Zealand Digital Skills Forum, 2018). In addition, both the OECD report *Skills strategy 2019: New Zealand* (OECD, 2019c) and the *New Zealand Digital Skills Survey* (New Zealand Digital Skills Forum, 2018) revealed a significant skills shortage in the New Zealand digital technologies workforce, reinforcing the necessity for the development of sound digital technologies skills in our education system. Implications for the tertiary education sector have flow-back (or knock-on) effects on the secondary sector, which needs to foster a greater orientation of school leavers to careers in digital technologies, the majority of which—for those still in junior schooling—have yet to be 'invented'.

In response to this need, three ICT graduate schools have opened as pilot initiatives in New Zealand to help close the gap between supply and demand in the digital technologies industry. Furthermore, collaboration between Auckland and Waikato Universities arose from the need to develop graduates with the ideal combination of technology skills, critical thinking and business initiatives, to drive innovation in New Zealand (Tertiary Education Commission, 2017). However, amalgamations between the education sector and industry must expand for real transformation to continue to take place. The former needs to continue involvement with further educational initiatives, including ongoing research, financial investment in professional development, and resources and support for schools, while also benefitting from industry engagement and mentoring. This amalgamation

between education and industry should see New Zealand continuing to improve its own education system, to develop important skills in digital technologies.

2. Pedagogical thinking

Evaluating usefulness

Though participants, interviewed in this study, saw digital technologies as a growth area within future curriculum development, they equally emphasised the lack of teacher expertise, which clearly stalls the demand for growth. This points to additional demands on teachers for professional development in order to enter "a culture of being better risk takers." There was a suggestion that teachers and students should learn these new technologies together, with teachers positioning themselves as learners within a school, while also ensuring the availability of resources to accommodate this investigation. Self-motivated students, inculcated with good time-management, led to effective utilization of digital technological components in their learning. The ability of teachers to effectively integrate digital practice into their classrooms was seen as being dependent on their enthusiasm for making change. An enthusiastic teacher, even without a full digital skill-set, creates a situation where students can engage these technologies to think critically and to problem-solve.

The participants suggested that one of the major impediments to teachers attaining a level of digital-competence is time. Teachers seem pressured in the undertaking of current teaching deployments that utilise established (perhaps now superseded) technologies. However, significant time is needed for intensive professional development, requiring learning of new technologies and their implementation in a radically revised approach to curriculum delivery. Furthermore, aligned with these innovations in teaching delivery are new requirements for rethinking timetabling. The timetable is a grounding administrative organiser for educational delivery and its fixity presents enormous inertia for change, which has widespread impact. The growth of collaborative subject areas necessitates reconsideration of timetabling of hour-blocks, into longer timespans, especially where students commence work on different projects within a single class. Finance posed another challenge. The difficulty of funding digital technological components is extremely problematic, with AR (augmented reality) and VR (virtual reality) cited as examples. This arena of technology seems too expensive for secondary schools at the moment, or at least for low-decile government schools. Though it is viewed as a much-needed and valued addition to many curriculum offerings.

Crossing disciplines

All participants concurred on the integration of subject areas as the desired way forward in an innovative learning environment (ILE). Students struggle to learn when processes are fragmented or detached, when topics or facets are not viewed as intertwined and connected. Purpose-built schools for integrated learning (ILEs) have demonstrated the efficacy of new spatial models of integrated classroom design, coupled with integrated curricula, where students are producing very coherent work because they have been exposed to integrated models of learning, enabling reflection and independence in learning.

Incorporated in these learning models at Sunnyvale High, is the adoption of Kaitiaki, a New Zealand Māori term for the concept of guardianship of the sky, the sea, and the land. This adoption is evident in cross-curriculum projects involving environmental concerns, with consistent use of digital technologies, as seen in initiatives such as vertical teaching with students from Years 9 to 13.

The Kaitiaki approach enables real-world linking, exposing students to community engagements in finding solutions to existing problems, along with learning from the world about them, as well as from global perspectives. Here, students are not merely participating in a science or biology curriculum as fixed knowledge, but using digital technologies and planning for an entire process—a 'living' project—from start to finish. Working across curricula standards, where there is co-creation with other teachers, students are able to work on a project that enables them to gain credits across several subject areas. In many cases, utilization of a digital platform combines a central project with elements from different traditional subject areas. In this way, students become involved in the world around them in real projects, while developing skills and collecting evidence along the way.

Change

Digital technologies have a revolutionary impact on learning, heralding their importance to future learning. The pedagogical shift in the teaching of digital technologies is intrinsic to all education moving forward. Participants suggested that students now interact so completely with digital devices that their absence hinders engagement in the learning environment. This pedagogical shift parallels the increase in technology, with importance attributed to the transferability of digital technological skills. Building key skills within one arena, which implies understanding of perspectives, identifying and analysing causes and consequences, becomes more easily transferable to other learning arenas when the media for learning coincide, as with the ubiquity of digital devices.

Role changes

For the participants, the greatest obstacle for many teachers in moving forward with change was acceptance of the shifting paradigm of their role from one of "an oracle of knowledge" to one of being a facilitator of learning. Expectations for students to self-directed research, through on-line tutorials, implies that teachers will no longer need to demonstrate expertise in their subject area. This quite fundamental change to the structure of pedagogy suggests the potential for an entirely new symbiotic relation between teacher and student. Within the digital technologies field, it is currently more likely that students know more than their teachers. The Deputy Principal who participated, emphasised the importance of teachers remaining open to the gaps in their digital technologies knowledge, meaning that they do not become defensive or negative concerning adoption of new technologies, recognising that students respond favourably when given agency. In other words, in order to allow students to make discoveries on their own, teachers need to be confident in being vulnerable, while still providing an essential degree of direction in student learning.

The impact of digital technologies leads, potentially, to a new vision of the changing role of schools as research centres, serving their immediate community with a variety of initiatives. However, the very ability to integrate schools more fully into their community initiatives necessitates students engaging beyond the 'perimeter' of their school environment, requiring change to understandings or definitions of 'school infrastructure'. To this end,

school leaders partner with local industry, with a view to enable better access for all students to digital devices. For example, industry mentors, such as Fisher and Paykel Healthcare, are involved with the planning and implementation of projects at Sunnyvale High, while also enabling teachers to practice or change the pedagogy that allows 'flip-learning' to take place. Concentration on the development of infrastructure for change raised concerns of time-allocation for learning. With the pairing of learning areas, longer 'blocks' have been created, to enable more extended time for concentrated research on projects, within the school's research remit. These collaborative projects allow several student grades, across several subject-areas, to be worked-on simultaneously within the one project.

Creativity was emphasised as essential within the building blocks of digital technologies. Ability to play and make mistakes is integral to driving new scientific breakthroughs and advancements in life. The ability to play was reinforced with the introduction and experimentation with the software product, *Minecraft*, which was deployed in developing a unit around cultural significance, looking at geographical and urban landmarks from cultural perspectives. Outcomes from this gaming approach highlighted the power of digital technologies and computer-based games that are highly visual in nature. Acceptance and engagement from students was immeasurable.

Ministry of education

All participants were in agreement with the initiative to include five Digital Technology areas in the New Zealand Curriculum by 2020. However, this was balanced by concerns over the pressure of teaching the already-established curriculum, while simultaneously endeavouring to integrate new initiatives within a short timeframe. The teachers were concerned for struggling students, already working hard to attain university entrance subjects, without adding more into the curriculum. They also voiced reservations about teachers' abilities to teach the new curriculum, as well as the lack of available resources, even though the government has indicated willingness to fund the integration. NCEA was also 'blamed' for restricting teaching content. All participants discussed the restrictions instituted by NCEA assessment requirements, regarding freedom for creativity and innovative teaching, without the restrictions of external assessment. Their opinion is that the students of their school do much better in internal assessments than under the pressure of exams. In other words, relevant projects with assessment objectives are far more suitable for the students' learning processes and achievement outcomes. This claim is supported by a New Zealand Herald article, which states:

> Students do much better when they are internally assessed than when they are put under the pressure of an exam. The difference in achievement rates between the two types of assessment can be nearly 50 per cent, although the gap differs according to subject, level and school decile. (Singh and Jones, 2014, p. 3)

Outside the school

The integration and use of digital technologies within the school curriculum has the potential to lead to innovation within previously undiscovered pathways. For example, students have used digital technologies to calculate the differential of expenditure of calories of a particular athlete, in his daily routine *and* in competition. Students have been exposed to new worlds, in on-line accessing of international sites through 3-D mapping visualisation. Virtual experience of environments enriches and broadens the lives of students, without the necessity for travel (or for those without the opportunity to travel). However, a common

theme for participants was the need for awareness of adverse influences within digital environments. Participants emphasised the necessity for responsibility by the present generation of educators, to ensure that safe practices are instilled into students to enable them to be honest and worthy citizens and civic leaders of the future.

3. Discussion

The aim of this third section of the discussion chapter is to bring concerns developed from the literature and from the empirical case study into more complex discussion. As intimated in the introduction to this chapter, how do the perspectives afforded by teachers actively practising digital technology integration compare to descriptions and prognoses in the literature, including international, especially OECD literature, and national Ministry understandings and prescriptions? Equally, to what extent are teachers unaware of the growing body of literature on secondary school pedagogies and learning environments? To what extent are the paradigms, by which teachers understand their futures, being eroded or superseded by research frameworks found in current literature? In order to extend discussion, this final section is structured in terms of key themes or concerns that have emerged from this study:

OECD

Undoubtedly, the OECD holds an influential role both internationally and nationally. In recent years, a large body of OECD literature has emerged as a result of rapid technological transformation, forming the theoretical underpinnings to pedagogical approaches, contrasting OECD member-nations, rating and ranking them according to OECD's own performance indicators, which then become, by default, operators for those member-nations. However, more research is needed on the role of the OECD, on the global and political agendas it fulfils in defining technology-driven educational expectations for nations whose individual cultures, languages, socio-economic make-up, and governmental structures are vastly different. The importance of competencies for the twenty-first century has led to fundamental questions about the extent of the knowledge-base to enable student competence for contemporary and future societies, and this fact can be recognised in the findings. It is generally agreed that twenty-first century competencies demand significant changes in curricula. These changes necessitate a reorganisation of aspects of the curriculum in order to make room for new teaching methods and assessment procedures for those competencies in OECD countries.

Consensus about competencies, considered critical for the learner and teacher, are evident in bodies of international and national literature. There is general accordance across these frameworks about the importance of collaboration, communication, digital literacy, citizenship, problem solving, critical thinking, creativity and productivity, as essential for living in and contributing to our present societies. However, few of the frameworks provide detailed descriptions, or clearly elaborated curriculum standards or include descriptions of what the curriculum experienced by learners will actually resemble, if the broader aims of these frameworks are to be realized (Voogt, et al., 2013).

Most OECD literature describing digital technology competencies includes different approaches for their curricular integration in the learning environment, including an

addition to the existing curriculum, as new subjects, or as new content within traditional subjects. Or, they integrate as cross-curricular competencies that both underpin school subjects and place emphasis on the acquisition of wider key competencies. There is a third direction, that includes competencies in a new curriculum in which the traditional structure of school subjects is transformed and schools are regarded as *learning organizations*. Although different approaches are acknowledged, most frameworks recognize the complex and cross-disciplinary nature of twenty-first century competencies and, thus, recommend integrating them across the curriculum in OECD countries (Voogt, et al., 2013).

New Zealand has responded reasonably well to the global direction of digital technological changes. Government has referenced OECD literature and collaborated with educators and industry to make sweeping changes to the teaching of digital technologies in the New Zealand curriculum. It has followed an important OECD recommendation, for school systems to find more effective ways to integrate technology into teaching and learning, with the introduction of five distinct disciplines in their own right and an expectation that digital technologies will be integrated within other learning areas of the curriculum. It has also made some progress with a further recommendation to provide educators with learning environments that support twenty-first century pedagogies. However, there is no directive for a further OECD recommendation, which suggests transforming the traditional structure of school subjects and viewing schools as learning organizations. Therefore, it was significant to recognise a particular Sunnyvale High initiative, with its timetable restructuring, which allows for flexibility and promotes an evolving role of the school as a 'research centre or hub', resonant with the OECD recommendation for a 'learning organisation'.

MOE expectations

The MOE plays a pivotal role in defining nationally the future of digital technology integration into schools. National structures and agendas have been produced, that align with a number of international (predominantly OECD) frameworks concerning the adoption and integration of technology into teaching and learning. The MOE has organised regional 'meetups' with hands-on workshops to support teachers and leaders in understanding and implementing the new Digital Technologies curriculum content, where experienced facilitators deliver workshops for all levels of expertise.

In June 2018, Education Minister, Chris Hipkins, launched an additional $12 million support-programme that aids the implementation-phase with face-to-face coaching sessions with digital technologies specialists and online toolkits, among other things. He encouraged all teachers to sign up to the programme, which he believed will help prepare staff correctly. However, teachers at Sunnyvale were not aware of these opportunities, pointing to an alarming discordance between Ministry expectations and teacher practice. While there was unanimous agreement among participants for the new curriculum content and a real desire to integrate digital technologies into their subject areas, a common concern was teacher readiness and time-pressures, a concern that translated into lack-of-time for its facilitation, especially when priority is given to assist students achieve NCEA Achievement Standards.

Schools have a responsibility to strategize carefully by appointing the drivers of the new curriculum, timeframes for walking towards it, decisions about appropriate technological tools, the professional learning required by teachers, and processes for integration within a

school's established systems. However, this requires substantial time from already 'time-poor' teachers, pointing to the compelling need for New Zealand schools to consider greater allocations of time to equip teachers with sound pedagogical and technological understandings. Unfortunately, there was a strong sense that teachers did not feel enough, if any, time had been attributed to learning about these new incentives. The Ministry has failed to take into consideration the existing heavy workload of teachers, the substantial time and planning needed for training, developing knowledge, and planning for curriculum integration.

Hence, while it has pushed through new curriculum content, it has done so without careful thought and consideration of the pressured nature of the existing teaching and learning environment in New Zealand schools. It appears that government has not considered the importance of teacher-readiness as one of the biggest challenges when implementing a new curriculum, nor the importance of teacher confidence, knowledge and capability, indicating important differences between MOE expectations and the reality of teacher-readiness for New Zealand educators. My findings suggest that New Zealand teachers do not feel sufficiently prepared or supported for new pedagogical approaches, nor do they fully understand how digital technologies and pedagogy interact. There was no evidence of implementation of relevant teacher training, skills development, nor peer mentoring. For effective implementation of digital technology competencies in the New Zealand secondary school system, amendments are required to strategic planning, resourcing and time management. The MOE's expectations and policies, including its timetable for integration in 2020, appear to be unrealistic.

Industry Expectations

> Today, and in the future, employers are looking for graduates who are curious, agile, creative thinkers and lifelong learners. (Fletcher, 2019)

Education, at all levels, serves the communities in which it is embedded. Yet, education that does not address national priorities in industry is considered inefficient. Those priorities are driven globally by rapid technology innovations. Such innovations in technology are New Zealand's third largest export earner. A repeated 'theme' developed within this research pointed to the value of industry collaboration. However, the case study found that educators are frustrated at industry partners' reticence to "become involved." They emphasise that industry should be more prepared to liaise with schools to help ensure more digitally proficient school leavers. Flynn et al (2016) corroborate this with their finding that industry–school partnerships are increasingly being recognised as a new way of providing important education opportunities, particularly in industries where there are skills shortages. However, there is a paucity of research investigating their impact on school-to-work transitions. My research suggests there to be a lack of government infrastructure to support collaboration between industry and schools. Continuation of current practice, where most collaborations between industry and schools occur on an 'ad hoc' basis, may well be disastrous, leading to a breakdown in the integration of digital technologies into subject areas. This leads to the question: are these rapid changes in our best national interests?

Government has initiated collaborative new programmes, such as P-TECH (Pathways in Technology) connecting schools with tertiary education organisations and industry

partners, with a view to helping provide relevant career pathways for students. An initial cohort of around forty students from South Auckland schools has teamed up with Manukau Institute of Technology, IBM and The Warehouse Group in a bid to open doors to discover where digital technology might lead in future careers. These students are supported to complete a five-year structured programme, spanning NCEA and into tertiary education, earning them a New Zealand Diploma aligned to industry needs. This will lead them to entry-level employment with industry partners, including IBM and The Warehouse. IBM and the MOE are eager to see the P-TECH programme adopted in other parts of the country, with more schools and industry partners coming on board (Education Central, 2019, p. 1). Undoubtedly, innovative programmes, such as P-TECH, help close the gap between industry expectations and students' digital skill sets.

This is a promising start with industry collaboration but, in reality, is only a small step in terms of the scale of required initiatives. Both government and industry need to inject more planning and funding to make this a reality for more school students in New Zealand. Much of the time these initiatives are spasmodic, lack on-going organisation, and do not offer aspects which are crucial, such as teacher up-skilling and time allocation. This research suggests, from discussion with participants, that teachers involved in collaborative programmes are not able to push the digital technological boundaries effectively enough to make real changes to student experiences. Teachers are not given sufficient time or resources to reach an appropriate level for successful implementation. Government appears to be failing to support their policies with development processes for teacher skills.

Real world understanding

Allied to industry expectations is the notion that education has its agency or efficacy in real-world situations and problems, and not in frameworks that foster learning simply for its own sake. There are drivers for secondary schools to find increasing porosity with the communities in which they live, not only industry connections, but also social, cultural and political communities. Are schools adapting, in the integration of digital technologies, to become service-providers for their embedded communities? For students to play a realistic part in all aspects of life, they will have to live with uncertainty, across a wide variety of social change: negotiating the temporality of how the past, present, and future are to be understood; in the complexity of scales of social space—family, community, region, nation and world; and in digital space. They will also need to engage with their natural world, to appreciate its fragility, complexity and value (OECD, 2018c). The OECD *Education 2030* project has identified three further categories of competencies, the "Transformative Competencies," that together address the growing need for young people to be innovative, responsible and aware:

- Creating new value
- Reconciling tensions and dilemmas
- Taking responsibility (OECD, 2018c, p. 4)

The OECD (2018c) report emphasises preparedness for a future when individuals have to learn to think and act in a more integrated way, taking into account the interconnections and inter-relations between contradictory or incompatible ideas, logics and positions, from both short-term and long-term perspectives. In other words, they need to be systems thinkers.

This approach, therefore, contains a complex notion: the mobilization of knowledge, skills, attitudes and values through a process of reflection, anticipation and action, in order to develop the inter-related competencies needed to engage with real world challenges. A successful complex approach for future students in a 'world-society' will necessitate significant realignment of curriculum content and delivery, world-wide. A digital curriculum in schools is, perhaps, simply the start when reimaging education. Experts from within the government note that New Zealand schools risk being 'left behind'. One of the major realignments to be negotiated is the role of the future teacher. Speakers in this year's *Bett Asia Education Leadership Summit* in Kuala Lumpur, envisioned the phasing out of the traditional role of teachers, reimagining them as data-scientists or change-leaders, who find educational trends and other problem-solving solutions (Long, 2019a). The revised role of the teacher as change-agent will lead supposedly to improved student involvement in real-world situations and problems, rather than in traditional frameworks and processes that foster learning for its own sake.

My research findings suggest that the changing role of teaching, due to student ability for quickly accessing large amounts of data, implies that teaching should now aim to push students into becoming active learners, thus fostering a thirst for discovery and knowledge. The teacher then acts as a quality and quantity 'filter' for large data, leading students to real-world understandings, with social, cultural and political implications. Teachers thus foster the importance of student-centered collaborative learning approaches, enabling students to recognize that they are crucial to the learning experience of their study-group. This involves an ethical dimension, as students are encouraged to recognise the necessity to be mindful of how fragile their world actually is: their actions have major effects on our collective environment.

Future proofing

Is future-proofing a myth? Given the prognoses of rapid change—in fact, accelerating change—what now does future-proofing mean? Given that those who look into the future suggest that forty percent of work opportunities that will exist in twenty years have not as yet been invented, how do educators focus on future prospects for their students? Teachers in New Zealand are increasingly encouraged to adopt a future-focused approach to education, with flexible approaches to teaching, situated within open and adaptable learning environments, embracing digital pedagogies (Leggatt, et al, 2015). Policy documents, such as *The New Zealand School Property Strategy 2011-2021*, (Ministry of Education, 2011) affirm that innovative learning environments are a means to develop a "world leading education system for New Zealanders with the knowledge, skills and values to be successful students in the 21st-century" (Ministry of Education, 2011, p. 2). It requires planning and design strategies from both government and schools to support a 'fluid-learning' environment where pedagogy, technology, and new ideas are continually evolving and blurring traditional boundaries. With the development and implementation of new curricula, comes the need for flexible and adaptable environments supporting the dynamic nature of teaching and learning with collaboration and active problem-based environments, for adaptive learning and use of the latest technology for amalgamated curricula and immersive simulation environments (Dumas & Johnson, 2015).

This calls for an increased need for teachers to teach digital technologies in ways that reflect future-focused approaches to learning. Its identified emphasis is likely to hold perplexity for some teachers, with its requirement to deemphasise the technical nature of the subjects they are teaching and, instead, extrapolate students' conceptual understanding by engaging in future-focused pedagogy (Reinsfield, 2018). While effective future-proofing of education ensures the usefulness and continuation of educational designs or changes, schools must realise they cannot continue to operate solely as transmitters of knowledge. Educators need to share international best-practice, to provide personalised learning experiences for all students, and guide them to develop cognitive abilities that will make them fit for the future. There needs to be an evolving paradigm, for the twenty-first century, based on creativity, collaboration, critical thinking and communication.

My research suggests there are persisting tensions affecting teachers' integration of digital technologies in the secondary school context. While there was some evidence of future-proofing, it was not part of an overall collaborative process within the school. Although the school was in the initial stages of instigating change to content delivery, with the integration of subject areas, existing processes appeared fractured and disjointed, with little collaboration. While some teachers demonstrated forward-thinking and innovation, these were isolated cases. Involvement of the students with their community and alignment with industry occurred in a limited fashion, with little collaboration, continuity or fluidity. Some teachers were highly motivated to introduce virtual digital technologies into their learning environments, but were stymied due to lack of financial resources. These are major impediments to the future 'thrust' of future-proofing digital technologies within New Zealand education. Forward thinking teachers should be applauded and encouraged as genuine pioneers in the education system, rather than hampered by lack of direction, guidance and resource.

Effective future-proofing of digital technologies in the education system is reliant on government and educators. Aspects, such as professional development, with ongoing need for sustained personalised and context-specific professional learning, as well as significant financial input need to be fully recognized and developed by the Ministry. However, emphasis on the government's agenda, and the recent changes to digital technologies within the curriculum, also present an opportunity for teachers to think differently about pedagogy, with the responsibility to enable a future-focused approach to its implementation. For success, educators need to be committed to dynamic learning approaches, enabling students' participation in a developing global and digital community (Dakers, 2016). This is particularly pertinent to Sunnyvale High, with its outward looking approach to future development of its holistic learning environment, or learning ecology.

Technology colonisations (and de-colonisations)

Technology colonisations and de-colonisations are important considerations for those responsible for child education, with the widespread adoption of digital devices in primary and secondary education. As I intimated in the opening discussion of this thesis, my own 'history' in educational environments is one that has witnessed an incremental colonising by technologies of educational delivery, that now come in the form of ubiquitous digital devices. More recently, we are also seeing a 'backlash' against the ubiquity of these devices in classrooms, as teachers attempt to wrest students away from digital screens, and into other kinds of social or communal interactivity. How do schools find a balance between the

demands of technology-rich environments and emphases on human-to-human interactions? One of the main concerns with the immersion of technology in the learning structure is the extent of its immersion. Most teachers have grabbed digital technologies with both hands, knowing little about how to apply it effectively into their pedagogical approaches. Several of the study respondents were adamant that 'the basics' not be overlooked, and suggested that digital technology should not be the focus of a class but, rather, incorporated in a holistic and inclusive manner. It is obvious that with the myriad of online resources, technology can help improve teaching, and it can be used to enhance traditional ways of learning, keeping students more involved.

There is also no doubt that when used productively, it can foster a more collaborative learning environment. Students, working together online, are able to share or combine information, thus be involved in group projects, that offer a student group the ability to interact when not at school. Online learning also enables direct communication with a classroom teacher, individually, or as a group. However, perhaps the integration of digital technologies needs a measure of decolonization so that students are not completely 'zoned in' to their digital devices, resulting in a lack of physical and verbal interaction with their peers. There is an argument for time-allocation for discussion and group interaction, without digital prosthetics. In this way, assignments created in class may incorporate digital tools as well as group-collaborations and oral presentations, to enable dynamic learning for students. It is clear that digital technologies are now embedded into the future of education at all levels, and that benefits are currently perceived to outweigh disadvantages. However, teacher-student relationships are paramount in any learning environment, and digital technologies should be viewed as an 'assist' rather than a displacement of such relations in classroom activities.

Conclusion

The participants at Sunnyvale High were well aware of the technology transformations expected to take place in their learning environments and, on the whole, were enthusiastic to incorporate a digital framework within their subject areas. While this was positive, the reality was that they were doing it almost *intuitively*. There was no professional training for digital technologies, resulting in teachers having to 'try things out' until they worked. In the absence of IT assistance, it would appear that students were a valuable resource in 'troubleshooting' and finding the way through technical difficulties. Furthermore, while innovative teachers were enthusiastic about incorporating technologies enabling virtual and augmented reality, flipped classrooms and the integration of digital technologies across subject areas, there was an alarming absence of planning, design, professional development and financial resource to make this possible. All teachers showed genuine concern about how the 2020 MOE initiative was going to be accommodated, funded and taught, considering the content is yet to be written.

The culture of the school was community-inclusive and with the Kaitiaki approach, the community was integrated into the school's curriculum and pedagogical approaches. Within this inclusiveness, teachers were working diligently on involving local and national industry groups. This was not entirely reciprocated by industry, as involvement with school systems did not seem to be high on their agendas. Lack of overall collaborative process between MOE and schools, and schools and teachers is causing persisting tensions in the integration of digital technologies. Urgent action needs to be taken by government and

schools. Only a groundswell of radical change will ensure success in the thrust towards future-proofing digital technologies in secondary schools in New Zealand.

This research brought to light several important aspects from interactions and investigations within the interview process. As a researcher, I have been involved for the past fifteen years within the tertiary sector, developing and heading for much of that time, a core degree strand in digital visual technologies. Encapsulated around this has been a contextual expectation of what a secondary school is, how it delivers curricula, and how the integration and development of digital technologies happen in schools across a range of subject areas. This research project uncovered a surprising dislocation between these views and expectations. It now appears to me that Sunnyvale High, as a case study Decile 1 school, is indicative of the partial positioning of high schools, where the integration of digital technologies is under development but lags far behind government intentions. However, there is some evidence of general student aptitude and student-centered approaches to learning incorporating digital technologies and new learning environments in the case study school. This researcher applauded and was intrigued by on-going developments of a common programme involving the school and its immediate community. This community aspect definitely requires further investigation, in terms of its reciprocal integration across school and community, including expectations for future-focused progress and its relevance for the tertiary sector.

Chapter Six

Conclusion

Introduction

Alignments between research findings from the participants and literature findings were addressed in the preceding discussion chapter, offering a broader contextual narrative of the experiences of participants. In this concluding chapter, I want to reflect on these findings, as well as implications for the future. This case study focused on selected teachers' perceptions and practices regarding benefits and challenges associated with introducing digital technologies into their subject areas. Though, I have aimed at broadening this case study to the wider concerns of national and international directions in education. There are nine short issues I address in this chapter by way of summary conclusion: a statement of the research, the research questions, the background, and the framework of the study, along with an outline of the significance of the work and its limitations. I also address the main findings, and potential future research.

Initial research question

This study sought to answer a main research question:

- How are New Zealand secondary schools currently implementing the digital technologies initiatives defined by the MOE?

There were also two secondary questions to be addressed:

- To what extent has implementation of the digital technologies initiatives led to the breaking of silo discipline areas in secondary school teaching practices?

- To what extent have the MOE's initiatives in twenty-first century curriculum innovation, school facilities design innovation, and digital technologies innovation been adopted by schools with perceived positive results?

Aims of the research

This study investigated what is actually happening in secondary schools with respect to the adoption of the digital curriculum, understanding that some schools are making the most of the technology while some are very slow on the uptake. Given that the project is a Master of Philosophy, its scale is modest, and the research is seen as preliminary or preparatory for future research. The research focussed on one Auckland secondary school, in the low decile range, with some commitment to adopting digital curriculum initiatives, including the potential for discipline divides to be broken down.

Research objectives

Secondary education in New Zealand is undergoing considerable change and the MOE is driving change via a number of initiatives. As suggested in Chapter Two, one initiative is in the implementation of *The New Zealand Curriculum*, a document with the intention to prepare school leavers for anticipated changes to work and living in the twenty-first century (Ministry of Education, 2017g). A second driver is the implementation of new school facilities design, as innovative learning environments, while a third is the implementation of New Zealand government 2014 initiatives to enhance the use of digital technologies in schools. This includes the 2017 implementation of a new curriculum initiative in digital technologies, which aims to work across all subject areas. As intention of the first two initiatives is to rethink the siloes of individual subject areas, developing holistic approaches to education. Digitization, as ICT innovation, is seen as a means of enhancing the potential for such holistic integration across discipline areas. The research had particular focus on digital technologies within the panoply of ICTs introduced into schools. It addressed a range of secondary school subject areas, with a view to establishing the level of integration of digital technologies into curricula. On the basis of its findings, the thesis recognises the need for policy recommendations addressed to the MOE, such as explicit guidelines for the advanced adoption of digital technologies across curriculum areas, as well as indicative procedures for schools to enhance holistic approaches to subject integration. The need for policy development is emphasised in the statement of contributions this thesis offers to research in the field.

Collation of literature

The literature discussed in Chapter Two established a critical background to the research, in terms of international and national perspectives on implementations of digital technologies, along with international and national contexts of agencies and adoptions of digital learning strategies. Given the limited overall scale of the research project, the literature search aimed at sourcing contemporary literature with an implementation orientation, hence the emphasis on OECD and New Zealand MOE sources. Academic-research literature in the field has been engaged to a lesser extent, though particularly

where its explanatory-value located aspects or issues concerning implementation. Thus, applications of digital technologies, implicating pedagogical approaches, revealed insights into both benefits and challenges for teachers and learners. Other literature provided background to the integration of digital technologies into secondary curriculum fields in a New Zealand context. This included investigation into both recent and future-focused processes and decision-making of New Zealand governmental digital technologies planning, within the schooling system. It further addressed OECD recommendations for implementation of the integration of digital technologies into curriculum areas in its member countries. In response to OECD guidelines, the MOE has revised the technology learning area in *The New Zealand Curriculum*, with inclusion of two new technological areas:

- Computational thinking for digital technologies
- Designing and developing digital outcomes

This inclusion aims to ensure that all learners know about digital technologies and understand decisions in their use and creation. Government intention is for students to move beyond simply engaging with digital technologies. It aims for students to be innovators of digital applications and creators of digital solutions. The New Zealand government's intention is for students to experience a rich curriculum that engages and challenges them, that is forward-looking, and inclusive.

Initial investigation necessitated establishing the background and development of the digital technologies field in the New Zealand education system. This was followed by an examination of its permeation and utilization in various subject areas, in some cases under strong opposition. Literature available on the subject was quite dispersed, thus containing it in a focused way was paramount. This led to focused investigation concerning the New Zealand government's *intentions* for the future of digital technologies in pedagogical arenas: its proposals and attempts for implementations of initiatives. Finally, there was analysis of OECD recommendations for integrating an advanced digital ethos into curriculum offerings in their member countries, developing a comparison with New Zealand processes.

Collation of empirical findings

This Master of Philosophy thesis used a number of methodological approaches, guided overall by an understanding of critical hermeneutics (Gadamer, 1975; Ramberg & Gjesdas, 2009). The research methods were 'critical' inasmuch as they aimed to question the basic structures by which the conditions of possibility for the various agencies were determinable. The frame of reference for this 'case' study, an empirical inquiry that "investigated a contemporary phenomenon within its real-life context," was to mark an emergent phenomenon in education (Yin, 2003, p. 13). I chose to use the 'critical-instance' case study, which examined one or more sites for the purpose of examining a situation of unique interest - in this case, the integration of digital technologies in a specific setting (Gülsecen & Kubat, 2006).

The study was informed by depth engagement with current literature in the field of education curriculum, its innovation and application. The participant study used a 'case study' methodology, whose findings were compared and assessed in relation to the literature study. The data gathering was interesting, as some participants were very forthcoming with their experiences while several were not. As illustrated in the Findings chapter, each

participant approached the digital aspect in their subject area differently. Some indicated reticence, while others allowed students to follow their creative inclinations. Wider and more investigative use of digital technology was evident where teachers were guiding collaborative subject project. This progressive endeavour seems critical for future teaching and learning in the integration of digital technologies.

Analysis of data

Data analysis was based on bring to synthesis three practices, those of noticing, collecting, and thinking. The analytic challenge was thus to establish findings by reducing data, identifying categories and connections, and developing themes, so as to offer well-reasoned, reflective conclusions. Inspired by Seidel's (1998) symphonic metaphor, I viewed the process of analysis as iterative (repeating cycle), recursive (returning to previous point), and 'holographic' (understanding changes as the position and orientation of the viewing system changes and retains the same object of focus). This process provided a transparent narrative of participants' voices. Miles and Huberman (1984) claim that "words, especially organized into incidents or stories, have a concrete, vivid meaningful flavor" (p. 13). I made meaning of the data by valuing stories that narrated personal transformations within the context of the exemplar learning environments. I did not establish pre-defined categories for qualitative data, and an iterative coding approach was used for analysis including:

(i) Identification of 'first-level' codes
(ii) Grouping into 'pattern codes,' identifying themes.
(iii) Mapping of codes (with data material) noting relations between them.
(iv) Comparison of networks of themes for the interview data corpora to key findings from the literature.

Research conclusions

Sunnyvale High School was in the initial stages of instigating change to content delivery, with the integration of digital technologies within subject areas. It was rewarding to witness the endeavours of some teaching staff to develop pedagogical approaches to subject delivery. However, existing processes in the case study school often appeared splintered and disorganised, with little cooperation across subject areas. While some teachers demonstrated enthusiasm and inventiveness, it appeared these were isolated cases across the school. In reality, there was a lack of structure, planning and professional development, resulting in teachers incorporating digital technologies at times haphazardly and arbitrarily into their learning environment. Lack of professional training resulted in teachers having to 'try things out' until they worked. I deduce from this that the New Zealand government has not planned effectively for the implementation of the new curriculum initiatives. Expectations for effective realisation of digital technologies across the curriculum appear to fall dangerously short. Teachers are expected to adopt new processes and incorporate them into their classrooms with limited training, time and resources. Questions need to be asked about government lack of insight and consideration for the mechanics and processes of schools. To date, there is strong evidence of unreal expectations for the immediate and effective implementation of innovative curriculum changes within New Zealand secondary schools.

In addition, it appears from the Findings that the traditional pedagogical approach to learning and the exam process are not working for many student groups. A different approach needs to be initiated and worked-through, which may be project driven, such as learning collaboratively across several subject areas, with students reaching 'milestones' at their own speed. This enables group work, 'real life' experiences and involvement with the community, as with Kaitiaki, where the teacher is a facilitator, rather than a disseminator of knowledge, directing from the front of a classroom. For example, a key finding was the immersion of a Kaitiaki approach into collaborative school projects. The integration of the philosophy of guardianship of the environment into pedagogical contexts with community involvement has real meaning for the participants. This approach, with its school-community-industry collaborations, leads to improved education and employment outcomes. Knowledge learned at school can be applied in real-world situations, adding value to learning. Such collaborative projects enable a realisation of personal values while also minimising the mystique when transitioning into work or tertiary study. However, the main concern is that this process is *ad hoc* and many of the teaching staff do not have the required skills to promote and develop integration. This resulted in limited collaboration, continuity or fluidity with community and industry. One area for further development is for industry and business to provide advice and assistance to students for future vocational pathways. This is something I intend for further research, in order to investigate and formulate future policy drivers.

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Contributions to the field

Arguably, the main finding arising from this research is the tentative nature of innovative and collaborative processes in the utilization of digital technologies evident in this secondary school, their relatively unplanned and under-resourced agency. Given that 2020 is only months away, and there is expectation for full implementation of the new curriculum, this research suggests a lack of realism on the part of the MOE and difficult times ahead for many New Zealand secondary schools. However, evidence did point, for this researcher, to more advanced digital technology learning approaches than initially expected, familiar as he is with tertiary requirements. Within these learning approaches are increasing developments of collaboration between subject areas. As Jenson (2014) suggests:

> Collaboration is increasingly valued in the education sector because it offers three key benefits. First, collaborative structures allow teachers to coordinate shared activities more efficiently than centralised bureaucratic organisational structures, which are often costly and rigid. Second, collaboration can lead to a more authentic engagement of teachers because it allows them to build voluntary, reciprocal relationships. Such relationships can create a greater sense of belonging for teachers in a system where a strong fragmentation into disciplines causes many to feel isolated. This level of collaboration also enables teachers to challenge each other to further improve practice and allows collaborative moderation that can address differences between classes. Third, collaboration can provide teachers with flexible and differentiated professional support tailored to their specific needs and objectives. (p. 9)

Where participants were pursuing active collaboration between different subject areas, including activities such as peer-observation and feedback, team-teaching and joint student projects, this proved a powerful platform for learning, with definite positive impacts on students. In fact, all teachers emphasised that teacher-collaboration improved student outcomes, more than when working alone.

Limitations to the findings

Although the findings from the study suggest real changes are occurring within pedagogical practice, this is gained from researching one low-decile school. In addition, the research utilized only one data collection method, the interview. Based on these two limitations, the researcher cannot assert confidently that the findings encompass a wider cohort of secondary schools. Nonetheless, this is a valuable study, contributing to research on this topic and definitely provides a basis or grounds for future research on a broader range of learning environments.

Putting the findings into action

My aim is to undertake further research on these various findings, with an intention for dissemination in journal and conference publications. In particular, I aim to investigate the validity of findings for a wider grouping of schools, across various decile ranges. Finally, based on these findings and a better understanding of their generalisation, I aim to develop policy documents, directed to the MOE and Tertiary Education Commission, concerning innovations in secondary-tertiary transitions, as well as a review of approaches to teaching digital technologies at tertiary level.

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APPENDICES

Appendix A
Ethics Approval letter

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

28 August 2018

Mark Jackson
Faculty of Design and Creative Technologies

Dear Mark

Ethics Application: 18/324 **The application of digital visual technologies in Auckland secondary schools**

I wish to formally advise you that a subcommittee of the Auckland University of Technology Ethics Committee (AUTEC) has **approved** your ethics application.

This approval is for three years, expiring 28 August 2021.

Non-Standard Conditions of Approval

1. Amendment of the Information Sheet as follows:
    a. Removal of the offer of counselling;
    b. Consider simplification to improve readability by non-technical readers.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/research/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/research/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/research/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: john.piper@aut.ac.nz; Andrew Gibbons

Appendix B
Information Consent Letter

Participant Information Sheet

3 March, 2019

Project Title

The application of digital visual technologies in Auckland secondary schools

An Invitation

My name is John Piper and I am a Senior Lecturer in the Bachelor of Design – Digital Design, in the School of Art & Design at the Auckland University of Technology (AUT). I am undertaking a Master of Philosophy degree at AUT investigating how secondary schools are adopting digital technologies across curriculum areas, with a particular focus on visualisation technologies. In this research, I am inviting you to participate as a secondary teacher who is likely to be working with digital visualisation technologies in your teaching. Whether you choose to participate or not is entirely voluntary and will neither advantage nor disadvantage you, though it may offer an opportunity for you to reflect on current digital strategies approaches in New Zealand secondary education. I have been involved in a number of secondary schools in the Auckland region in my role within the Digital Design programme at AUT. Should you be someone I have worked with in the past, I ask that for potential conflict of interests issues you refrain from accepting this invitation.

What is the purpose of this research?

This research aims to develop a better understanding of ways in which curriculum initiatives from the Ministry of Education (MOE) are being adopted in secondary schools in New Zealand. The particular curriculum focus is on digital technologies and their adoption *across* curriculum areas, with special focus on visualisation technologies. My research looks at MOE policies and frameworks regarding initiatives in implementing digital technologies, along with current national and international literature on this field. To complement these aspects of my research, I am also looking to see how these initiatives are working in schools. As this is currently a small-scale investigative study for a Master of Philosophy, aiming at developing a larger study in the future, I am limiting my school engagements to one mid-decile secondary school in Auckland, aiming to interview teaching staff in four curriculum areas, along with the school's Associate Principal for curriculum. You may want to consider potential benefits in participating in this research, in that it can provide an opportunity for you to discuss these curriculum innovations and their implementation in an open-ended interview session. You will have an opportunity to reflect on the interview when sent a transcript and have an opportunity to receive the findings of the overall research project. Outcomes from the research will include a Master of Philosophy thesis available on the internet, though a copy will be sent to you directly. There will also be conference presentations and journal articles in both national and international settings developed on the basis of my findings from this study.

How was I identified and why am I being invited to participate in this research?

In selecting one school in the Auckland region, I decided to work with a mid-decile school, as one representative of a broad range of schools nationally. I was aware of a number of schools active in implementing the MOE's digital strategy and approached the principle of your school to seek permission to undertake participatory research. My participants are defined in part by

the structure of schools into curriculum areas, and in part by the overall appropriate scale of research suitable for a Master of Philosophy. Hence, you have been identified as someone teaching in one of four curriculum areas, these being Science, History, Geography and Visual Communication. Or you may be the Assistant Principal (Curriculum) of the school. My aim is to interview separately one teacher from each curriculum area as well as the Assistant Principal, in one-hour open-ended sessions that will be recorded and transcribed.

How do I agree to participate in this research?

You will have already responded to an invitation to participate in this research that was circulated in your school, and will have thus received this Participant Information Sheet. Should you want to now participate in the research, I invite you to complete a Consent Form that will be made available to you upon confirmation that you are included in the project. Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

As I have outlined above, this study aims to gain a better understanding of how MOE digital curriculum initiatives are being adopted in schools. My aim is to see what is working well and also see, in a preliminary way, if there are impediments or resistances to implementation. As a Master of Philosophy project, its scale is modest, and the research is seen as preliminary or preparatory for a larger PhD project to be undertaken in the future. Thus, the research has a focus on one Auckland secondary school, in the middle-decile range, though with some acknowledged commitment to adopting digital curriculum initiatives. The study uses open-ended indicative question interviews with five participants drawn from the teaching body at the selected school, as I have outlined above. The overall aim is to elicit the extent to which adoption of digital visualisation technologies enhance cross-discipline approaches to learning. Your responses in the interview will be recorded and transcribed. The transcript will be made available to you in case you may want to edit it, or correct it or even withdraw from the study. From your responses and those of other participants I will analyse the material in order to develop an overall understanding of how your school is working with digital visualisation technologies across curriculum areas. My findings will be sent to you once the research is complete.

What are the discomforts and risks?

The level of discomfort or embarrassment is likely to be minimal. The range of open questions for discussion will concern your experiences in daily practices of implementing digital technologies. It may be the case that you may feel you have not been fully successful in this, leading to discomfort in disclosure. However, your responses are optional, and the interview may be terminated if you feel it difficult to discuss these matters. The research does not aim at eliciting judgemental values with respect to adoption or lack of adoption, but rather genuine successes as well as obstacles both potential and actual. I anticipate the level of risk or discomfort to be low, though teaching can be an emotional and stressful occupation, especially at times of curriculum innovation. Discussion of issues of technology innovations may raise strong feelings for you or may alert you to arenas where stress is particularly high. Again, if you begin to seem stressed in the unfolding of your experiences, you are free to avoid discussion or terminate the discussion entirely.

Your participation in this research will remain confidential in that the participating school and you as respondent will be given fictitious names in all of the findings documents, including conference presentations or journal articles. Though it may be the case that some in the secondary schooling sector in New Zealand may be able to identify your school and you as

participant on the basis of the characterisation of the school's adoption of digital curriculum approaches even though fictitious names were used.

How will these discomforts and risks be alleviated?

As mentioned above, we may avoid potential discomfort and risk by allowing you to skip over questions that you may feel inappropriate to respond to. You also may terminate the discussion altogether and withdraw from the study.

What are the benefits?

There are a number of potential benefits for you in this research. Participation offers you the potential to have informed discussion and reflection on your school's current processes of digital curriculum implementation, thereby offering the possibility for you to engage more critically with that process. In receiving interview transcripts, you will have further opportunity to reflect, and to potentially further contribute to the study in offering edits or alterations to the transcript material. In receiving a summary report of the study, you will have the potential to reflect and act on how the research has characterised the adoption of digital visualisation technologies across the school, thereby affording, potentially, positive change in the school.

As the researcher, I also may potentially benefit from this research in multiple ways. The most direct beneficial outcome will be a Master of Philosophy degree in a research field that offers significant potential for up-scaling to a larger PhD project. In terms of my teaching/research engagements, this research offers me potentials for better understanding secondary/tertiary transition, such that enhancing progress in sophisticating secondary adoptions of digital visualisation technologies may impact on how tertiary curricula are understood and developed. I will gain considerable experience in methodological approaches and methods in undertaking this participatory research, that will better prepare me for future research initiatives. I will also have opportunities for publishing findings from this research, with potentials for enhancing and consolidating my research field and reputation.

Education initiatives, whether at primary, secondary or tertiary levels have very direct flow-on benefits for wider communities whether they be communities of cultural interest, economic interest or civic interest. This research into effective holistic educational experiences in secondary schools, in its potential to ultimately enhance the creativity of schooling experiences for both educators and learners, has potentials for affecting how 21st century learning develops new frameworks for work, leisure and civic responsibility.

How will my privacy be protected?

As mentioned above, your privacy is protected in a number of ways. You may choose not to respond to questions or discussion that you consider sensitive or you may withdraw some or all of your responses when reviewing your interview transcript. You will remain confidential in all findings documents, along with your school. This is achieved by giving you and the school fictitious names. Though, as I mentioned above, this does not eliminate the potential for someone well informed about the implementation of digital curricula in Auckland, or New Zealand for that matter, to be able to identify the participating school and hence the possibly identities of those participating.

What are the costs of participating in this research?

There are no direct monetary costs that you will have to cover in participating in this research though you will have to commit your time to the study. I am planning for interviews to take no more than one hour and I will aim to conduct these interviews at a time most convenient for you, and at your school. There may be further time you will need to commit to reviewing and approving the transcript of your interview. It is hoped that this cost will be compensated by the potential benefits in engaging in discussion on curriculum development in a new and exciting arena in New Zealand secondary schools.

What opportunity do I have to consider this invitation?

In responding to the invitation to participate, and having been sent this Participant Information Sheet, you have up to two weeks to get back to me by e-mail in order to indicate that you would like to participate. During this period of consideration, I am more than happy to discuss further the nature of the research should you want greater clarification or more detail than is provided in this document.

Will I receive feedback on the results of this research?

Again, as I have indicated above, I aim to provide you with the findings from this study, especially as I consider that this research has key benefits for secondary teachers who are currently engaged in the implementation of the MOE's digital strategy.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor,

Associate Professor Mark Jackson
School of Art and Design
Auckland University of Technology
E-mail mark.jackson@aut.ac.nz
Phone 021 92 01 14

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC,

Kate O'Connor,
ethics@aut.ac.nz,
921 9999 ext. 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Mr John Piper
School of Art & Design
Auckland University of Technology
921 9999 ext.
john.piper@aut.ac.nz

Project Supervisor Contact Details:

Associate Professor Mark Jackson
School of Art and Design
Auckland University of Technology
E-mail mark.jackson@aut.ac.nz
Phone 021 92 01 14

Approved by the Auckland University of Technology Ethics Committee 28 August, 2018, AUTEC Reference number 18/324

Appendix C
Consent Letter

Consent Form

For use when interviews are involved.

Project title: **'The application of digital technologies in Auckland secondary schools'.**

Project Supervisor: ***Mark Jackson***

Researcher: ***John Piper***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 3 March, 2019.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature: .....

Participant's name: .....

Participant's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Participant should retain a copy of this form

Appendix D
Confidentiality Letter

Confidentiality Agreement

For someone transcribing data, e.g. audio-tapes of interviews.

Project title: ***'The application of digital technologies in Auckland secondary schools'.***

Project Supervisor: ***Mark Jackson***

Researcher: ***John Piper***

- ○ I understand that all the material I will be asked to transcribe is confidential.
- ○ I understand that the contents of the tapes or recordings can only be discussed with the researchers.
- ○ I will not keep any copies of the transcripts nor allow third parties access to them.

Transcriber's signature: .....

Transcriber's name: .....

Transcriber's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Project Supervisor's Contact Details (if appropriate):

.....

.....

.....

.....

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Transcriber should retain a copy of this form.

Appendix E
Interview Questions

AUT SCHOOL OF ART & DESIGN

TE ARA AUAHA | FACULTY OF DESIGN AND CREATIVE TECHNOLOGIES

Questions:

1. Can you tell me how you understand the term 'digital visual technologies'?
2. Are such technologies currently being used in your subject area?
3. Are they being used as well as they could? Is there room for improvement here?
4. Do such technologies lend themselves to bringing different subject areas into closer proximity?
5. Do you consider that new and emerging visual technologies open the possibility for changing or developing learning environments overall?
6. How are such technologies being promoted in New Zealand? What are the curriculum initiatives?
7. Can such technologies become drivers for 21st century curriculum and learning environment innovations?
8. Can such potential innovations open to new understandings of work, leisure and civic responsibility?

Regards,

John Piper

Senior Lecturer
Bachelor of Design – Digital Design
School of Art & Design
AUT University
021 575 403