The application of ICT in the music classroom: Factors that influence technology integration in New Zealand secondary schools.

A thesis
submitted in fulfilment
of the requirements for the degree
of
Doctor of Philosophy in Music
at
The University of Waikato
by
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THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

2018

Abstract

This thesis investigates how New Zealand secondary school music teachers used ICT in their music programmes between 2008 and 2012. It started from the assumption that the adoption of technology in secondary music classrooms was uncommon and mostly limited by inadequate equipment and the low premium teachers put on the value of integrating technology into their teaching.

Two data samples were collected consecutively, four years apart (2008-2012), and the data was used to identify the drivers that influence changes in the surveyed teachers' pedagogical practice. The research questions focus on music teachers' use of computer technology in their teaching pedagogy. The questions probe whether teachers integrate technology in their teaching programmes, and if they do, why and how. The questions also investigate the strongest influences on teachers' adoption of new technology. The thesis examines the changes and constants over the period of the study and reflects how New Zealand music teachers' practice aligns with that of teachers abroad. The data collected from interviews provided sufficient evidence to conduct a comparative analysis over the extended period.

Methodologically, the thesis followed a qualitative research approach combined with longitudinal elements to support the comparative analysis. The data was collected by means of interviews with 13 respondents during each of the two separate data collections in 2008 and 2012. The two data sets captured teachers' practice and provided evidence of change for analysis and evaluation. The interview questions probed teachers' skills and their use of ICT, the perceived difficulties of ICT integration, and possible changes to their practice.

The thesis divides into seven chapters. Chapter 1 introduces the topic of the thesis. It explains the role of the teacher-researcher against the background of a secondary school music department in New Zealand. Chapter 2 introduces and reviews the relevant local and international literature on the use of ICT in education, how ICT affects teachers and students during the process of

teaching and learning, and how ICT is used in music education. Chapter 3 establishes the qualitative methodological approach and outlines the analytical process that was used to determine the findings. Chapters 4 and 5 present the two data sets organised into five categories: *infrastructure, skills and knowledge, inside the classroom, support,* and *ways forward*. Chapter 6 presents the findings and provides a comparative analysis of the two sets of data. The chapter concludes with a thematic synthesis of the findings.

The findings identify four elements that are present when effective technology integration occurs: accessibility, connectivity, pedagogy, and motivation. The latter two produce intrinsic motivation for teachers to engage in the process of ICT integration. Accessibility and connectivity, on the other hand, are the most important extrinsic motivators for ICT integration.

Chapter 7 is the concluding chapter that summarises the aims of the thesis by revisiting the five research questions. The answers to these questions are discussed in relation to the findings with literature references to current music education and ICT practice. The original contribution of the thesis provides a comparative analysis of classroom practice over a four-year period. It shows how teaching practice in music classrooms changed from 2008 to 2012 and suggests reasons for these changes. Chapter 7 highlights the limitations of the thesis and provides practical implications for music teachers. Suggestions for ways to build on the knowledge gained from this thesis are made.

The thesis found that technology is not integrated effectively or consistently in secondary school music classrooms. This is despite ongoing government initiatives and professional development opportunities. The findings indicated that teachers' outlook and belief systems were powerful intrinsic motivators for the use of ICT, more so than extrinsic factors such as policy changes or access to ICT equipment. This thesis gives a unique glimpse into music teachers' practice and technology integration in New Zealand.

Acknowledgments

This thesis started out as a distant relative and gradually became an intimate friend. It began as a hunch followed by curiosity. Finally, after many ups and downs scattered with doubtful uncertainty, hopeful enthusiasm, grateful progress, and exhilirating relief, I close this book.

I would like to thank Ian Whalley and Martin Lodge for their ongoing support and encouragement as supervisors for the longest time. Many colleagues, friends and family members were involved in reading and fine-tuning my writing. I thank Anne Ferrier-Watson for her skillful assitance, patience, and eye for detail. Laraine O’Connell always made time to give me advice, regardless of her own writing and editing deadlines. My husband and two sons have been endlessly supportive and understanding during all this time, and I sincerely thank them.

Lastly, my parents’ unwavering belief in me carried me through when I was feeling doubtful and discouraged. I dedicate this thesis to my dad who passed away before he could hold a copy of the manuscript in his hands. I am certain he is looking down on us with a great big smile.

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Chapter 1

As educators, students and life-long learners we are required to distil, assess, adopt, rethink, apply and communicate knowledge continually, using a plethora of interwoven channels, modalities and media. Technology - any form of technology - enables us to do so.

(Himonides & Purves, 2010, p. 123)

How does technology fit into a secondary school music teacher's daily practice? How do teachers make use of computer technology in their pedagogy? These were some of the thoughts that piqued my interest in music technology when I was teaching in the early 2000s in a secondary school in South Auckland, New Zealand.

In this chapter, I first provide background information to locate the thesis within New Zealand's secondary schooling sector. I introduce myself as a teacher-researcher immersed in this environment and share my research perspectives on the topic. The research questions are stated to frame the inquiry and to explain the rationale and significance of the thesis. I provide the thesis statement and describe the approach that I have taken in this research. New Zealand's educational landscape is explained, aided by the description of a few prominent ICT initiatives from the past decade. Chapter 1 concludes with a brief overview of the other six chapters to follow.

Background to the study

As a single-charge teacher and head of the music department at a secondary school in South Auckland, New Zealand, I often grappled with ways to enhance the students' learning experiences with emerging technologies. By introducing them to computers in the music classroom, we started on a journey of discovery. The extent of the available technology was a set of twelve Windows-based desktop computers in the main music classroom. The situation of being the only teacher in the department prompted me to explore ways of employing technology to provide support for students when I was engaged in teaching other classes and not immediately available to address their need for support. The available technology had the potential to extend the reach of my teaching beyond my physical presence in the classroom.

The school was home to mostly Pasifika and Māori students, many of whom were very musical. They appeared to be naturally gifted performers, and many had well-developed performance skills. Their natural talent was something to be celebrated and enhanced, but they struggled with the Eurocentric skills of reading music notation and notating aural dictation. They relied mostly on aural acquisition when learning a new repertoire, shying away from printed scores.

The national music curriculum in 2004 required Western notation skills, for example, to notate, present, record, and evaluate a composition. To improve their music literacy, I introduced the students to the music notation software program, Sibelius, gradually giving them more challenging tasks to enable them to compose with the software. This prepared them to achieve the required standard of the new composition achievement standards introduced in 2002 as part of the National Certificate in Education Achievement (NCEA). They were expected to use the music software available on the computers in the music department to improve their music notation skills.

Until 2002, the education system in New Zealand utilised the School Certificate music syllabus. School Certificate (New Zealand Qualifications Authority, 2015) was awarded in single subjects. Music, along with Design Technology and Art, was internally assessed but moderated externally by the New Zealand Qualifications Authority (NZQA). The teaching content focused mainly on Western Art music and notation-based composition and aural tests, with assessment concentrated in one final examination at the end of the year. In 2003, the year I began teaching at this particular school, the National Certificate of Education Achievement (NCEA) was in its second year of implementation. There was a shift away from the previous examination-based system to a more outcomes-based programme that encourages ongoing assessment against a set of criteria that describes a range of knowledge and skills.

Achievement Standards are based on the New Zealand Curriculum (New Zealand Qualification Authority, n.d.). It allows for students to study a variety of topics throughout the year. Once they are adequately prepared for the topic, students are assessed against specific criteria. Once they meet the criteria, they achieve the standard according to a graded system of Achieved, Merit or Excellence. Each standard has a set number of credits attached to it. This new system allowed for a wide range of knowledge and skills to be included in the teaching and learning process. Teachers could customise the internal assessment content and tasks to personalise the learning material for their students.

Alongside the internally assessed achievement standards introduced in 2002, the Ministry of Education introduced externally assessed standards for which students had to sit for a national examination at the end of the year (New Zealand Qualifications Authority, 2015). My students and I had to adjust to this new way of teaching and learning in a standards-based system. It was crucial to support the students in getting used to a new assessment process while maintaining their confidence and focus on achieving well. The newly-introduced achievement standards created a subtle shift in teachers' practice where they taught only the content necessary to meet the criteria of each particular standard. Since then, teachers have expressed their concerns about an imbalance between assessment and the curriculum. They have stated that the standards-based system encourages a teaching culture in which assessment drives the curriculum (Alison, 2005).

Throughout the implementation process, I wondered how other music teachers were coping with this new system, and if they were making use of technology in their music programmes to support this shift. These pedagogical challenges led to my decision to embark on this research journey. My teaching experiences deepened my interest in improving classroom pedagogy by incorporating technology into my daily teaching practice. The combination of music education and ICT (information and communication technology) fascinated me, and I wanted to improve my practice by investigating how other secondary teachers implemented and integrated technology in their music programmes.

Teacher as researcher

As a teacher, I wanted to channel my focus towards researching secondary school teachers and their classroom practice. My exploratory reading revealed some New Zealand-based research, but that most of this was focused on practice in primary and middle-school classrooms (Parr & Fung, 2000; Bolton, 2007; Bolton, 2008). Educational technology in learning areas such as mathematics and science had been researched, and these studies provided some insights into general approaches, barriers perceived by teachers, and enablers that supported the integration process (Haddad & Jurich, 2002). There wasn't much literature available on the use of music technology in a secondary school context for New Zealand schools.

In 2008, I was seconded to a facilitation position for the Future Pathways Information and Communication Technologies Professional Development (ICTPD) cluster. This cluster was established by Te Aho o Te Kura Pounamu/ The Correspondence School and funded by the Ministry of Education (MoE) to support a professional development contract focused on improving technology use in schools. The Future Pathways cluster was one of many ICTPD cluster programmes established around the country since 2001.

This Ministry of Education-funded initiative lasted from 2001 to 2012 and had a positive impact on overall teacher development while extending general ICT technical skills to focus on pedagogy application (Education Counts, 2015). The purpose was to support teachers in the integration of ICT in their teaching, with the expected outcome that their practice would be sustainable after three years on the teacher development contract.

The ICTPD School Cluster programmes were dedicated to:

- Increasing teachers' ICT skills and pedagogical understanding of ICTs,
- increasing the use of ICTs for professional and administrative tasks in schools, and
- increasing the frequency and quality of the use of ICTs in schools to support effective classroom teaching and learning.

This full-time position as cluster facilitator required me to provide technology assistance to early childhood, primary, and secondary school teachers. I developed an eCapability Cycle, a sustainable professional development framework, to give teachers access to resources and professional development to improve their understanding of ICT integration in a distance education setting. This facilitation role enhanced my awareness of the perceived barriers and enablers teachers faced when they started to incorporate technology into their daily teaching practice. In my facilitative capacity, I was both practitioner and support person while operating as a change agent.

My experience of the early adopters of technology (Rogers, 1983) was that they were usually self-driven and enthusiastic practitioners and did not need much encouragement to experiment with new ideas. It was the challenges that the late adopters faced that sparked my curiosity to delve deeper into classroom practice and the extent to which technology was integrated into general teaching and in music programmes.

Topic

My topic probes the deployment of technology integration in secondary school music programmes between 2008 and 2012. It explores data from a representative sample of music teachers in New Zealand secondary schools. The data was collected by interviewing thirteen respondents during two separate data collection instances in 2008 and 2012, respectively. The interview transcripts were used to identify categories and themes from the data through a deductive coding process.

Research approach

The research framework for this thesis is anchored in a constructivist research paradigm with a phenomenological genre of inquiry. It aims to portray the insider point of view of the researcher as a secondary music teacher, with a flexible stance towards the research subjects. The reason for this approach is that I am an experienced music teacher and have a certain depth of understanding and empathy with the respondents in this thesis. It provided an opportunity to explore the teachers' perceptions and ideas.

The research uses a phenomenological approach to explore the classroom practice of teachers and their integration of ICT in their teaching programmes. It captures and portrays the daily practice of music teachers, refraining from intervening or making immediate suggestions about how they could change or improve their practice. The research describes interview data collected during two separate data collection instances. The information is organised, coded, and presented as word clouds to convey similarities, changes, and developments between the two data sets.

Methodologically, the research combines qualitative and descriptive approaches with elements of a comparative study. The strategies for this research are derived from qualitative research methods, particularly because qualitative educational research involves real-life situations being studied in all their complexity (Lamont, 2002).

The research seeks to explain the reasons for using ICT, and then to convey the perceptions of the users in detail, hence the use of qualitative research methods as opposed to a quantitative approach. The qualitative method of interviewing respondents ensured that the data would be rich with detail. The individual interviews ensured that the teachers could be impartial and candid in their responses.

The research process was initiated with an online questionnaire to identify suitable participants willing to volunteer for the study. The Musicnet listserv was used to circulate information about the research and to request volunteers to respond in 2007. Available candidates were first contacted by email. They were informed about the interview process, and the interview outline was shared with them in advance. Face-to-face contact was then made with prospective candidates who fitted the profile outlined in the questionnaire. The research respondents were guided by an outline of open-ended interview questions which was shared with the respondents before the interviews (See Appendices 4 and 5). Most of the interviews were conducted face-to-face, but Skype and the telephone were also used when it was not possible to meet in person with a specific respondent.

Thirteen interviews were carried out and recorded during each of the data collection events. The data for the first dataset was gathered from interviews conducted with eleven teachers in charge of music departments in secondary schools from 2008-2009. In addition to the eleven teachers, there were two industry stakeholders involved. Their input provided perspectives on technology support from a resource development angle as well as from a software retail perspective. In 2012, the same respondents were contacted to complete a follow-up questionnaire sent to them as a Google form. Participants could complete the questions online by completing the Google form, and the cumulative responses were captured in a spreadsheet. These two datasets provide two separate snapshots of teaching pedagogy and technology integration in secondary classrooms, four years apart. My field experiences, readings and first coding aided me to develop five research questions which shaped the structure of this thesis.

Research questions

The five research questions focus on educational technology, reasons for technology integration, factors influencing technology adoption, shifts in teacher practice, and knowledge required for effective pedagogical practice in a technology-enhanced learning environment:

1. Do music teachers use computer technology in their teaching pedagogy?
2. Why and how do teachers integrate technology into their teaching programmes?
3. What are the major influences on the teachers' adoption of new technology?
4. What are the changes and constants over the period of the study?
5. How can the Technological Pedagogical and Content Knowledge (TPACK) framework improve technology integration in music classrooms?

Rationale and significance

Why should we bring ICT technology into classroom music pedagogy? Alan Kay, the personal computing guru, has a sobering outlook on computers and schools:

> Computers are not rescuing the school from a weak curriculum, any more than putting pianos in every classroom would rescue a flawed music program. Wonderful learning can occur without computers or even paper. But once the teachers and children are enfranchised as explorers, computers, like pianos, can serve as powerful amplifiers, extending the reach and depth of the learners. (as cited in Galileo Educational Network, 2015, para. 1)

Music - Sound Arts is one of the four arts disciplines included in the New Zealand Curriculum. The others are drama, dance and visual art (Ministry of Education, 2007). Although the New Zealand Curriculum document of 2006 refers to using technology in general, it does not prescribe specific ICT objectives for any of the four arts disciplines. While agreeing with the assumption that computers and ICT will not 'fix everything', I wanted to explore what new teaching possibilities they could provide.

My original contribution to the field of music education and technology integration is the analysis of data collected as two snapshots of classroom practice in New Zealand secondary schools, one taken in 2008 and the other in 2012. This data provides insights into the general perceptions of music teachers about the integration of technology in music classrooms in secondary schools. The snapshots portray the successes and failures of technology use in the daily teaching practice of New Zealand music teachers. The data also sheds light on the implementation and innovation processes that occurred in classrooms. The aim of the thesis is to provide ways to improve the integration of technology in the arts curriculum, and more specifically, in the Music - Sound Arts strand of the New Zealand Curriculum.

This thesis focuses on advancing knowledge in the field of technology integration in secondary school music programmes as there has been little recent documented research on this topic in New Zealand. A review undertaken by Dunmill and Arslanagic (2006, p. 4) confirmed this point, noting that “no New Zealand-based robust print or online literature has been able to be sourced that generically considers ICT in arts teaching and learning contexts”. They also report that there is “little data on the impact of ICT in arts praxis” (p. 8), and that “the potential of ICT in arts education in the New Zealand context is in its early stages of development and only partially realised” (p. 16). Crow comments on the nature of the new technology and suggests that it might, if effectively and imaginatively employed, “engage a larger proportion of pupils in a more broadly-conceived and culturally-relevant creative response” than is currently the case in music classrooms worldwide (2006, p. 121) . My research, therefore, investigates the practice of secondary school music teachers regarding technology uptake and integration in the New Zealand secondary school context. It takes a closer look at teachers’ dispositions towards technology and how they manage the practicalities around technology integration.

This focus on the teachers' perspectives, as they were the ones interviewed, excludes the views and perceptions of the music students. Wherever there is a reference to student skills and knowledge, it refers to teacher perceptions rather than the students' personal points of view. Reporting on the personalised student voice is outside the scope of this thesis.

Thesis statement

Technology adoption in New Zealand secondary school music classrooms is slow and often limited by teachers' teaching values and beliefs rather than by the technologies itself.

Educational technology in the New Zealand context

Dunmill and Arslanagic (2006) report on a review of the literature about ICT in arts education, that although New Zealand's development and evaluation of ICT policies over the period of the previous decade looks at the impact of technologies, none of these studies hone in on arts education. Although generic themes like student engagement, motivation and digital literacy of teachers apply to the arts, they provide no guidance for effective ICT integration with an arts-specific focus. Further, the New Zealand Curriculum is relatively vague about the role technology plays in the music learning area. The music (sound arts) curriculum statement indicates that "In music education, students work individually and collaboratively to explore the potential of sounds and technologies for creating, interpreting and representing music ideas" (Ministry of Education, 2007, p. 21). A report from the Education Review Office in 2005 states that "ICT use in schools is uneven and low in arts classrooms compared with other learning areas" (as cited in Dunmill & Arslanagic, 2006, p. 8).

Although the arts have not been targeted specifically to advance the integration of technology in teaching programmes, the infrastructure and networks in schools have seen a variety of upgrades and initiatives since the late 1990s. To position my research within a New Zealand context, I now look at the role ICT has played in education in the New Zealand since the start of the 21st century.

New Zealand's Ministry of Education has initiated a variety of ICT strategies since the turn of the century. The purpose of these has been to support schools and advance learning for students by providing better and faster internet access and technology equipment. These include the provision of ultra-fast broadband connections for schools, a country-wide school network update, access to a managed network for schools, access to free software, and provision of laptops for teachers and principals (Ministry of Education, 2015). These initiatives have been rolled out over the past decade to support the integration of digital technologies in schools across the country.

The goals of the first ICT Strategy for Schools focused on school capability and infrastructure (Ministry of Education, 1998). During the late 1990s, the term *digital divide* became popular in America, describing the virtual divide between people with and without access to ICTs. This buzz word soon spread to New Zealand.

The New Zealand Ministry of Education acknowledged the ways in which the digital divide could present and consequently developed the *Digital Horizons: Learning through ICT* strategy (2002) for schools to focus their attention on bridging this divide. The Ministry of Education released the new education strategy in 2002 (Ministry of Education, 2002). In the same year, Boyd reported to the Ministry of Education in a literature review of New Zealand's status regarding the 'digital divide'.

According to the OECD (Organisation for Economic Co-operation and Development), the digital divide for students presents in three ways:

- as a missing link in remote rural or poor inner-urban areas where telecommunications are limited and/or expensive, especially for students with disabilities

- as a wasteland for groups who find the technology isolating and mechanical, for example, females and some minority groups
- as a foreign language in high-poverty homes lacking equipment and language skills (cited in Boyd, 2002, p. 3).

Boyd continues to describe another four dimensions of the digital divide, including general perceptions, skill levels of teachers and people in ICT support roles, financial limitations, and relevant online content.

The primary objective of the *Digital Horizons: Learning through ICT* strategy (Ministry of Education, 2002) was to integrate ICT more fully into curriculum practice across the New Zealand school sector. The strategy states that to meet this challenge the New Zealand education system must recognise the enhanced breadth, richness and authenticity of learning that can be achieved through ICT. It further points out the need for people to use ICT and information to participate in society and the workplace, and the importance of specialist ICT skills to sustain economic development (Ministry of Education, 2003).

In July 2006 a new strategy, *Enabling the 21st Century Learner: an e-Learning Action Plan for Schools,* replaced *Digital Horizons*. It outlined key outcomes and actions for e-learning in the New Zealand school sector from 2006 to 2010. The strategy described the goals for e-learning in schools and the projects, tools, and resources to support these outcomes:

> Effective teaching for all students depends on teachers becoming confident and capable users of ICT and understanding how to integrate ICT effectively into their teaching practice. Teachers make key decisions about how to integrate ICT effectively in the classroom, to achieve the desired learning outcomes for students. They evaluate the appropriateness and effectiveness of technologies and digital resources and decide when and how to use them with students. (Ministry of Education, 2006, p. 10)

It is significant that the action plan acknowledged the need for teachers to be well-equipped to make informed decisions about technology and to have the required knowledge to aid students in their learning supported by technologies.

Other government initiatives

The following initiatives give an indication of the infrastructure that was made available to enable teachers to use technology in their teaching. These initiatives were introduced to address some of the issues identified within the New Zealand education context since the turn of the century. The initiatives endeavoured to improve equity of technology access, reliability of infrastructure, and scalability of school networks and servers to accommodate an increase in devices (Ministry of Education, 2005).

ICTPD Clusters Programme

New Zealand benefited from an ICT-focused professional development initiative (2001-2012), namely the ICTPD Clusters programme. The intended outcomes of this programme were to increase understanding amongst the education community about the benefits of ICT within an educational setting, to improve student achievement by increasing the skills, capability and confidence of teachers' use of ICT, to build and strengthen collaboration within and across schools, and establish a repository of resources, expertise and learning materials available at local and national level. The design of this ICTPD initiative broke new ground regarding professional development delivery in New Zealand. The support was based on an empowerment rather than a deficit model with emphasis on sharing, co-learning, and collaboration with peers (Clayton, 2010).

Some of the operational success of this initiative was due to the sustained focus on the three areas of how, when, and why. Practical sessions concentrated on the operational side of the ICTs, both for administrative and student-learning purposes. Activities and authentic New Zealand examples supported the effective integration of these ICTs. Applied research and the theory behind the integration process underpinned all of the above (Clayton, 2010).

Other initiatives have been introduced since the ICTPD clusters programme, such as the Blended e-Learning and Learning with Digital

Technologies professional development programmes that supported teachers in schools with effective technology integration.

Ultra-Fast Broadband in Schools (UFBiS)

The New Zealand Government invested $1.5 billion in connecting schools to ultra-fast broadband (UFB) and aimed to have 97.7% of schools connected by 2016. The connectivity would enable schools to access connection speeds of 100Mbps or more (te Kete Ipurangi, 2015).

Contracts were signed with four providers in May 2011 to complete the roll-out of fibre to urban areas by 2016. The first area to receive fibre connectivity in New Zealand in August 2011 was Albany in Auckland. The Ministry of Education *Ultra-fast Broadband in Schools* (UFBiS) programme delivered the *Learning without Limits* seminar series between July and September 2012. Twenty-four sessions were held across New Zealand with 1700 people attending. The seminars focused on the progress of the government's fibre roll-out, explaining the timeframes and process for delivering ultra-fast broadband to schools. Further discussions about the opportunities that ultra-fast broadband bring and the benefits the *Network for Learning* would provide, were part of the facilitated discussions.

School Network Upgrade Project (SNUP)

The Ministry of Education’s *School Network Upgrade Project* (SNUP) was an initiative that aimed to upgrade electrical and data-cabling infrastructure in schools in preparation for fibre readiness. The Government contributed 68% of the upgrading costs to state-integrated schools and 80% to state schools. These upgrades have been implemented since 2011. Part of the purpose of these improved systems was to ensure schools have robust internal networks so they can easily access the national *Network for Learning* (Ministry of Education, 2011).

The Network for Learning (N4L) managed network

Network for Learning is a Crown-owned company established by the Government in July 2012. The purpose of this company is to develop and operate a managed network which schools can access free of charge (Te Kete Ipurangi, 2014). The provision of fast, predictable access to the internet through a Government-funded connection ensures that teachers and learners can operate effortlessly in an online environment. The roll-out of the managed network started to connect 700 schools in 2014 and in 2016 all schools had been offered a connection to the N4L.

Software for schools

Another of the initiatives the Ministry of Education provides is support for state and state-integrated primary and secondary schools with an entitlement to a selection of computer operating systems, office productivity, anti-virus and web- filtering software. All of these are offered free of charge. Included are software from Apple, Microsoft, Novell, Symantec and Websense (Te Kete Ipurangi, 2014a).

Laptops for teachers and principals

The TELA Laptop Scheme is an ongoing initiative that enables eligible principals and teachers in state and state-integrated schools to lease laptops for classrooms and professional use. The laptops are leased on a three-year replacement plan. They are delivered with software imaging and are covered by warranty and indemnity policies (Ministry of Education, 2004).

Thesis chapter overview

This thesis wants to shed light on how computer technology has been used to enhance teaching and learning in music classrooms in New Zealand since 2008. It wants to uncover the levels of confidence and capability music teachers demonstrate when using technology, and, gauge how well the teachers integrate technology in music classrooms in a selection of New Zealand secondary schools. The research unfolds over the next six chapters.

Chapter 2 focuses on a review of the literature about the theoretical grounding of this research, ICT in education, technology integration, and teachers' and students' experience of technology in music education. Chapter 3 explains the methodological framework based on a qualitative approach informed by constructivist theory. It describes the research design, the methodology, and the data-collection process. This chapter is organised around the pedagogical framework which grounds this thesis, specific educational practices within a critical pedagogical framework, and the methods involved to collect and analyse the data. Chapters 4 and 5 present the data from the two separate data collection instances. In Chapter 6 these two datasets are analysed and compared. It concludes with a thematic synthesis of the findings that identifies four elements of effective technology integration: accessibility, connectivity, pedagogy, and motivation. Chapter 7 links back to the research questions to conclude with a discussion of the findings as they are placed in the literature, the limitations of the thesis and implications for teaching practice, as well as recommendations for further research.

Chapter 2

Throughout human history there has been a consistent theme of technologies influencing our societal development, with periods of accelerated influence occurring at times such as the Renaissance, the Industrial Revolution, and the information age. This pattern is paralleled by a relatively similar pattern of changes in music technology developments.

(Brown, 2007, p. 31)

Chapter 2 reviews the theoretical grounding of this research and positions ICT in the education environment. It examines the use of ICT in secondary schools and more specifically how ICT is applied in teaching programmes. It also explores how ICT affects pedagogy and which models are used to integrate technology into teaching and investigates the factors that influence this integration process. Lastly, this chapter covers ICT integration into music classrooms in secondary schools internationally and then more specifically in New Zealand. It highlights the tensions and limitations that the use of ICT brings to music classrooms and teaching, and how teachers and students experience technology. It looks at some models of technology integration, the effect of digital technologies on this integration, how ICT enhances music learning, and how technology influences pedagogical change. The final section highlights areas regarding ICT integration into music programmes in secondary schools that are not explored in current literature, and the particular gap I am addressing in the thesis.

Terminology

The term ICT (information and communication technology) refers to computer-related technology in an educational setting. ICT includes but is not restricted to terminologies such as educational technology, digital technology, digital devices, and mobile devices. Whereas the term ICT is mostly used in an educational context, IT (information technology) refers to the industry of managing information for businesses (Indika, 2011). ICT may also include a range of hardware, software applications, and information systems (Hennessy, Ruthven & Brindley, 2005).

Closely related to ICT is the term educational technology, often used interchangeably with ICT. To establish a shared understanding, Januszewski and Molenda define educational technology as “the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources” (2007, p. 15). Further to this description, educational technology is also “a field of study that investigates the process of analysing, designing, developing, implementing, and evaluating the instructional environment and learning materials in order to improve teaching and learning” (Educational Technology, n.d., para. 1). Both these definitions emphasise the teaching process or pedagogy involved when using educational technology, and not any preferred device, computer hardware, or software program.

For the purpose of this thesis, the terms ‘technology’ and ‘digital technology’ exclude sound production and amplification equipment such as speakers, PA systems, microphones and amplifiers. These technologies are used in most music departments in secondary schools, and their use and application are not the focus of this investigation. My research focuses on technology and teaching supported by computers and ICT. The use of the term digital technology rather than ICT has become more common over the past decade and is used interchangeably with ICT in this thesis.

The technologies referred to in the thesis are computer technologies, digital and mobile devices, and other equipment such as data projectors, portable memory devices, and MIDI equipment. These technologies include any peripheral equipment with the ability to connect or be attached to a computer and used to enhance the students' music-learning experiences.

Although the term ICT initially referred to information and communications technology in quite a narrow sense, for the purpose of this thesis it is used for computer and network hardware and software within an education context. Dunmill and Arslanagic define ICT as a term that "encompasses a range of human-devised hardware, software and telecommunications technologies that facilitate communication and sharing of information across boundaries and which may be used to generate arts experiences and objects" (2006, p. 7). This statement describes the meaning of ICT in this thesis. In New Zealand, reference to computers and ICT have moved towards a preference for the use of the term digital technology since 2012. The government-funded Learning with Digital Technology professional development initiative, as well as the explicit breakaway in the technology curriculum area to have a distinct Digital Technology strand have influenced this preference.

ICT literacy is a term which refers to the meaningful use of ICT appropriate to the needs of the user and also applies to the "conceptual and functional skills to support learners and teachers to further participate in work and society in the future" (cited in Dunmill & Arslanagic, 2006, p. 22).

Philosophical and theoretical grounding

The philosophical grounding of this thesis is phenomenological because it investigated and evaluated how teachers experienced the use of technology in their classrooms. Phenomenology is a study in observation and experience.

> Phenomenology is the study of phenomena: appearances of things, or things as they appear in our experience, or the ways we experience things, thus the meanings things have in our experience. Phenomenology studies conscious experience as experienced from the subjective or first-person point of view. (Smith, 2016, para. 4)

As Adu (2016) further clarifies, a phenomenological study captures the participants' experiences and examines how they make sense of these experiences. Phenomenology also focuses on the specific meaning of things during a particular experience, including "objects, events, tools, the flow of time, the self, and others" (Smith, 2016, para. 6). In this thesis, the "tools" under scrutiny were ICT and digital technology.

According to Creswell (2007), a phenomenological study "describes the meaning for several individuals of their lived experiences or a phenomenon" (p.57). The purpose of a phenomenological study is to describe the commonalities of the individual experiences and aims to deduce the essence of an experience to describe the "what" and "how", making it a popular approach in education research. In this thesis, the "what" and "how" of ICT integration in music classrooms was investigated. The phenomenology stretches further than a mere description and is also seen as "an interpretive process in which the researcher makes an interpretation" (Creswell, 2007, p.59). Creswell warns that being the researcher as well as the interpreter poses certain challenges:

> Knowing some shared experiences can be valuable for groups such as teachers. The participants in the study need to be carefully chosen to be individuals who have all experienced the phenomenon in question, so that the researcher, in the end, can forge a common understanding. Bracketing personal experiences may be challenging for the researcher to implement. (Creswell, 2007, p. 62)

This thesis took a phenomenological approach because it investigated and evaluated how New Zealand teachers experienced the use of technology in their classrooms. The experiences of music teachers were captured and studied through semi-structured interviews and online surveys. The researcher was mindful of avoiding asking leading questions of the participants during interviews. This prevented the transfer of any of the researcher's perceptions and personal views to the participants.

ICT in education

To establish what the literature reveals about the use of ICT in education, this section visits some of the motivations and reasons for the use of ICT, firstly at secondary-school level, and then, more specifically, in secondary schools in New Zealand.

Developments in technology have impacted on education throughout history, but, since the start of this century, ICT has played a significant role in the way that classrooms operate. Carnoy (2004) refers to four independent but congruent threads running through the vision of educational computing. Each of these threads has influenced education in different ways. Firstly, computer-assisted education (CAI) originated in self-scoring tests. Secondly, computer programming developed as a school subject, resulting in vocational ICT education. Thirdly, cognitive development and problem-solving developed as computer-related skills and thinking patterns. Lastly, the internet has significantly impacted on the same skills by making information available on a global scale and enabling learning networks for both teachers and students. The cognitive impact of using ICT in education has influenced both the content and the manner of student thinking and reasoning.

ICT in secondary schools internationally

As this research was conducted in secondary schools, the literature reviewed focused mostly on secondary rather than primary schools as there is a distinct difference in how these two sectors apply and integrate ICT into their learning and teaching programmes. In secondary schools, Carnoy (2004) states that “the general lack of teacher computer skills is the single largest barrier to the spread of ICT-based learning in schools” (p.14). To gain an overview of ICT integration over the past decade, and moreover, of what the possibilities are, it is useful to investigate the ways ICT has been and is still being implemented in secondary schools internationally.

The World Bank commented in 2010 that apart from the expected development in ICT and education in the United States, Western Europe, and Australia, 11 other countries were making significant progress. The list is both surprising and somewhat unexpected as countries such as Chile, India, Jordan, Macedonia, Malaysia, Namibia and Russia were named (Trucano, 2010).

Mooij and Smeets (2001) investigated the process of ICT implementation in the Netherlands. They identified five sequential phases of an ICT implementation process in secondary schools. These processes involved how teachers' ICT use would at first be sporadic and happen in a few isolated cases. As awareness increased, ICT would become more relevant in the school and specific curriculum areas. That would transfer the focus to infrastructure and facilities across the school. Following this, teachers would start to change their educational and pedagogical practice, and lastly, ICT would be integrated to support the learning process for students. This review focused on ICT integration across subject areas.

ICT or computing is also an independent subject area in many curricula around the world. UNESCO had already developed an ICT curriculum for secondary schools in 2002. It provided a curriculum in ICT for secondary schools that was in line with international trends at the time and proposed a programme of professional development for teachers, which was necessary to implement the specified ICT curriculum successfully (Anderson & Van Weert, 2002).

Webb (2002) remarked that the pedagogy for teaching ICT efficiently as a school subject was unclear at the start of the century. As computing is a relatively young curriculum area, the pedagogy is still evolving and developing. Webb (2002) measured her reasoning against an early model of pedagogical thinking and action that Schulman produced in 1987. It is important to mention here that the Schulman model became the precursor of what exists today as the TPACK model developed by Mishra and Koehler in 2006. Schulman's model originally had six distinct components: content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners and their characteristics, and knowledge of educational contexts.

Webb (2002) highlighted the issues around the teaching of ICT as a subject that she identified concerning the Schulman model. Webb's most prominent concern was that “subject-specific interpretations” (p. 241) for general pedagogical knowledge, curriculum knowledge, and pedagogical content knowledge, were far more limited and less defined for ICT than for other subjects. She also found that teachers did not have adequate content knowledge to integrate ICT into different subject areas. There was no established research base in 2002 for the problems and misconceptions that teachers might have had in the understanding of ICT. She urged teachers to develop their knowledge while refraining from becoming overwhelmed by the many intricacies of software operation and manipulation.

Secondary schools face significant challenges for the integration of ICT with their tightly regimented timetable and "division of intellectual labour into subjects" (Pearson & Naylor, 2006, p. 284). The promotion of innovative practice, investment in new technologies and pedagogies, and the changing role of teachers to promote teaching and learning with ICT are given as the primary drivers for successful innovation and ICT integration. They highlight the complexity of the innovation-implementation partnership which is intensified by the ever-evolving development of digital technology. The challenge for teachers is to keep up with the technology while maintaining professional integrity in their teaching practice. Pearson and Naylor conclude that the load and responsibility should be shared with students by developing new pedagogies that empower them to be active participants in their learning instead of passive consumers.

The most prominent difference between primary and secondary schools world-wide is the distinction made between curriculum areas. Primary schools tend to follow an integrated approach, whereas secondary schools focus on teaching individual subjects. Each subject has its distinct content and pedagogy that adds to a unique subject profile which in turn influences their adoption and integration of ICT. John and La Velle (2004) refer to the existence of “subject subcultures” (p. 314) in secondary schools and how these potentially impact on how teachers interact differently with ICT in their various curriculum areas. Hennessy et al. (2005) support this observation when they report that "teachers are considered to be reluctant to adopt a technology which seems incompatible with the norms of an antecedent sub-culture" (p.161). John and Le Velle (2004) further maintain that "cultures and styles of teaching are inextricably linked to the cultures of subjects" (p. 308), which then directly determine how teachers view the challenges of ICT in their subject areas of science, mathematics, English, music, and history. Although ICT creates a sense of unease for teachers, most acknowledge its potential.

> The inherent idea that ICT can create powerful learning opportunities in a way that might empower students and create more individualised learning was seen in an optimistic light. This view was consistent with many of their espoused theories about what constituted good practice in their subject areas and their conceptions of the ideal student. For some, ICT articulated strongly with their belief that new technology might provide greater opportunities for experimentation in the classroom and thereby change radically the relationship between teacher, learner, and subject. (John & La Velle, 2004, p. 315)

The quote above emphasises that teachers are wary of ICT becoming a "competing paradigm of communication where subjects might begin to resemble the technology rather than vice versa" (John & La Velle, 2004, p. 321). This outlook supports the notion that teachers struggle to find the right balance between ICT being a helpful support and an unhelpful distraction.

Secondary teachers often guard the integrity of their subject by exhibiting retreatism, which amplifies their insecurities and fears. The teachers that John and La Velle (2004) interviewed in their study were apprehensive about including too much technology in their particular subject areas because of the consequent threat of being exposed and losing face if they appeared to be less than competent. This way of thinking stems from the notion that teachers are conditioned to be the experts in their subject fields and are reluctant to relinquish that control. When the role of a teacher changes from that of the expert to becoming a facilitator of learning, the threat of embarrassment diminishes considerably.

In a study about the practice of English, mathematics and science teachers, Hennessy et al. (2005) reported that ICT gradually amended the existing classroom practice and pedagogy of these teachers as their perceptions of ICT changed over time. The main factors that influenced their practice were their “professional beliefs and concerns” about the benefits of ICT (p. 173). This study highlighted teachers’ perceptions that ICT integration required both dedication and caution, but also imposed constraints on their pedagogical freedom. The eventual change that manifested as evolved pedagogical practice was due to the critical evaluations and carefully considered actions of the teachers involved.

ICT in New Zealand secondary schools

ICT adoption is not a new concept in the New Zealand education system. A considerable amount of funding and support has been focused on professional development and strategic thinking around technology integration over the past decade. Ward (2002) stated that although the implementation and integration of ICT were happening in New Zealand secondary schools, it was the "use of ICT as a learning tool that is still disappointing at best" (Ward, 2002, abstract). She maintained that, at the time, the primary use of computers was to teach students the skills to use them efficiently, and not to strengthen and support their learning in the various curriculum areas. A report published in 2006 by New Zealand’s Education Review Office (ERO) about the use of e-learning in primary and secondary schools supported Ward’s statement. This report found that although schools had made progress in their vision, policies and e-learning plan development, the integration of the technology and the linking of the planning back to their vision were not yet established (Dunmill & Arslanagic, 2006).

New Zealand has invested in an upgrade of its infrastructure for schools over the last two decades. The initiatives have focused on the provision of fast and stable broadband connections, better equipment, and professional development for teachers, to support these investments.

These technology initiatives have been discussed in more detail in Chapter 1.

The ICT PD Cluster Model supported groups of schools to reflect upon the "why, when and how ICTs would be integrated into their current practice" (Clayton, 2010, p. 2). These initiatives and support have been available to New Zealand secondary schools since the early 2000s. Ward and Parr (2010) studied four New Zealand secondary schools with robust infrastructures and a commitment to ICT professional development to establish the nature and extent of computer use in these schools, what variables influenced the use of ICT, and why levels of use varied. Ward concluded that the overall levels of ICT use were low, that a perceived need to use computers would override possible barriers, and that levels of use varied depending on teachers' self-efficacy and the subjects they taught. She suggested that schools invest in professional pedagogical development

> which provides teachers with an understanding of the practices implicit in the use of computers and the benefits to teaching and learning of using these practices. With such understanding teachers are likely to be more willing to learn, to try new things and to move away from more traditional classroom practices. If this were the case, the need for ICT integration would be set up before its implementation and computers would be seen as a tool to be used to support changed practices rather than as a driver of change. (Ward & Parr, 2010, p.121)

A complex relationship: ICT and Education

The relationship between ICT and education often polarises teachers on a love-hate continuum. Watson (2006) describes this relationship as complex and multifaceted. He attributes the complexity for teachers to a professional expectation of becoming lifelong learners and to the way teachers share and develop their newly-acquired knowledge.

Watson (2006) explored four decades of this complicated relationship in English schools and identified a “shift of focus from the technology to learning” (p. 199) as the biggest change in teachers’ perspectives. The ongoing dilemma of “learning about or learning with” ICT (p. 202) feeds teachers’ uncertainty about new technologies and their concerns about not having the skills to operate the computers. No schools ever teach students how to text, and yet they are perfectly capable of communicating in this way. The same premise applies to learning with ICT. The basic skills of operating a computer do not need to be taught explicitly but should be interwoven in deeper-order thinking activities and collaborative tasks. This dilemma circles back to the role of the teacher – either as “catalyst” or “conservator” (p. 203) within the “complex and multifaceted relationship between ICT and education” (p. 205). Watson also believes that the use of ICT in education always happens in tandem with innovation and change. This idea calls for a moment’s pause to explore the role change management plays in ICT implementation.

In its broadest sense, change management is either focused on identifying a problem and the structural needs to solve the problem, or it is focused on the human factor and seeing people as “sentient, dynamic systems” (Watson, 2006, p. 214), as is the case in educational change. He urges us to pay careful attention to three interdependent components involved in ICT change: society, technology, and education:

> I would maintain that using theories and models of innovation and change will help us ground our new empirical work within a perspective that acknowledges the complexity of both the nature of innovation and the change process, and which allows a reflection upon the reality in context. (Watson, 2006, p. 214)

The use of ICT in teaching always implies some measure of change for teachers (Ertmer & Ottenbreit-Leftwich, 2010). They identify a subject and school culture, knowledge, pedagogical beliefs, and self-efficacy as measures for this change. Robertson, Webb and Fluck (2007) agree with Ertmer and Ottenbreit-Leftwich (2010) on the vital role these four areas play to bring about change. They contend that ICT integration requires careful change management and that this is usually interpreted as "taking the policy and translating its intentions into practice" (Robertson et al., 2007, p. 35). However, to manage change effectively, they suggest finding the "habit zone" of teachers which is "the point at which personal beliefs intersect with working knowledge and related skills" (p.36). If teachers use the habit zone as the starting point to grow ICT integration, they then need to be supported through professional development opportunities in a high-trust environment. Such a scenario would ensure that everyone could be comfortable having their varied skill levels exposed while he or she engaged in a constructivist or reciprocal learning milieu. Successful ICT integration most often requires a mindset change in teachers.

The effect of ICT application on teaching and learning

The use of ICT influences the teaching and learning that occur in classrooms. Whether this influence is positive or negative depends on the stance of the observer, teacher, user, student or researcher. There are many views on the benefits as well as the negative influences that technology brings to education. It is timely to review a selection of these arguments, perspectives and issues to build an understanding of the educational landscape and the digital dilemmas teachers face on a daily basis.

Arguments, perspectives, and issues relating to ICT

ICT challenges teachers to adopt a modified pedagogy to make the most of the technologies and to steer the students towards improved learning outcomes. The introduction of ICT alone is not a guarantee that the teaching and learning process will change (Trucano, 2005), but ICT can undoubtedly enable teachers to change their pedagogy from being ‘teacher-centric’ to adopting a ‘learner-centric’ style. Ofsted warns though, that “when ICT fails to add value to teaching and learning in other subjects, it is often because the planning has been driven by the technology and not the subject-matter itself” (Ofsted, 2004, p. 51). Trucano supports the idea that ICT is most effective when it helps to promote “learner-centric pedagogies” (Trucano, 2005, p.39).

> Construction of knowledge from information requires far more than the ability to use a variety of ICT techniques or skills with the latest range of software applications; it relates more to an ability to question, access, interpret, amend, analyse, construct and communicate meaning from information. (Wise, 2013, p.70)

ICT has impacted on the way teachers and learners interact over the past two decades and as Mantie (2017) reasons, our understanding of ourselves has been influenced by technology, “both as human beings and as musical beings” (p. 131). The computer has drawn some attention away from the teacher as the co-construction of knowledge occurs. The role of the teacher has become that of a facilitator that sometimes controls the focus of the learner through technology and sometimes steps back to let the learner take control of the process to follow their own investigation (Wise, 2013).

Digital literacy

Paul Gilster first made the term ‘digital literacy’ popular with the publication of his book with the same title (1997). He defined digital literacy as “the ability to understand what is on the computer screen, the skill to find things and also then to apply them according to your circumstance” (Gilster, 1997, p.2). He implied that digital literacy goes deeper than skills and competence, but also includes critical thinking skills (Martin, 2009). The definition of digital literacy has since experienced a few iterations.

Martin (2009) proposed three levels of digital literacy: digital competence, digital usage and digital transformation. He maintained that the first level, digital competence could only be seen as a precursor to digital literacy. This precursor is often the level that teachers focus on when they first attempt to integrate ICT into their teaching practice. This level included a variety of user skills regarding software and navigating various online platforms such as gaming or digital learning environments. The second level of digital literacy applied to the purposeful application of the skills relevant to a specific situation, group or profession. He coined it digital usage. The third level implied transformative behaviour through critical reflection, where the user applied the existing skills to modify existing practice in creative ways. This aligns with the bottom three levels of the SAMR model of technology integration, designed by Puentedura (2006) to guide the level and purpose of technology integration.

The most basic level (substitution) of the SAMR model is where the technology is used as a direct substitute for another tool with no functional change to the task. The second tier (augmentation) is when the technology improves the task because of additional capability to that of the original tool. The third tier (modification) is when the technology allows for a redesign of the task, because of its possibilities. The final tier (redefinition) is when the technology enables a task that would previously have been inconceivable. Substitution is the level at which the teacher exhibits digital competence through a variety of skills. Augmentation happens when these skills are purposefully applied, making the teacher digitally competent. Modification happens when the teacher transforms their existing practice to modify tasks creatively.

Redefinition of learning tasks (SAMR) and digital transformation both imply that the designer or teacher possesses a degree of digital fluency (Martin, 2009). The term digital fluency is explained in New Zealand's bilingual education portal, Te Kete Ipurangi. It adds another dimension to the understanding and application of digital literacy. Here they make a distinction between digital literacy and digital fluency. Digital literacy is described as knowing "**how** to use digital technologies and **what** to do with them" and digital fluency as knowing "**when** and **why** to use digital technologies to achieve a desired outcome" (Te Kete Ipurangi, 2016).

Medvinsky (2017) advocates digital literacy for musicians in the 21st century. He points out that digital literacy provides "new opportunities for musicians to be able to use technology to organise sound, create and innovate, share ideas in a global community, and think creatively about performers' musical interfaces" (p. 466).

Modified pedagogy

The introduction and integration of ICT in teaching programmes challenges teachers to adopt a revised pedagogy to make the most of the technologies and to steer the students towards improved learning outcomes. The introduction of ICT alone is not a guarantee that the teaching and learning process will change (Trucano, 2005), but ICT can undoubtedly enable teachers to improve their pedagogy from being ‘teacher-centric' to adopting a ‘learner-centric' style. Ofsted warns though, that "when ICT fails to add value to teaching and learning in other subjects, it is often because the planning has been driven by the technology and not the subject-matter itself" (Ofsted, 2004, p. 51). Trucano supports the idea that ICT is most effective when it helps to promote "learner-centric pedagogies" (Trucano, 2005, p. 39). Dorfman (2017) envisages that modern music pedagogy with technology could provide students with the opportunity to engage with learning in creative and imaginative ways. The potential of how ICT could modify pedagogy is emphasised in four ways described by Way and Webb (as cited in Wise et al., 2011, p. 120):

- A shift from instructivist to constructivist educational philosophies.
- A move from teacher-centred to student-centred learning activities.
- A shift from a focus on local resources to global resources.
- An increased complexity of tasks and use of multimodal information.

Teachers’ pedagogical belief systems

A teacher's pedagogical belief system traditionally includes multiple levels of interrelated beliefs on learning and teaching (Ertmer & Ottenbreit-Leftwich, 2010). It is essential to look beyond the visible elements of teaching methods and pupil organisation to understand such a belief system (Orlando, 2009). These beliefs, acquired over an extended period, are usually "resistant to change" (Tondeur, Van Braak, Ertmer & Ottenbreit-Leftwich, 2017, p. 557).

> Beliefs can influence knowledge acquisition and use of technology, but context also affects teachers' applications of technology. Teacher beliefs have been shown to be heavily influenced by the subject and school culture in which they participate. (Ertmer & Ottenbreit-Leftwich, 2010, p. 264)

Webster (2007, p.1294) proposes that we “consider knowledge, skills, attitudes, and values” when the role of technology in arts education is considered. The unique nature of ICT and how it is embedded in today's society urges teachers to change their pedagogical practice (Orlando, 2009). Just as ICT is part of professional practices outside education, ICT should no longer be seen as a "supplemental teaching tool", but rather as "essential to successful performance outcomes (i.e. student learning)" (Ertmer & Ottenbreit-Leftwich, 2010, p. 256). Tondeur et al. (2017) explored the link between pedagogical beliefs and technology use in education in a review of 14 research studies. The findings across these studies were used to develop common categories. Out of these categories, they produced a set of five synthesised findings. They acknowledged that the state of technology integration was closely linked to a plethora of factors, including the complex change in educational organisations, factors that are not technology-related, teachers' beliefs about pedagogy, and teaching strategies. They concur that "the role technology plays in teachers' classrooms is related to their conceptions of the nature of teaching and learning" (p. 556). They maintain that technology integration has to be seen through the lens of pedagogical beliefs to understand its complexity.

It is apparent from the body of research that teachers with strong constructivist beliefs often do better with technology integration (Ertmer, 2005; Gilakjani, Mei & Ismail, 2013; Mangan, 2016; Orlando, 2013; Ward, 2009), the reason being that a student-centred approach aligns well with constructivism, as opposed to a more traditional, but outdated, teacher-centred viewpoint (Tondeur et al., 2017). Beliefs are, however, not uni-dimensional or mutually exclusive, and teachers can have a blend of both student and teacher-centred beliefs. Neither is a teacher's belief system a predictor of how effective they will manage technology integration, as there are many "inconsistencies between beliefs and practices" (Tondeur et al., 2017, p.558). Teachers often measure new approaches against their value judgements and the more valuable they perceive the strategy or tool to be, the more likely they are to adopt it (Ertmer & Ottenbreit-Leftwich, 2010). Tondeur et al. (2017) provide a set of synthesised findings that shed light on how teachers' beliefs influence their use and integration of technology in the classroom. They have found that the process involves an iterative, "bi-directional relationship" between integration and technology (p.568). Teachers' beliefs can also be the direct reason for not engaging in technology integration, although these beliefs can vary from situation to situation. Almås and Krumsvik (2008) support this view in their report, saying that teachers' practice will stay unchanged if they do not feel comfortable with the expected changes to their digital pedagogical content knowledge. Wise (2013) reiterates this point:

> practitioners might continue to work in the same way they always have while rejecting or actively resisting assigned identities that are not aligned with their existing identities as teachers and their identities in other areas of their lives. (p. 317)

Pedagogical change affects more than one aspect of teaching practice for teachers. It challenges the way they plan, implement, and evaluate all at once (Ertmer & Ottenbreit-Leftwich, 2010). Technology confronts teachers' knowledge base about effective teaching by requiring them to learn more about the affordances ICT brings within the pedagogical content knowledge domain (PCK) described in the TPACK framework. This challenge means they have to understand the relationship between ICT and "the skills, concepts, and processes of a content domain", such as the subject area of music (Ertmer & Ottenbreit-Leftwich, 2010, p. 260). Teachers suffered from 'technostress' in relation to their TPACK and intentional ICT use in a study conducted in South Korea (Joo, Lim & Kim, 2016). Teachers who received sufficient technical, as well as peer support, experienced lower levels of stress than those who were unsupported. When technology integration is imposed on teachers, they are more likely to resist. Joo et al. (2016) also refute the common perception that when teachers' TPACK increases, so does their technology use. Therefore, intentions and knowledge do not always correlate.

Vongkulluksn, Xie and Bowman (2018) studied the importance of teachers' belief systems based on their values concerning their technology integration practice. They found the more teachers valued technology as a way to enhance their teaching, the more they used technology in their classrooms. They also proved that teachers who valued technology could provide quality integration and used the technology "to foster student-centred instruction and higher-order tasks" (Vongkulluksn et al., 2018, p.79). Positive value beliefs influence teachers to perceive fewer first-order barriers such as access and support in their school context.

ICT integration models in education

Hennessy, Ruthven and Brindley (2005) developed a grounded model for the successful exploitation and integration of ICT in classroom practice. They based this model on the analysis of their research conducted with secondary school science, mathematics and English teachers. The themes that emerged from their study provided the four strands of an ICT integration model. These strands are:

1. Commitment to the integration of ICT in subject practice
2. Acknowledgement of the constraints that arise when ICT is integrated
3. Caution and critical reflective practice to maintain subject integrity
4. Acceptance of change in practice and pedagogy.

Watson (2006), however, identified one of the ongoing issues for ICT being how the theories of learning were interpreted through the lens of ICT and reported that despite the close investigation, it still wasn't clear "what learning gains can be explicitly associated with using ICT" (p.202). This uncertainty seems to reiterate that although teachers are aware of the necessity to support learning through ICT-based theories of learning, it is challenging to identify the specific benefits with the addition of ICT. The reason for this could be that practitioners struggle to evaluate their practice while in the act of teaching. One or the other suffers in the process, and it is only through thoughtful reflection and analysis that specific traits and notions can be identified. In an attempt to assess how teachers developed specific pedagogic strategies for ICT in their subject areas, Deaney, Ruthven and Hennessy (2006) coined the term "practical theory". They did this in a bid to encourage the research participants to reflect on "how a technology is seen as supporting learning, and guiding the development of a pedagogical strategy incorporating its classroom use" (Deaney et al., 2006, p. 5). The teachers reflected on their practice, guided by five themes. The themes aimed to determine and clarify how the teachers broadened, enhanced, mediated, fostered and improved their

ICT practice in specified ways. The study concluded that these teachers modified and augmented their pedagogical practice sustainably through deliberate and purposeful reflection.

The New Zealand Ministry of Education developed the e-Learning Planning Framework (eLPF) as a tool to provide schools with a roadmap to reach e-capability and e-maturity (Te Kete Ipurangi, 2012). The tool itself is a synthesis of the Concerns-Based Adoption Model (CBAM) of Hall and Hord (1987), TPACK (Mishra & Koehler, 2006) and the Best Evidence Synthesis iteration (BES) (Timperley et al., 2007). The tool is designed as a rubric and consists of five interconnected dimensions:

- Beyond the classroom
- Teaching
- Professional learning
- Leadership
- Technologies and infrastructure.

Each of these dimensions is organised into five phases of integration to describe how technology is adopted into teaching and learning, ranging from pre-emerging, emerging, and engaging, to extending, and empowering. The tool is intended to be used for discussion, reflection, and planning by teachers and leadership teams.

Starkey (2010) described four categories similar to the organising themes in the thematic network. These four categories were identified as critical requirements when digital technologies were used for learning, as portrayed in Table 1. She labelled the categories according to the way technology was applied in learning.

Table 1: *Four categories of digital technologies use for learning*

Use:	Technologies	Purpose	Learning
1. Subject specific programme or tool	• Logo • simulations	• Developing conceptual understanding • Problem solving • Developing computer skills • Mastery activities – memorise information or practise key processes	• Subject based • Constructivist • Cognitive • differentiated
2. Presentation	• Word processing • PowerPoint • Interactive whiteboard • Data projector • Teacher laptop	Transmissions of information, ideas and concepts	• Transmission • Passive learning • Engaging students using multimedia
3. Accessing information and students presenting 'projects'	• Internet • Web 1.0 • Web pages • Word processing • PowerPoint	• Inquiry • Web quests • Constructivism	• Inquiry learning • Constructivism
4. Connections	• Mash ups • Web 2.0 • Video conferencing • E-learning • M-learning (through forum discussions and interactions	Create knowledge by making connections between information, ideas or people	• Global knowledge development • Diversity • personalisation

Note: Adapted from Starkey (2010, p. 34) "Digital saviours: Digitally able secondary school teachers in their first year of teaching," by L. Starkey, 2010, p.34.

Starkey (2010) summarised her four categories of technology use in Table 1. She suggested that subject-specific programs or tools were used to develop understanding, solve problems and practice key processes. 'Presentation' described the software and hardware used when the learners shared their new knowledge and insights. Accessing information and students presenting ‘projects’ related to the way the teacher interacted with student work and accessed online resources. ‘Connections’ described Starkey’s understanding of collaboration and the social aspect of learning with digital technologies.

Other technology integration models include the Technology, Pedagogy, and Content Knowledge (TPACK) model; the Substitution-Augmentation-Modification-Redefinition (SAMR) model developed by Puentedura (2006); the Technology Integration Matrix (TIM) developed by the Florida Center for Instructional Technology (Roth, 2015); and the Technology Acceptance Model (TAM) developed by Davis (1989) with the extended versions TAM2 and TAM3.

Alongside the models and frameworks for ICT use, there is also an active body of tools focusing on the measurement of successful ICT integration. An effective tool for measuring technology acceptance amongst teachers is the *will, skill, tool* technology acceptance model (Petko, 2012). The tool is based on a self-analysis method with a descriptive six-step design. In this model, *will* measures the ICT-specific and general attitudes of teachers towards ICT. *Skill* measures the personal ICT competencies as well as “*professional, pedagogical* and *didactic* competencies” (Petko, 2012, p. 1352). *Tool* refers to how, where and in what quantity devices can be accessed.

TPACK - a framework for ICT integration

One of the ICT integration models, TPACK, has sparked a lot of research interest since its inception in 2006. It warrants more detailed scrutiny, as it provides a framework for considerations about music technology integration later in this chapter.

TPACK is a theoretical framework for technology integration developed in 2006 by Mishra and Koehler. It builds upon an earlier synthesis model designed by Shulman in 1986 based on teachers' pedagogical and content knowledge (PCK):

> TPACK is 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. (Niess, 2011, p. 301)

Mishra and Koehler (2006) developed the TPACK model over a five-year period as part of a teacher professional development program. They extended Schulman's model in response "to the phenomenon of teachers integrating technology into their pedagogy" (p. 1017). In essence, the initial purpose was to identify the teacher knowledge required to teach efficiently with technology. The pedagogical content knowledge model evolved into the technology, pedagogy, and content knowledge model (TPCK). The *A* was added for clarity to become the technology, pedagogy, *and* content knowledge model (Thompson, 2008).

The TPACK model contains three main components: technology, pedagogy, and content knowledge. These components can be portrayed as a Venn diagram with three overlapping circles. These circles converge in a central focus area to provide the sweet spot where technological, pedagogical, and content knowledge overlap. The three domains further intersect to portray PCK (pedagogical content knowledge), TCK (technological content knowledge), and TPK (technological pedagogical knowledge).

The main knowledge components of content, pedagogy and technology each have a particular focus. The TPACK model comprises seven sections in total. Content knowledge (CK) refers to the subject matter of a specific course or curriculum area. It includes the knowledge fundamentals of any particular discipline and ensures the integrity of a subject area (Koehler & Mishra, 2009). Content knowledge refers to the teachers' knowledge specific to a subject area such as music. It answers the 'what to teach?' question.

Pedagogical knowledge refers to teachers' "deep knowledge about the processes and practices or methods of teaching and learning" (Koehler & Mishra, 2009, p. 64). It answers the ‘how to teach?' question. Pedagogical knowledge (PK) is teachers' specific methods and processes to convey the subject matter to students. This knowledge about how students learn is described in many learning theories.

Technology knowledge (TK) is the newest addition to the model and the education world in general. Technological knowledge is a complex term to define as it describes an area of knowledge that is continuously evolving and changing at a rapid pace. It would imply that teachers have a disposition of lifelong learning and openness to embrace change. However, Graham (2011) debates that "the definition of technology has failed to delineate the scope of TPACK and designate its meaningful additions to the PCK framework" (p. 1956). For example, both archaic and modern technologies such as pencils, chalkboards and digital technologies, were included in their definitions.

Pedagogical content knowledge (PCK) is "the notion of the transformation of the subject matter for teaching" (Koehler & Mishra, 2009, p. 64). Every subject area requires specific methods to teach particular content. For example, an entirely different strategy is used to illustrate an algebraic equation than to explain a harmonic progression. The critical component of this knowledge type is the teachers' interpretation of the subject matter. This insight enables teachers to be flexible in their teaching approaches.

As the model becomes more complex, the converging components become more involved. Technological content knowledge (TCK) is:

> an understanding of the manner in which technology and content influence and constrain one another. Teachers need to master more than the subject matter they teach; they must also have a deep understanding of the manner in which the subject matter (or the kinds of representations that can be constructed) can be changed by the application of particular technologies. (Koehler & Mishra, 2009, p. 65)

TCK requires teachers to have a strong technology knowledge base to apply technologies in a variety of ways.

Technological pedagogical knowledge (TPK) is:

> an understanding of how teaching and learning can change when particular technologies are used in specific ways. TPK includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies. (Koehler & Mishra, 2009, p. 65)

The knowledge goes deeper than a mere understanding of the technical constraints of specific technologies.

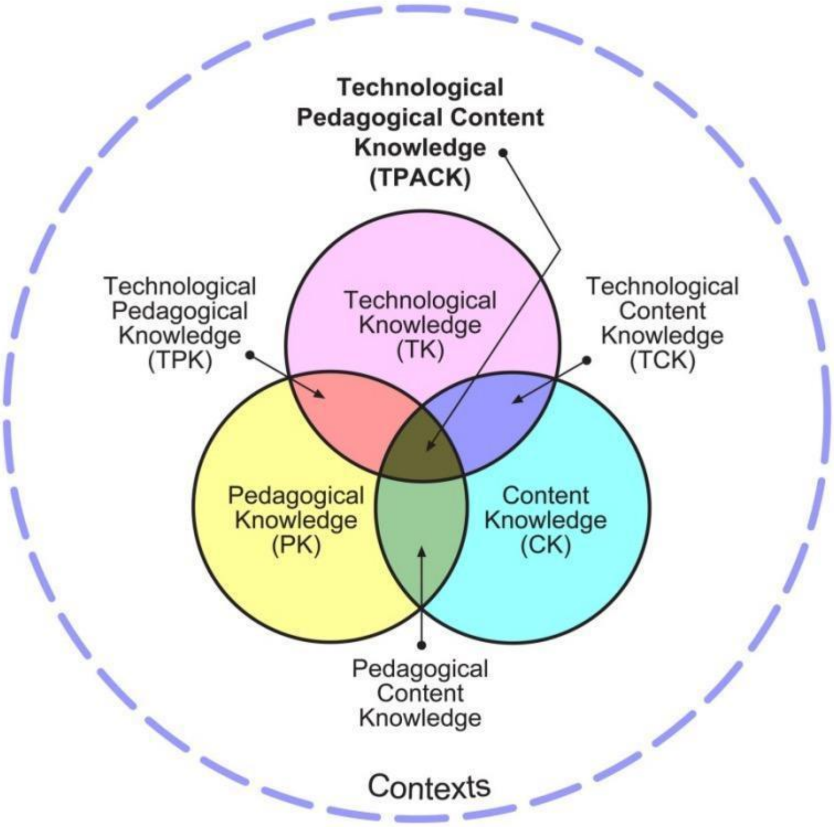

Figure 1: The TPACK framework and its knowledge components. Used with permission under Creative Commons License CC BY-NC 4.0 (Koehler & Mishra, 2009, p. 63)

The framework as seen above in Figure 1 recognises that knowledge about technology alone is not sufficient and does not exist in isolation, but is connected to teachers' pedagogical and content knowledge, influenced by the specific learning and teaching context (portrayed by the dotted circular line). The successful application of TPACK requires thoughtful interweaving of the three knowledge sources and takes into account the contextual influences of organisations, culture and socio-economic status (Harris & Hofer, 2011).

> There is no single technological solution that applies for every teacher, every course, or every view of teaching. Quality teaching requires developing a nuanced understanding of the complex relationship between technology content, and pedagogy, and using this knowledge to create appropriate, context-specific strategies and representations. (Mishra & Koehler, 2006, p. 1029)

Technology, pedagogy and content knowledge (TPACK) in combination is different from the knowledge of the three concepts when treated in isolation.

TPACK is:

- the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies
- pedagogical techniques that use technologies in constructive ways to teach content
- knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face
- knowledge of students' prior knowledge and theories of epistemology, and
- knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler & Mishra, 2009, p. 66).

The TPACK framework seeks to unpack and describe the types of knowledge required of teachers to manage a robust and sustainable way of integrating technology into their classrooms. It also provides a measure to identify the gaps in professional knowledge for teachers if they wish to address these through professional development opportunities. Graham (2011) is critical of the theoretical robustness of the model and suggests a variety of developments to support the model into maturity. His criticism is based on three components of the framework:

1. TPACK is built on an existing theoretical framework that lacks theoretical clarity (PCK)

2. There is a conflict between the complexity and apparent parsimony of the framework
3. The constructs in the framework are not all defined.

Graham (2011) recommends that the PCK model is first understood clearly before anyone endeavours to implement or advocate TPACK. He maintains that the superficial simplicity of TPACK could be misleading because the underpinning constructs are complex and ill-defined. Because there is no set benchmark, it is difficult to measure success or failure when the framework is applied.

Angeli and Valanides (2009) introduced ICT-TPCK as a new strand of the TPACK framework in an attempt to delineate the technology component better. ICT-TPCK is:

> the ways knowledge about tools and their affordances, pedagogy, content, learners, and context are synthesised into an understanding of how particular topics that are difficult to be understood by learners or challenging to be represented by teachers can be transformed and taught more effectively with technology in ways that signify its added value. (p. 154)

The ICT-TPCK strand restricted the technology component (T) to that of ICT and can be defined as “the ways knowledge about tools and their pedagogical affordances, pedagogy, content, learners, and context… can be transformed and taught more effectively with ICT” (Angeli & Valanides, 2009, p. 159). They emphasised that ICT has become more than a tool of delivery and has developed into a component that can enhance student learning. The complexity remained when teachers attempted to apply this model to grow their practice and to improve their pedagogical skills because ICT-TPCK always remained dependent on "teachers' beliefs and practical experience" (Angeli & Valanides, 2009, p. 159). ICT-TPCK aimed to develop the thinking to provide multiple ways of presenting information with technology to enable students to learn in a style most suitable to their learning needs.

Research into the measurement of teachers' TPACK application (Koehler, Shin & Mishra, 2011) discovered 141 instruments in use. The instruments broadly measured teachers' practice through methods such as self-reporting, questionnaires, performance assessments, interviews, and observations. They maintain that TPACK remains a "moving target" because the developing technologies consistently require pedagogy to be adapted and revised. They conclude that these instruments fall short on robustness when it comes to reliability and validity and suggest that better data triangulation processes be administered.

Niess (2011) explored the dilemma teachers faced when they had to develop their TPACK strategic thinking but "have not learned the content with these technologies" (p. 308). She addressed the important matter of improving training for student teachers regarding ICT skills and TPACK. She also made suggestions on how to better prepare for classroom teaching. One suggestion to enhance the impact of teachers' TPACK was to include student ideas and perspectives (Chai, Koh & Tsai, 2013). They explored students' conceptions of learning within specific learning environments and how these experiences influenced their learning outcomes. As a result, they suggested a focus on how students learn particular content (LCK), how they learn with technology (TLK) and how the two constructs overlap (TLCK) to further inform teaching practice. Although this is a valid addition, it further complicates the model. TPACK is a useful framework, but exactly how teachers are expected to change remains vague. As White aptly wonders: "The question remains about how education can change existing teaching practice to utilise TPACK and the perspectives that leaders need to embrace for teachers and students to become fluent in the use of digital technologies" (White, 2013, p. 7).

Factors that influence ICT integration

Because of the complex relationship that ICT and education have, there are many factors that influence the partnership, either positively or in a restrictive manner. These factors may include aspects that influence teachers’ thinking and behaviour such as belief systems and values. It also encompasses perceived barriers and enablers of the integration process (Chen, 2008; Tondeur, Van Braak, & Valcke, 2008; Prestridge, 2012; Kim, Kim, Lee, Spector, & De Meester, 2013; Ovens, Garbett, Heap, & Tolosa, 2013).

The term ICT integration is often used to imply computer use, but Lloyd (2005) emphasises that ICT integration is more often understood to “reflect a change in pedagogical approach to making ICT less peripheral to schooling and more central to student learning” (p. 5). Furthermore, ICT integration “can be a state, an outcome and also a process” (Lloyd, 2005, p. 8). Fluck (2003) defines ICT integration as “the degree to which ICT vanishes into the background of the classroom learning activity” (p. 42).

It remains clear that although teachers covet effective ICT integration, the means to accomplish this integration remains elusive. In 2006, Watson reported:

> That after 20 years of computers in schools and efforts to integrate ICT into teaching, the use of computers in classrooms is still low. And this is despite the fact that computers are now relatively cheap and ubiquitous, and that software is much easier to use. (p. 205)

Robertson et al. (2007) developed a seven-step professional learning model for teachers to accommodate the "ever-evolving technologies" (p. 46) in classrooms to support the integration process. They proposed that the first step was to suggest the clarification of the purpose and rationale of ICT integration. Further to this, they encouraged the pedagogical connections of ICT in the current teaching process and sharing and collaboration in communities of practice.

In Step Two, teachers were encouraged to discuss the envisioned outcome as well as the means to achieve this goal. This step involved a focused effort to manage change within the organisation. In Step Three, teachers identified the constraints that could hinder successful integration. These included teacher motivation, ICT knowledge and skills, the reliability of the equipment, and teacher confidence. In Step Four, they encouraged teachers to implement "new ways of doing things or initiate entirely new kinds of learning activities" (Robertson et al., 2007, p. 94) through action learning. They proposed that action learning was a way to construct new pedagogy. By using "programmed knowledge" (P) and "insightful questioning" (Q) as well as "activities and experiences" (A), it fostered Action Learning = P + Q + A (p. 98).

The core of action learning was to kindle responsible actions based upon new knowledge acquired through focused inquiry. All of this needed to be done using ICT as the magnifying glass to enhance practice within a reasonable time frame. It was at this stage of practical implementation that they suggested the use of learning objects (customisable generic learning opportunities). The added awareness that action learning brought, took teachers to Step Five which identified the need for focused professional learning. In this step, teachers were charged with the stages of ICT adoption and how the principles and application of a professional learning cycle could support the integration of ICT in the teachers' newly adjusted pedagogy. Step Six beckoned teachers to share their modified practice and to engage in "just-in-time" as well as "just-in-place" collaboration (p.137). Step Seven pleaded for reflection and responsible action in the face of new and ongoing challenges. Robertson et al. (2007) suggested a redefinition of professional learning practice for ICT. This altered practice should include an emphasis on an awareness of the levels of discomfort staff experience with ICT, an effort to build confidence through "familiarity and success" (p. 145) and being comfortable with the possibilities and limitations that ICT brings. Lastly, Step Seven should be treated as a spiral of improvement and transformation, similar to a spiral of inquiry (Timperley, Kaser & Halbert, 2014) to reflect on professional practice.

Perera (2008) investigated the procedures and strategies that teachers used when integrating technology into their teaching. Teachers used technology in several ways, for instance:

> Teachers used instructional procedures that integrated technology to introduce the lesson; to motivate students; to keep them focused and engaged; to build bridges to prior knowledge; to introduce and reinforce concepts, facts and perspectives; to provide practice experiences; for review of lessons; for follow up activities; and for culminating evaluation. (Perera, 2008, p. 90)

If teachers align new technologies with their current practice and approaches, they increase the likelihood of their success exponentially (Tondeur et al., 2017). However, Ertmer and Ottenbreit-Leftwich (2010) stress that even when teachers follow constructivist, student-centred approaches, it is no guarantee of leading-edge practice. They emphasize that teachers need the knowledge to identify and use appropriate technologies, as well as know how to apply technologies to enable students to use these technologies during the learning process.

Kafyulilo, Fisser, and Voogt (2016) claim that teachers would continue their use of technology in classrooms if the school management supported and motivated their efforts. This observation was made from a post-professional development vantage point. To illustrate how interdependent the factors involved in technology integration were, Howard and Thompson (2016) developed the practice causal loop diagram to demonstrate how teaching, beliefs about teaching, knowledge about integration, and individual professional learning fed into the complex system of teachers' technology integration (p. 1888). This model provided three new approaches to examine the integration process. Because this model was grounded in systems thinking and methods, it gave a platform to apply system dynamics to dissect the "complexity of integration and change" (p. 1892). They proposed that a systems approach could be used to shift the focus back to technology integration for learning, rather than mere technology use.

As technology integration involves many interconnected thinking processes and external influences, Drossel, Eickelmann and Gerick (2017) wondered what the predictors were that determined the frequency of technology use in classrooms. They conducted a review of 22 countries, finding very few similarities regarding technology enablers or barriers. They identified teachers' background characteristics, school and teaching processes, teachers' attitudes, and school characteristics as priority areas for predicting technology use. Their findings are depicted in Table 2 below.

The ranking is organised from the most to the least impact of the antecedents.

Table 2: *Antecedents impacting on the frequency of computer use in classrooms*

Antecedent	**Influencing factors**	**Non-influencing factors**
Teachers' attitudes – highest impact	• ICT self-efficacy regarding lesson preparation • Positive view on using ICT	-
School characteristics – minor effect	Sufficient ICT equipment	ICT resources at school
School and teaching processes	Teacher collaboration to develop ICT use	Observation of how other teachers use ICT
Teachers' background variables	Teachers' experience in using ICT for teaching purposes	Age of teachers (only in Germany); the younger the teachers, the more frequently computers are used

Note: Adapted from "Predictors of teachers' use of ICT in school – the relevance of school characteristics, teachers' attitudes and teacher collaboration," 2017, *Education and Information Technologies, 22*(2).

The effect of ICT use on teachers' practice

Teachers refer to barriers and enablers in the context of ICT integration to explain what factors help them in their practice and what keeps them from integrating technology successfully (Ertmer & Ottenbreit-Leftwich, 2006; Howard & Thomspon, 2016; Perrotta, 2012; Spector, 2013; Starkey, 2010; Ward & Parr, 2010. Spector (2013) acknowledges that both enablers and barriers fall mainly into two categories. The first category concerns technology and infrastructure, and the second category human use and adoption (p. 28). Drissel, Eickelmann and Gerick (2017) identifies teacher attitudes to have the most significant impact on technology use, especially when teachers' self-efficacy is considered. If they believe themselves to be confident and competent users of ICT, their frequency of technology use increases.

Enablers

If Spector's first category of technology and infrastructure is considered, access to the Internet and a robust infrastructure is a strong enabler for technology integration. There are many diverse reasons for teachers to include ICTs as part of their teaching practice. Trucano (2005) lists a few enabling factors: shifting pedagogies; redesigning the curriculum and assessment; providing adequate access to functioning computers; ensuring sufficient technical support; making adequate time allowance to develop new skills, explore and plan; tapping into formal and informal learning communities aided by ICTs; and sharing lessons learned.

Ward and Parr (2010) found that teachers' readiness to use ICT as well as their skill levels impacted significantly on the success or subsequent failure of their attempts to use ICT. They discovered that even if teachers were faced with obstacles such as a lack of access, they would persist if they were motivated by a perception of need. They further define "readiness to use ICT" to include teacher confidence and self-efficacy in addition to skill levels.

Teachers' self-efficacy about technology receives priority over relevant knowledge and competence (Ertmer & Ottenbreit-Leftwich, 2010) to ensure they can support students with confidence. This confidence can be acquired over time by encouraging teachers to engage in formal and informal learning opportunities and to allow time to play with and explore what the technology is about.

Barriers

There is no shortage of barriers teachers experience when it comes to ICT integration. Spector (2013) speculates that the lack of access to the Internet and proper infrastructure could "become a barrier to progress and… widen the digital divide" (p.28). Resistance to technology integration may present in a variety of guises. Teachers reported that they perceived that technology threatened their established teaching routines. Resistance also presented as the fear of looking inadequate compared to students' adeptness. Fear of change or resistance to change was another barrier that stilted technology integration. Restrictive policies at school and national level were identified as a perceived barrier, regardless of adequate access and infrastructure (Spector, 2013). He concluded that the three significant barriers of insufficient budgets, resistance to change, and a disregard of the value placed on education, remained.

In a Canadian study by the Galileo Educational Network (2001), they discovered that teachers could identify a variety of inhibitors that prevented them from embracing ICT innovation in their teaching programmes. The study was conducted as an inquiry to encourage collaboration and knowledge construction amongst students and across curriculum areas. Some of the inhibitors recognised were: the conservative nature of most teachers, the inflexible nature of high schools, conventional expectations of a typical classroom, technical barriers such as locked-down networks, internet filters, outdated equipment, and centralised ICT control.

An Ofsted (2004) report mentions that where access to computers is localised to a computer suite, it often restricts the use of ICT, whereas greater mobility and access through laptops on trolleys and wireless networks proves beneficial across subject areas. Access is also identified as the most significant inhibiting factor by Trucano (2005) when he looks at teacher confidence and motivation for using ICTs. Hennessy et al. (2005) agree that access to resources could act as a barrier to ICT use but promotes "timetabled use of dedicated ICT classrooms" (p. 162) as the preferred option for using the equipment. This opinion is in direct contrast to the Ofsted findings. Other barriers that are identified in this report are lack of confidence, experience, motivation, and training, as well as the unreliability of equipment.

Dorfman (2008) highlights inadequate facilities and budgets as barriers to integrating technology into their teaching in a study conducted in Ohio (p.53). Watson (2006) adds the need for a "range of media competencies" as an inhibitor of teachers' ICT integration skills and competence perceptions. Buabeng-Andoh (2012) identifies three tiers of potential barriers at teacher, school and system level. The most prominent barriers to ICT integration for teachers are inadequate ICT skills, lack of appropriate pedagogical knowledge, and non-differentiated professional development.

Gall (2017) reports the shortage of computer hardware and a lack of teacher training to ensure confidence, as the main barriers to using technology to support music learning. She is pessimistic about the vicious cycle of "inadequate pre- and in-service teacher training" (p. 41) and insufficient provision of equipment for whole-class teaching leading to an overall reluctance to use technology in music classrooms. Ertmer and Ottenbreit-Leftwich (2010) refers two sets of barriers to technology integration: first-order and second-order barriers. First-order barriers are the initial obstacles teachers encounter in their attempts to integrate technology in the classroom. Some of the first-order barriers are:

- Lack of access to software and hardware
- Lack of access to technical assistance
- Lack of a unified school vision for classroom technology integration
- Professional development with few applied examples.
  (Vongkulluksn et al., p. 71, 2018)

Second-order barriers relate to teachers' value beliefs regarding the relevance and importance of technology integration. These value beliefs can be indicative of teachers' student-centered pedagogy and teaching style and can make them more resilient when facing first-order barriers ((Vongkulluksn et al., 2018).

Professional development

Trucano (2005) reports that in developing countries ongoing training is key to ensuring that teachers use ICT in their classrooms. Alongside the training aspect, proper planning is crucial, as well as the traditional teaching skills of preparation and follow-up. He emphasises that professional development should be a process, not a one-off event and that “activities should model effective practices and behaviours and encourage and support collaboration between teachers” (Trucano, 2005, p. 38). Ward and Parr (2010) advocate multi-faceted professional development, which entails more than mere upskilling. They suggest professional development that supports teachers to “understand the educational benefits to using ICT, providing them with sufficient motivation to try” (Ward & Parr, 2010, p. 121). This approach could improve their self-efficacy to a level where they feel ready to facilitate learning with ICT.

Professional development should be situated within “the context of teachers’ ongoing work” (Ertmer & Ottenbreit-Leftwich, 2010, p.262) and provide opportunities to share with and learn from skilled peers to make the learning experience immediate and applicable. Professional development should also include a focus on teachers' value beliefs (Vongkulluksn et al., 2018). Currently, professional development focuses mostly on exposing teachers to new technologies to improve their skills in using these technologies. A consolidated effort should be made to influence teachers' value beliefs about technology integration positively to bridge the existing "value gap". This gap has developed between teachers with high value beliefs and those teachers "who lack both the skills to use new educational technologies as well as the value-beliefs to drive them to overcome existing external barriers or mitigate their lack of knowledge" (Vongkulluksn et al., 2018, p. 79).

Akuno (2017) suggests better pre-service and in-service training for music teachers in Kenya to develop an understanding of available technologies for music education, to better appropriate these technologies for teaching and learning purposes, and to learn how these music technologies can be used to foster skill development in students.

Medvinsky (2017) suggests that teachers use social media to stay abreast of developments and trends in music education. Networks such as

Pinterest, Facebook, and Instagram could provide a “connected digital community” (p. 468) for sharing resources, conversations, and expertise.

ICT integration into secondary school music classrooms

This review of the literature has so far commented on the use of ICT in education, and the effect these technologies have on teaching and learning. This information segues smoothly into the lynchpin of this thesis, the use of ICT in secondary school music classrooms. The relationship between ICT integration in music education is similar to that of ICT and education in general. Wise (2013) describes the situation as one of “complexity and tension” (p. 328). Crawford (2009) affirms that the use of ICT in music education is often misunderstood and utilised to do the same mundane tasks with different tools. For example, using “music technology as glorified typewriter, whereby students enter a simple melody into a computer only to be printed out and then stuck in their workbooks. This is an ineffectual strategy” (p. 164).

Although the research points to an underutilisation of technology for music instruction, it does not mean it is non-existent. New Zealand, as well as a range of countries such as England, Scandinavia, the Netherlands, Germany, Greece, Kenya, the United States, and Australia value and apply technology in their secondary school music programmes (Ho, 2007; Akuno, 2017; Chrysostomu, 2017; Crawford, 2010; Dorfman, 2017; Gall, 2017). It is how varied this utilisation is that remains intriguing to the researcher. The reasons for these variations in practice continue to be evasive.

An Ofsted (2004) report about the impact of government initiatives for ICT in schools in England refers to the wide variation in quality use of ICT between different secondary school departments. Some schools stated that this was due to the challenge of providing professional development in specialist subjects. However, Music received special mention as a curriculum area where ICT was used for creativity and where music technology was sparking interest in secondary school students.

Gall (2017) reflects upon the use of music technology in England and 14 European countries, with a specific focus on 2008-2011, very similar to the period of time when the data for the research in this thesis was collected. She found that technology was used for a range of activities that were similar to those reported in the data for this thesis. These technologies included YouTube access for a range of music, recording music performances for self-evaluation, ear training, musical listening and appreciation, analysis, notation and score writing. At the time, technology was used mainly for composing and arranging activities in England.

John and La Velle (2004) interviewed music teachers in England to establish the differences in subject subcultures' use and integration of ICT in their specific subject. They found that music teachers had little exposure to ICT at the time. In contrast, the popular music industry generally relied heavily on the innovative possibilities technology provided. These teachers were open to the possibilities that ICT brought to their subject area.

> For them it represented a way of integrating performance with composition as well as challenging the performative nature of the subject. For some it was also a 'democratising tool' in that it allowed children with little traditional cultural capital to express their musicality with devices that connected with their personal experience of music. Finally, ICT was perceived as giving music the opportunity to 'update itself' and move away from the standard instrument image. (John & La Velle, 2004, p.319)

In Kenya, with its diverse culture of music-making and a "rich and varied landscape as the learning environment" for music students, Akuno (2017, p. 130) reports that music teachers are mostly suspicious of technology and working under heavy time constraints. The technologies that are used (computer labs, SMART boards, Internet, Youtube, mobile phone applications) are applied for teaching purposes, not for students' learning activities. She advises that teacher training should be adjusted to instill a better understanding of the nature and operation of the technologies at hand. This could then progress to an adjustment in pedagogy so teachers would adapt new ways of teaching with the technologies available.

In Greece, Chrysostomu (2017) reports a similar scenario to that of Kenya. Reluctance and unpreparedness keeps music teachers from embracing the technology skills their students already possess. She proposes a shift in focus away from “teaching about technology and with technology to *thinking with technology”* (Chrysostomu, 2017, p. 109). A number of nationwide schemes have been implemented to support music teaching in Greece since the turn of the century. These include Melodisia (an online music history resource), Euterpe (an interactive online resource for music teachers), and textbooks for music available as interactive e-books. She reports that despite the available resources, the uptake of music technology in classrooms is still sporadic and mostly unrecorded. Regardless of how much technology is available, she maintains that teachers are the main change agents.

Crawford (2010) was concerned about the shortage of computer and music technology resources in Australian schools. She reported that many schools did not hold music as a subject in high esteem, and therefore did not consider making computer resources available to music students. Even if the schools were well-equipped, it did not increase music technology integration.

Having established the existence of technology use in music departments around the world, the next steps is to ascertain what student and teacher perceptions are about music technology.

Teacher and student perceptions about music technology

If the research maintains that ICT integration offers numerous possibilities for creative ways of learning and teaching, what are the perceptions of teachers and students? Teacher perceptions were described by John and La Velle (2004) who interviewed music teachers to establish the differences in secondary school subject subcultures' use and integration of ICT in their specific subject. These teachers were open to the possibilities that ICT brought to their subject area.

For them, it represented a way of integrating performance with composition as well as challenging the performative nature of the subject. For some, it was also a 'democratising tool' in that it allowed children with little traditional cultural capital to express their musicality with devices that connected with their personal experience of music. Finally, these teachers perceived ICT as giving music the opportunity to 'update itself' and move away from the standard instrument image (John & La Velle, 2004, p.319).

A study conducted by Wise (2009) on student perceptions, concluded that students were "highly technologically capable and are able to use technology to support a range of musical activities that they undertake both in and out of school" (p. 332). The students surveyed in this study reported a range of transferable skills like downloading music onto mobile devices and collaborating on performance skills with material downloaded from the internet, blurring the lines between using technology inside and outside the classroom.

A study conducted in China investigated students' experiences with and preferences for using ICT in Shanghai's secondary schools (Ho, 2007). The students were positive about the role of ICT in motivating them to learn about music, especially popular music styles. They preferred to use music technology mainly for listening to music and believed that the technology "would make music lessons more interesting" (Ho, 2007, p.710). In an earlier study, Ho (2004), reported on the differences in gender perception about music technology. He found that primary-aged students were more receptive and interested in using technology for their music learning than their secondary counterparts. Girls were lagging behind boys regarding confidence to use software for composition and music literacy skills. Girls preferred to use ICT for listening and performing. The study concluded that there were "no great gender differences in students' attitudes toward IT" (Ho, 2004, p. 159). A more recent study in England (Savage, 2017) reports that the gender uptake of music courses that have a core element of music technology, still lean heavily towards males with an 80% difference for the Level 3 BTEC (Business and Education Council) qualifications.

How ICT enhances music learning

The literature provides considerable evidence to support the notion that ICT can enhance and support students to learn better, be more engaged, and evolve with a deeper understanding when technology is efficiently integrated into their music learning programmes. If we adopt a positive approach towards technology, it is important to investigate the opportunities that technology brings to music education. This section delves into current practice as well as possibilities that might not yet have been fully explored:

> The learning of music technology should go beyond the ‘core’ study areas – such as sound and its properties, basic audio processing, introduction to MIDI, digital audio basics, basic recording techniques and introduction to music sequencing – to explore ways of applying these skills and knowledge in empowering artistic expressions, and strategies that locate music effectively as an essential, integral and vibrant aspect of human lives and civilization. (Leong, 2012, p. 241)

A positive response to the use of technology was demonstrated in a study by Crawford (2010) in an under-resourced Australian music classroom. She indicated that teachers and students were in favour of music learning that “valued knowledge, authentic learning and multidimensional/non-linear learning” (p. 31). Technology enabled students to engage in self-directed learning and allowed the teacher to facilitate their learning.

Medvinsky (2017) advocates that “21st century musicianship” could be supported through “innovative technological possibilities” (p. 467). He suggests some guiding questions for teachers to consider when they design music lessons that include technology:

- “What (if any) technology is suited to support each learner?
- How can the technology connect the musicians outside the walls of the classroom?
- Does the technology support the musician in creating music previously unachievable?” (p. 466)

These questions are valid as they consider in the first instance the relevance of the inclusion of technology. It is not always necessary and should be regarded as a tool of choice. The second question alludes to the authenticity and real-world experience of the learners. Music never exists in isolation and neither should the learners when they connect with music (see also Tobias, 2015; Wise, 2009). Thirdly, the addition of technology should enhance the creative process. Medvinsky further suggests a transparent, scaffolded approach for technology integration into the design of learning opportunities. “Technology simply provides musicians with multiple pathways to express, problem-solve, and show their understandings of learning goals, thus fostering divergent thinking” (2017, p.468).

It seems incredible that the first iPad was released only eight years ago. Touch-screen devices such as smartphones and other tablets have evolved rapidly over the last decade. If strict policy regulation and cyberbullying fears could be set aside for a moment, the possibilities that these hand-held devices offer for music learning can be explored more closely.

Medvinsky (2017) advocates several ways to use mobile technology in the music classroom. One example is to turn an iPad into a controller for Logic X with a Logic Remote app. This enables students to control the recording process remotely and have recording, mixing, and even other digital instruments at their fingertips. Another example he gives is of students that mirror their digital devices when they share a composition. It provides the class with the visual means to provide feedback and peer review each others’ creations. This makes the creative process much more collaborative, and learners can learn from each other and have reflective discussions about the creative process.

A New Zealand perspective

The ideas above can be applied to a New Zealand context to enhance current music teaching practice for teachers. The ideas in the next section are organised around the Music – Sound Arts strand in the New Zealand Curriculum.

An overview of the Arts curriculum in New Zealand provides a backdrop for the next section. Music – Sound Arts is one of the four strands available in the Arts curriculum, along with Visual Art, Dance and Drama. The New Zealand Curriculum allows for a range of contexts to include ICT in the Music – Sound Arts strand of the Arts curriculum. Based on four achievement objectives, the Music – Sound Arts strand provides opportunities for students to understand music in context (UC), develop practical knowledge in music (PK), develop ideas in music (DI), and to communicate and interpret music (CI). Current evidence points to the latter providing the most opportunities for ICT integration and skill development (Wise et al., 2011; Wise 2016). These four achievement objectives all provide some context for technology integration. These technologies include but are not restricted to ICT. The explanation in the achievement objective glossary explains technologies as follows:

> equipment used to help create, present, explain, document, listen to or view, interpret, analyse, or learn about musical works, including electronic media (for example, video, computers) and production technologies (for example, mixing desks). (Te Kete Ipurangi, 2017)

In addition to the music achievement standards, there are four music technology unit standards available for students studying at secondary school level (see Table 3). Although this is a welcome addition to the existing achievement standards available to students, the outcomes of these music technology standards are still very traditional. The technology is only applied to produce a conventional score by using sequencing and notation software at progressing levels of difficulty according to the qualification level of the unit standard. Below is a summary of each of the four standards with its purpose statement. The outcomes of these standards still require the student to produce a traditional composition or arrangement, but with specified tools. This type of thinking only utilises the bottom levels (substitution and augmentation) of the SAMR model and very basic music technology literacy skills.

Table 3: *Music technology Unit Standards (NZ)*

Unit standard (*strand*)	**Purpose**	**Suggested technology**
US27656 *(DI)*	People credited with this unit standard are able to: demonstrate introductory knowledge of the features and function(s) of music technology equipment and techniques; and use the features and functions of music technology equipment and techniques to create a simple sequence and short score	• Sibelius • Audio interface • MIDI keyboard • Microphone and cable
US27657 *(UC)*	People credited with this unit standard are able to demonstrate knowledge of the development and usage of music technology equipment and techniques.	• Research presentation: • Features • Techniques • Functions • application of techniques for 3 types of music technology equipment
US27658 *(DI)*	People credited with this unit standard are able to: demonstrate and apply knowledge of electronic music production processes using sequencing applications; and demonstrate and apply knowledge of music notation application(s) by creating a notated score.	• Sibelius or Logic Pro • Musical instrument digital interface (MIDI) sequencer or a Digital Audio Workstation (DAW) • Audio interface • MIDI keyboard • Microphone and cable
US23730 *(DI, CI)*	People credited with this unit standard are able to: operate music sequencing and editing application(s) for a music or performing arts situation; and	• Sibelius or Logic Pro • Musical instrument digital interface (MIDI) sequencer or a Digital

	operate music notation application(s).	Audio Workstation (DAW) • Audio interface • MIDI keyboard • Microphone and cable

Note: From "Standards," New Zealand Qualification Authority, n.d.

Developing ideas in music – sound arts (DI)

In the New Zealand Curriculum, the Music – Sound Arts strand has an achievement objective to develop ideas. This objective refers to the creation and recreation of music through composition and arrangement of music. The following section describes some of the ways supported by the literature of how ICT could be integrated into this achievement objective.

Wise (2016) found that even teachers who were regular users of digital technologies set tasks for students that were "fundamentally traditional and procedural in nature when connected with composition" (p. 293). Bauer (2014) recommends several processes to facilitate student composition with technology support. Technology can provide students with a scaffolded process, and a means to "think in sound" (p. 63). Technology can support composing with traditional notation-based software or non-notational strategies. The immediate playback function of notation and sequencing software gives students the ability to listen to their creations without having to wait for a capable musician to perform the composition. Freedman (2017) reasons that "if we are teaching students to create music using available technology, standard music notation can take a back seat" (p. 381). The biggest advantage of the graphic depiction of a composition is that students who do not read music notation can still be creative and capture musical ideas. Sequencing software also gives them access to a range of instruments and timbres at their fingertips. Tobias (2015) investigated the connection between secondary students' musical engagement in a combined song writing and technology class with their musical experiences outside of school. He found that "crossfading" these experiences (p. 18) engaged and inspired non-traditional students who might otherwise have been uninterested in a composition class.

Music notation software brings a variety of additional functionality to producing hand-written scores. Firstly, it provides clearly formatted scores. Although students still need to apply the rudiments of music theory, the end product always looks professional. Teachers could set parameters in a composition template to assist with a scaffolded creative process. The software enables peer feedback and critiquing when a composition is shared with another user. Teachers could also provide feedback with "screen capture software" (Bauer, 2014, p. 67) to make videos for sharing feedback with the students. This could provide personalised guidance in an asynchronous manner.

In addition to arranging music, more recent practices along similar lines exist in remixing and mashups. Technology is an excellent enabler of these processes. Remixing also introduces students interested in audio recording and sound engineering to a range of skills used in the music industry.

Sound design is an option that students interested in composition can explore. The practice of sound design was made popular through visual media such as television, movies and even computer games. Sound designers create the soundtrack for such media. It is the combination of the musical score and all the sound effects. Savage (2005) explored how the "processes and practices of sound design, i.e. creating, classifying, editing and mixing sounds to picture, could extend existing school-based compositional pedagogies" (p. 331) in the Sound2Picture project. This was an interesting approach that has not been widely considered by music teachers. It further provides the opportunity to establish cross-curricular connections with media and visual arts. Art design "contains a range of artistic skills, often specific to the use of new technologies, that widen the opportunity for pupils to engage in music composition" (Savage, 2005, p. 345).

Communicating and interpreting in music – sound arts (CI)

The New Zealand Curriculum describes musical performance as communicating and interpreting in Music – Sound Arts. Technology can enhance and support music performance skills in a variety of ways. Bauer (2014) suggests the following: tuners and metronomes, digital accompaniments for practising and performing, video and audio recordings to use as examples and monitor progress, videoconferencing to access a professional mentor or tutor. The technology itself can also become the musical instruments. Examples of such ensembles are the Princeton Laptop Orchestra (PLOrK), the Stanford Mobile Phone Orchestra (Mo-PhO). The Internet provides collaborative music-making opportunities with software like jam2jam, Audio d-touch, NINJAM, and eJAMMING (Bauer, 2014).

Students can develop their digital music-making skills with live coding. Live coding plays on the intersection of improvisation, composition and computer programming. Sonic Pi is a digital tool that was developed by Sam Aaron. It "is a novel medium that provides ways to combine traditionally separate musical concepts of composition, performance, instruments, and notation through programming" (Burnard et al., 2014, p. 5). Live coding enables a programmer/composer to create music by writing code while performing in a live setting, much like a DJ in a nightclub. The code is usually projected on a screen for the audience to follow as it is happening. Although the software can produce sophisticated performances, it provides a coding environment that is simple enough for children and young people to access.

Bledsoe (2017) offers three principles that he abides by for implementing technology to support and encourage creativity in music classrooms. These principles are:

1. "treat all musical tools as equal in the classroom,
2. provide access to both acoustic and electronic instruments in all classroom settings, and

3. provide opportunities for exploration and play to occur with all instrument.” (p.501)

This approach implies that all tools, technologies and instruments are embraced as long as they fit the purpose and lead to a musical outcome.

Understanding music – sound arts in context (UC)

This strand of the New Zealand Curriculum focuses on the history and context of music through the ages.

Technology can provide a visual context for students to enrich their understanding and deepen the learning experience about a period in music history or a specific genre. Tools such as “websites, wikis slideshow software, podcasts, and timeline tools could provide a platform for students to demonstrate their understanding of these topics” (Bauer, 2014, p. 117). The internet provides numerous opportunities to learn about the musics of the world, for example, YouTube videos of traditional cultural performances. Online art collections and interactive websites for museums like the Smithsonian (Washington, DC), Te Papa Tongarewa (Wellington), or the Louvre (Paris) provide music students with the means to make connections with other art genres within a similar time period to develop contextual understanding of the music they are studying. One example of a website with multiple resources is www.teachingmusichistory.com

Electronic books (ebooks) are freely available and can either be read or created by students. The software allows for text, sound, graphics, video, and some interactive elements (Bauer, 2014), which makes for a richer user experience than text-based resources.

Developing practical knowledge in music – sound arts (PK)

Developing practical knowledge in Music – Sound Arts is about understanding the expressive qualities of music and how these are influenced by a variety of factors. This achievement objective focuses on how we respond to music.

One of the most frequent activities of developing practical knowledge in music is the act of listening. Most students engage in what is called “intuitive listening” (Dunn, 2011, p. 42). This is an informal way of responding to music where the listener “has control over all aspects of the listening experience, often processing the music holistically rather than analyzing specific aspects of it” (Bauer, 2014, p. 108).

Listening to music is probably one of the ways that people will continue to engage with music for most of their lives, even if they stop playing an instrument. We are fortunate to live in an age when mobile technologies have enabled this for anybody with a smartphone or access to the Internet. It is a common sight at airports and on other public transport to see many people with earphones plugged into a mobile device. The listening experience on mobile devices can be of surprisingly high quality. Bauer suggests that music teachers tap into these technologies to simplify access to, storage of, and curation of collections of samples. This could be done by creating playlists for specific lessons, establishing listening stations equipped with headphones, and sharing the listening experience in class with portable speakers (Bauer, 2014).

The skill to respond to the expressive qualities of music is one acquired over time and best done collaboratively. Listening activities can be extended to an online forum such as a classroom blog. This is a powerful tool to encourage students’ reflective practice by comparing musical performances, styles, performers, and other listening experiences (Kerstetter, 2010).

Aural perception and music theory skills form part of this achievement objective. Music theory enjoys a variety of technology support tools, both as websites and software programs. Many of these programs combine listening and theory skills. Some examples are Teoria, Music Ace and MusicTheory.net. In combination with mirroring or projection hardware, these technologies can be used in whole-class settings (Bauer, 2014).

Models for ICT integration into music education

Music teachers need to be encouraged to integrate technology into their teaching programmes. Dorfman (2013) suggests three ways to accomplish technology-based music instruction (TBMI) by addressing the ways pre-service teachers are trained. Firstly, technology could be blended into existing teacher-training courses. The chosen technologies should have an appropriate purpose and provide a musical outcome. Technology could also be offered as a methods course rather than focusing on different technologies and operating techniques "without much regard for related teaching concepts" (Dorfman, 2013, p. 180). His third suggestion was that music students be made responsible to acquire certain baseline technology competencies independent of their course work through self-guided learning.

The TPACK framework was designed to be a model for teachers who want to find an equilibrium between their content, pedagogy and technology knowledge and implementation. The conventional view that "pedagogical goals and technologies are derived from content area curricula" (Koehler & Mishra, 2009, p. 67) is inverted by this framework when teachers realise that new technologies require adjustments to their pedagogical beliefs and development of their existing content knowledge. Dorfman (2017) acknowledges that

> until quite recently, few theoretical models have existed that helped both music teacher educators and future music teachers to conceptualize the difficult interconnections between music, pedagogy, and technology, and the specific kinds of knowledge associated with each of those domains. (p. 259)

Although the TPACK model is aimed at teaching in general and can be applied in any curriculum area, music-specific implications are of critical importance to this research focus to relate the findings to the music classroom. William Bauer has made a significant contribution with his book, *Music Learning Today* (2014). In the preface of the book, he states that "it provides the essential understanding required for educators to become adaptive experts with music technology", describing the "intersections of music, learning, and technology" (Bauer, 2014, p. xi). His research is grounded in the TPACK framework to examine the relationship between content, pedagogy and technology in a musical context, and to support teachers in bringing these components together effectively. He maintains that any technology integration should be based on the premise of learning outcomes and not what the technology can do. However, he candidly states that teachers have a responsibility to "know how to effectively use the technological tools to maximize learning" (Bauer, 2014, p. xii).

As Dorfman (2017) asserts, pedagogy and skill development are equally important for teachers to shape their technology-enriched practice with more refinement. The TPACK model is merely a framework to help teachers navigate their knowledge to inform their pedagogical practice.

TPACK-based training for pre-service and in-service teachers is another consideration that Dorfman (2013) proposes. He aligns TBMI and TPACK domains to interpret TPACK in the context of TBMI. He maintains that technology-based music instruction requires a specialised skill-set from teachers to have a clear understanding of:

- "Technology and its permutations
- Musical content
- The ways in which students may learn musical and technological content well". (Dorfman, 2013, p. 46)

He urges that the content domain of both these models continue to receive considerable attention, so it does not become submerged by the technology focus. Essentially this suggestion remains the same as the original format of TPACK. Dorfman only tweaks the pedagogical statement to be student-centred, but it still focused on 'how' teachers should design their teaching.

Bauer (2010) and Bauer et al. (2012) propose a musical TPACK (MTPACK) to be used as a model for technology integration into classrooms and rehearsals, as a theoretical basis for further research, and as a design framework used to plan professional development for music teachers. In a questionnaire that measured teachers' MTPACK, Bauer modified the domains to represent a music focus: (a) technology (TK), (b) music (CK), (c) generalised approaches to teaching (PK), (d) music-specific approaches for teaching (PCK), (e) technologies that are used in music (TCK), (f) generalised approaches for teaching with technology (TPK), and strategies for combining music, technology, and teaching and learning strategies (TPACK). The respondents performed the best in the PK, CK and PCK domains (Bauer et al., 2012), showing their confidence in their own pedagogical, content, and music-specific knowledge. Unsurprisingly, they measured the lowest in the technology domain. The second part of the questionnaire explored how teachers developed their TPACK. Bauer found that self-exploration was the most popular way for teachers to develop their technology insights.

The interpretation of TPACK is often too abstract for teachers to easily apply it to their daily teaching practice. This is even truer for music educators. Table 4 describes each of the domains with their sub-domains. It further provides an interpretation of what each domain entails in a music education setting.

Table 4: *The TPACK domains in a music context*

Domain	**Description**	**Music context**
Content Knowledge (CK)	A comprehensive understanding of the subject matter being taught.	Knowledge of music theory and music history, aural and performance skills, collectively known as musicianship.
Pedagogical knowledge (PK)	An understanding of the general principles, practices, and methods of instruction and student learning that apply across disciplines.	Knowledge of music-specific principles, practices, and methods of instruction.
Pedagogical Content Knowledge (PCK)	A combination of the expert knowledge of a subject with the ability to teach the subject to learners	Basic knowledge of the three fundamental processes of creating, performing and responding to music. More specialised

		knowledge and skills in at least one of them. An understanding of the range of pedagogies that are useful within and between areas.
Technology Knowledge (TK)	An understanding of general technologies, digital and otherwise, that are required for teaching and learning.	Basic skills to operate a computer, computer hardware and software, input devices, connect peripheral devices. Music educators need specialist knowledge about MIDI, digital audio, multimedia, and instructional software.
Technological Content Knowledge (TCK)	An understanding of how technology is used in a content area as well as how the content area may be impacted by the technology.	Knowledge of how modern music technologies impact on traditional techniques of music making and recording.
Technological Pedagogical Knowledge (TPK)	An understanding of the affordances and constraints of using common technologies for teaching and learning across disciplines.	Knowledge to design and implement a music lesson making use of technology to improve the effectiveness of the lesson.
Technological Pedagogical and Content Knowledge (TPACK)	An understanding of how the three domains of technology, pedagogy and content restrain and influence one another in a transactional relationship.	A disposition of adaptive expertise for the integration of technology into music teaching and learning.

Note. Adapted from "Music learning today: Digital pedagogy for creating, performing, and responding to music," by W. I. Bauer, 2014, pp. 13-17.

Bauer, Hofer, & Harris (2012) developed the Music Activity Types Taxonomy to guide teachers to include technologies in their lesson planning. They proposed activities organised by the three musical processes of creating, performing, and responding to music. A list of possible technologies is provided for every activity. This resource could be very useful for teachers who still feel uncertain of the technology integration process and support them to develop their MTPACK.

Pedagogical implications for music educators

> In our current educational practices, the teacher acts as the gatekeeper who chooses which technological tools are available and acceptable in the classroom. Whether or not this control is ethical, it exists. Perhaps teachers can position themselves as co-learners who learn to use new tools alongside students rather than excluding new technologies. (Bledsoe, 2017, p. 497)

Wise, Greenwood & Davis (2011) reported that the music teachers in this study changed their pedagogy in several ways from what they would traditionally do because of the availability of ICT. One teacher adopted a more student-centred approach to accommodate the technology intervention. Another teacher with 20 years' experience found that he was more relaxed about allowing the students to complete tasks without his intervention. Another teacher acknowledged the usefulness of YouTube to support how she was teaching composition, but in essence, she still used her traditional approach. Some of these teachers have started to adjust their pedagogy without realising it, moving from an instructivist to a more constructivist approach. They have become more comfortable around the affordances that technology provides and willing to experiment with these. It also challenges them to review their prior held beliefs and attitudes towards technology.

Gall (2017) acknowledges that “equipment availability and/or teacher expertise” (p. 41) are not the only factors that influence music teachers' pedagogy practice. A renewed focus on authentic learning experiences is required to connect the technological world of the students with their classroom experience. Gall suggests focusing on “the networking, sharing, and co-construction of knowledge that typify not only children's engagement with technology in their own time but also professional practice in music and the arts”. Although the suggestions in policy documents encourage teachers to engage students with examples of how

“ICT is used in the real world so that students can explore processes used professionally" (p.41), this is rarely the case in practice.

Tobias (2017) urges a consideration for “how people and technology are co-evolving and impacting one another” (p. 294). Tobias draws on the previous thinking of Hayles (2012) regarding the use of strategies of assimilation and distinction to administer pedagogical change. During assimilation, technology does not change existing practice but merely replaces one tool with another. Distinction requires teachers to “integrate or adapt a broader spectrum of practices for music education contexts” (Tobias, 2017, p. 295) to inform changes to the curriculum and praxis. It is important to acknowledge that several factors impact on music educators’ integration of technology. These factors include their philosophies, principles of practice and understanding of pedagogy, and curriculum. If any of these factors are ignored, it limits the effectiveness of the change process (Tobias, 2017).

Where is music education heading?

Savage challenges music educators to consider their handling of music technology very carefully:

> The history of music education with technology is a difficult one. At a time of rapid technological change, it is vital that music educators adopt a principled and informed response to the choice and use of their technological tools. Change for the sake of change is seldom productive. (2017a, p. 149)

He cautions us to maintain our “sense of humanity” (p. 153) when engaging with music and fellow musicians; to refrain from seeing technology as a quick fix; to be mindful of the constant distraction of technology, and not to let technology steal our sense of joy when learning. It is a stern warning from an advocate of music technology. What does this mean in practice?

Perhaps one of the most important considerations to find a practical way forward is to start with pre-service training of music teachers. Dorfman

(2017) suggests that TPACK could be used as a basis for skill development in student teachers:

> Studies in music education that draw on the TPACK framework might also examine the extent to which technology can be an effective means for teaching music, and the types of preservice technology experiences that translate particularly well into in-service classroom applications. (Dorfman, 2017, p. 536)

Gap in the current literature

The gap in the literature that this thesis wants to address is captured in the research questions which will be introduced in Chapter 3. The literature provides many studies on the use of ICT in schools, but few studies focus on music-specific settings in a holistic sense. The focus of current literature would often be on a component of a music programme, such as composing (Bolton, 2008; Savage, 2010; Ward, 2009), but rarely on the complete range of what constitutes a music programme, including the infrastructure, skill levels, technology integration, and aspirations of teachers.

Most of the existing literature that have a combined music-ICT-education focus have been conducted abroad (Bauer, 2013; Crawford, 2009; Savage, 2007; Tobias, 2012). This thesis contributes to the literature within a New Zealand context.
There is a lack of comparative data collected from a same sample over a period of time in the literature. Most of the qualitative studies (Jones & Cowie, 2010; Wise, 2013, 2016; Webster, 2011) have been conducted with a very small sample of respondents, and these studies have not provided evidence of progression or changed practice, apart from what has been measured during the single intervention.

This thesis also aims to identify the barriers and enablers of ICT integration specific to music programmes in New Zealand secondary schools.

Chapter 3

"I think metaphorically of qualitative research as an intricate fabric composed of minute threads, many colors, different textures, and various blends of material. This fabric is not explained easily or simply."

(Creswell, J. W., 2007)

This chapter explains the research methodology for the thesis and describes how the methodology is situated in a larger body of research about the effective use of ICT in music education settings. Influences of critical pedagogy, constructivism, and the TPACK technology integration model are explained within the context of the research questions and outcomes of this study.

Methodologically, this thesis combined a qualitative approach with elements of a comparative study. The perspectives of 11 teachers and two experts from the music software and educational resource industries were captured in 2008 through open-ended interviews. The same participants were interviewed four years later in 2012 using similar interview questions. This scenario consequently lent itself to a comparative 'then and now' approach, representative of a longitudinal analysis which is "primarily a method for studying social processes and patterns of change that cannot be approached on the basis … of data collected at a single instance" (Longitudinal analysis, 2002).

Longitudinal studies investigating teachers' adoption of technology have described the phenomena of a "pedagogical evolution" (Hennessey et al., 2005, p. 186) as teachers incorporate more technology into their practices. The findings in Chapter 6 will report on the changes perceived over the four-year period of this research. Orlando (2009) looked at the reasons for teachers' changed ICT practices in a longitudinal study extended over a five-year period. Her study has some touching points with the findings of this thesis. She examined these changed practices from the perspective of the teachers, rather than as a “longitudinal analysis that simplified change in terms of chronological order” (Orlando, 2009, p. 41). She reflected on the nature of change with ICT as being a “concentrated form of change” (p.42) because of the pace and frequency at which technology innovations occur. She further acknowledged that these changes are influenced by the role played by “social, cultural and institutional representations of ICT, professional and personal experiences with ICT, as well as teachers’ beliefs regarding ICT in their role as a teacher in a school” (Orlando, 2009, p. 35). These findings resonate with the findings of this thesis discussed in more detail in Chapter 7.

The five research questions for this thesis were:

1. Do music teachers use computer technology in their teaching pedagogy?
2. Why and how do teachers integrate technology into their teaching programmes?
3. What are the major influences on the teachers’ adoption of new technology?
4. What are the changes and constants over the period of the study?
5. How can the Technological Pedagogical and Content Knowledge (TPACK) framework improve technology integration in music classrooms?

The thesis posed questions about educational technology, the reasons why teachers integrated technology in their music programmes, what influenced them to integrate technology or not, the similarities and differences between two data collection periods, and how music teachers could use the TPACK model to improve technology integration in music classrooms in New Zealand.

In essence, the main focus was to discover whether the technology was used in music classrooms, and if so, how the technology was integrated. The main argument is neither for or against the use of ICT in music classrooms, but rather to cast some light on the daily practice of teachers, their struggles and their challenges.

The study was situated in a New Zealand context to contribute to the body of research about technology use in music education. The results were compared to a body of international research to test for validity, integrity and synchronicity of the New Zealand findings. The findings provided insights into how computer technology has been used to enhance teaching and learning, what levels of confidence and capability music teachers have demonstrated when using technology, and the perceived barriers to and enablers of technology integration.

Research design

The research design was derived from a framework designed by Buckley, Buckley and Chiang (1976). Figure 2 depicts the process of defining the research problem.

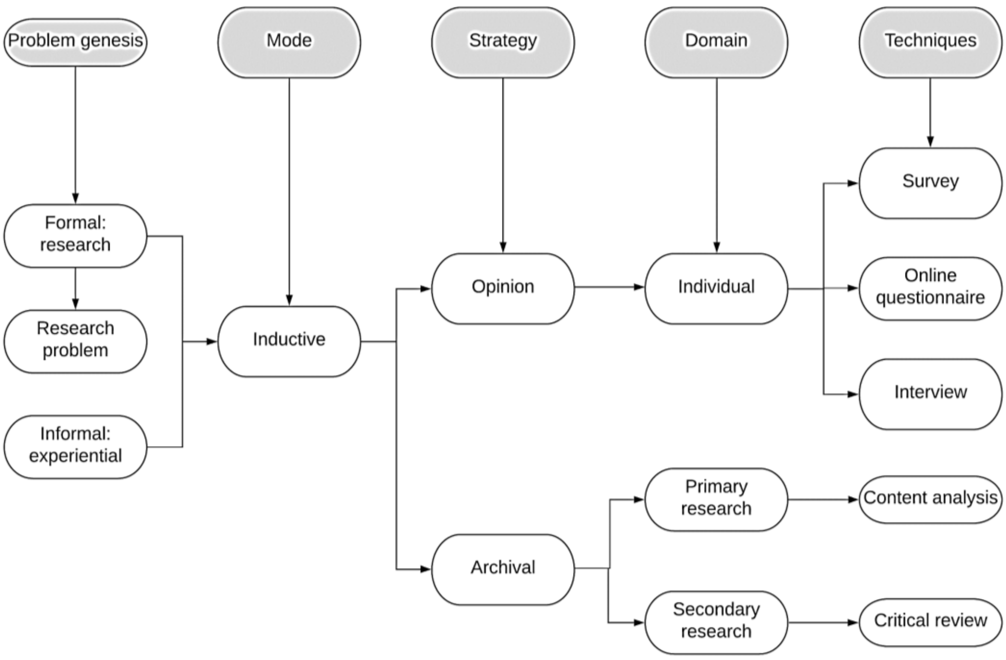

Figure 2. Research methodology and business decisions. An adaptation of the diagram from Buckley, Buckley and Chiang (1976, p. 15).

Problem genesis occurred through formal research of the literature on the effective use of ICT in music education settings, and informal investigation of certain phenomena experienced during the course of teaching music to secondary students. A phenomenological approach employing qualitative data collection methods was used to conduct this research. The focus of the thesis was to understand the essence of ICT use in secondary music classrooms. The phenomenological approach is well-suited to researching this type of problem as it aims to describe the essence of a lived phenomenon (Jansen, 2010).

Once the research problem had been formulated by reviewing relevant literature in the field and incorporating real-life experiences of classroom teachers, the mode of investigation could be decided upon. In this instance, a pilot survey, followed by semi-structured interviews were chosen. The mode of investigation was inductive to allow the data to speak rather than to test the data against an existing hypothesis. This was done by transcribing the interview data, reading and coding the transcripts, and then allowing the data to reveal emerging themes. The data collection strategy followed was to gather data through fieldwork and empirical research to enable an inductive process. Respondents' opinions were obtained through interviews, and archival data was studied as part of the literature review. Secondary sources were investigated using a critical review of the literature. This strategy was chosen to gather the opinions of educational practitioners through individual semi-structured interviews. Prominent categories and themes were identified through an inductive coding process when the data was interrogated.

Both formal and informal techniques were used to gather data. Surveys, online questionnaires and face-to-face interviews provided the rich content for qualitative analysis. All the interviews were transcribed to provide data that could be coded and analysed. Initially, an online questionnaire identified suitable candidates for a purposive sample. These suitable respondents were then interviewed, and the content of the interviews was analysed to deduce categories and themes.

The background to the research problem is rooted in philosophy and education. To study this phenomenon, several teachers with their shared experiences of secondary school teaching, music classrooms, and technology integration were selected. The participants were interviewed on two occasions, with a time lapse of four years between the two data-gathering events of 2008 and 2012. The data collected from the interviews was then analysed for significant statements and textural description, resulting in a coding scheme which informed the identification of prominent themes. The final analysis was a comparative summary of the two datasets that provides the reader with a thematic synthesis culminating in the identification of the four components required for the successful integration of ICT in secondary school music classrooms, namely accessibility, connectivity, pedagogy, and motivation.

Qualitative research approach

The nature of the research required an approach that would do justice to the topic's technological, pedagogical and musical foci. For this reason, a qualitative approach was chosen to enable the researcher to explore the topic in detail by collecting personalised responses through interviews and questionnaires. Because of the educational focus of the research, it combined appropriate research methods used in the social sciences and educational settings to best discover teachers' use of technology in secondary school music programmes.

The research was not aimed at producing quantitative data about the number of users and software applications, and therefore the qualitative focus was chosen as it deals better with phenomena that are difficult or impossible to quantify mathematically. This approach was selected because qualitative research enables researchers to study social and cultural phenomena. In summary:

> qualitative research, in all of its complex designs and methods of data analysis, is guided by the philosophical assumptions of qualitative inquiry: To understand a complex phenomenon, you must consider the multiple "realities" experienced by the participants themselves—the "insider" perspectives. (Qualitative data, analysis, and design, 2012, p. 344)

Differences between qualitative and quantitative research

In educational research, a qualitative approach is often chosen in preference to quantitative methods. According to Mack et al. (2005), qualitative and quantitative research approaches differ regarding the general purpose, analytical objectives, question and data formats, and the flexibility of the data design (see Table 5). The table below gives a concise overview of the main differences between qualitative and quantitative research approaches.

Table 5: *Comparison of quantitative and qualitative research approaches*

	Quantitative approaches	**Qualitative approaches**
General framework	Seek to confirm hypotheses about phenomena	Seek to explore phenomena
	Use instruments for a more rigid style of eliciting and categorising responses to questions	Use instruments for a more flexible, iterative style of eliciting and categorising responses to questions
	Use highly-structured methods such as questionnaires, surveys and structured observation	Use semi-structured methods such as in-depth interviews, focus groups, and participant observation
Analytical objectives	To quantify variation	To describe variation
	To predict causal relationships	To describe and explain relationships
	To describe characteristics of a population	To describe individual experiences
		To describe group norms
Question format	Closed-ended	Open-ended
Data format	Numerical (attained by assigning numerical values to responses)	Textual (obtained from audiotapes, videotapes, and field notes)
Flexibility in study design	Study design is stable from beginning to end	Some aspects of the study are flexible (for example, the addition, exclusion, or wording of particular interview questions)

	Participant responses do not influence or determine which questions researchers ask next, or how they ask them	Participant responses affect which questions researchers ask next and how they ask them.
	Study design is subject to statistical assumptions and conditions	Study design is iterative, that is, data collection and research questions are adjusted according to what is learned

Note. From Qualitative research methods: A data collector's field guide," by Mack et al., 2005.

As the term implies, quantitative research aims to quantify research data, "predict causal relationships", and "describe the characteristics of a population based on statistical assumptions and conditions". Qualitative research, on the other hand, attempts to describe the phenomena by "describing variations, relationships, and individual experiences". It is more flexible in design than quantitative research because it allows participant "responses to influence the iterative process" (Mack et al., 2005, p. 3).

A strategic qualitative approach provided opportunities to investigate the individual thoughts, reactions, beliefs and recollections of teachers and music industry experts. Denzin and Lincoln (2005) describe qualitative research as involving "… an interpretive naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them" (p. 3). The phenomenon of ICT usage in music programmes was investigated for the purpose of this research.

A qualitative approach was the most suitable for the types of questions chosen for the semi-structured interviews. A small sample of 13 respondents was sufficient to gather data on music teachers' ideas and experiences. The interviews were transcribed to provide in-depth information on two separate datasets. The process was repeated four years after the first instance. A slight variation was made in the method of data collection for the second dataset. This involved a qualitative online survey sent to all participants which they completed as a Google form. The survey questions were based on the interview outline used in the first interviews. The sample consisted of eleven school teachers and two independent business experts, eventually translating into two sets of comparable data that informed the probe into changes in practice and noticeable developments occurring over the span of four years between the two data collection events. As Jansen (2010) describes: “In *empirical phenomenology,* unrelated individuals are interviewed, as in a qualitative survey. These individual persons are not selected because of their membership of a given population, but because of their experience with the topic of study” (para. 58). The sample representation was sufficient to provide information that could be applied to the wider secondary school sector and music departments of New Zealand schools.

Critical pedagogy and constructivist approaches to qualitative research

The research was an empirical study based on a qualitative approach with components of a comparative analysis. The learning theories of constructivism and critical pedagogy guided the analysis of the results.

The thesis was positioned in the framework of critical pedagogy and challenged the current paradigms of research and pedagogy in 21st century secondary school music classrooms. It delved into the barriers to and enablers of technology integration in classrooms designed to serve the learners of this century. Inquiry into own practice (teaching as inquiry), as well as inquiry teaching, are currently primary areas of focus for educators as they take on the role of facilitators of learning rather than being the fountainhead of all knowledge for their students. Learning spaces are changing to accommodate this shift in pedagogical focus from being teacher centred to placing the student at the centre.

Critical pedagogy attempts to emancipate and free learners to experience the world as it is and to interact in a non-hierarchical way with their teachers and peers:

> Adopting critical pedagogy is about making a conscious choice of teaching style. Critical pedagogy, like other pedagogies, is not just an innocent bystander. It is a partisan. It is not objective and value free, but subjective. Furthermore, critical pedagogy believes that knowledge is never a “give me”. Knowledge is always negotiable and always partial. (Shokouhi & Pashaie, 2015, p. 209)

Critical pedagogy focuses on freedom of expression and interpretation and encourages teachers to learn, relearn and unlearn as part of an on-going reflective cycle, constantly evaluating their teaching practice. Critical pedagogy challenges the thinking and the embedded ideologies of institutions and places of learning. “Critical pedagogy is also interested in learning facilitation but is primarily concerned with exposing the interests involved in the production and dissemination of knowledge" (Pedagogy/ critical pedagogy, 2007).

Critical pedagogy is further concerned with the co-construction of new knowledge through the collaboration of teachers and students, moving away from the concept of students being passive recipients of knowledge, also known as the banking system of education. In the banking system teachers hold all the knowledge and students are passive receivers of information (Shokouhi & Pashaie, 2015). When critical pedagogy is applied, students are encouraged to enter into a learning partnership with teachers to construct their own knowledge. Teachers pose a problem to students and encourage them to use critical thinking skills to find possible solutions. This type of pedagogy is appropriate in a music technology classroom where the environment is familiar but the ICT tools to solve the problem need to be explored to find new solutions.

> Critical pedagogy welcomes teachers who are confident and at the same time humble enough to know that they don’t know all the things and their students are going to know things that they do not. Dialogue is essential to the implementation of critical pedagogy in the everyday classroom. (Shokouhi & Pashaie, 2015, p. 207)

One of the prominent role players and advocates of critical pedagogy, Henry Giroux, commented in an interview in the *Global Education Magazine*, that critical pedagogy is not a method or a “fixed set of references or prescriptive set of practices” (Tristán, 2013), but an ‘ongoing project'. Giroux is also very outspoken about the 'deskilling' of teachers in the sense that they are reduced to 'teaching for the test' and in the process are reducing students to 'consumers and workers'. A true critical pedagogue will realise that teaching should include the realisation of the value and meaning of "citizenship, democracy and hope for the future" (Department of Art and Art Professions, 2018) and be concerned with a change in practice. Shokouhi and Pashaie (2015) support this stance when they describe teachers who apply critical pedagogy as being "engaged and imaginative" and not "afraid of leaving their comfort zones and taking risks in the classroom" (p. 207).

Paulo Freire refers to three rules prescribing the course of action that forms the foundation of critical pedagogy. Firstly, he wishes for learners to reflect on their situation within their cultural context of learning; secondly, he teaches that several prerequisites such as the connecting of "word to world" (Abrahams, 2005, p. 13). The understanding of the forces of hegemony has to be met before learning can occur; and thirdly, he maintains that the phenomenon of conscientization or "knowing that they know" has to occur. Hegemony refers to the dominance of one social group over another. Once all three precepts have been met the process can be referred to as critical pedagogy. Freire claims that only once transformational learning has happened where both the teacher and student are changed by the experience, has true and meaningful learning occurred (Freire, 1996).

Five key principles of critical pedagogy

Critical pedagogy (Abrahams, 2005a) is defined by five key principles describing education as:

1. conversational
2. broadening
3. empowering
4. transformative
5. political.

Education is a conversation between students and teachers that occurs during the collaborative process of problem solving. Critical pedagogy aims to broaden and change the perception of how students and their teachers observe and experience the world. Education is empowering when conscientization occurs, and the students, as well as their teachers, know that they know. Student perceptions are transformed when learning occurs, and this change can then be assessed by teachers as evidence that learning has taken place. Critical pedagogy challenges the issues of power and control as they occur within the classroom and the education system as a whole.

In this research context teachers have been probed to consider their practices and the forces that influence their integration of digital technologies within secondary school music classrooms. Shokouhi and Pashaie (2015) suggest that by selecting topics “which are both socially and individually of great value and importance to the students” (p.209), student can be co-constructors of their own learning.

Critical pedagogy as a synthesis of critical and learning theories

To understand the origins and meaning of critical pedagogy as a philosophical framework, it is important to look at the two learning theories that have influenced it most. Constructivism and experiential learning have found a synthesis in critical pedagogy because of similar beliefs of equality and fairness in the classroom as well as the emphasis on involving the student as a whole person in the learning experience.

Critics of critical pedagogy

C. A. Bowers, Kenneth Strike and D.P. Liston have been critical of critical pedagogy as a philosophical framework for education (Abrahams, 2005). The prominent advocates of critical pedagogy have been accused of being too idealistic and liberal in their outlook and views. The ethical dimension of critical pedagogy has been criticised as contributing to the "reproduction of an unjust system" (as cited in Liston, 1988). Knight and Pearl (2000, p.206) write that "the approach of critical pedagogy is distressingly similar to that of traditional educators. Whereas one *tells* about the glories and wonders of ‘our democracy’, the other *tells* of its imperfections and oppressiveness. They are equally boring". They continue to point out the vulnerability of critical pedagogy to assess learning when they claim that "nothing in critical pedagogy is testable" (Knight & Pearl, 2000, p. 221). Ellsworth (1989) criticises critical pedagogy for music education in that she finds the idea of the teacher becoming a student in relation to the student faulty because this implies that the teacher has a level of superiority over the student. According to her, our own experiences of oppression will always be influenced and limited by our individual life stories (Abrahams, 2005).

Critical pedagogy and music education

> ... if music education is to enable and empower students to be informed critical thinkers and active, reflective creators of their own cultural history, then it must look to both the implicit *and* the explicit, the internal *and* external understandings, meanings and practices of music in education. (Abrahams, 2005, p. 17)

The value of critical pedagogy in music education is indisputable. To support this view, Abrahams (2005, 2005a) has published several articles about critical pedagogy in music education. He summarises the contributions of music educators such as Elliott (1995), Schmidt (2002) and Regelski (2004) in support of the notion of critical pedagogy in music education. Elliott and Schmidt refer to music as a verb and even a "verb of power", allowing children to be "critically active and mindful but also critically emotive" in their music making (cited in Abrahams, 2005, p. 18).

Abrahams, Jenkins and Schmidt (2002) developed an eight-step lesson model to integrate the ideas of critical pedagogy for music education, critical theory, constructivism and experientialism. The notion to actively involve the student throughout the process of co-constructing learning encourages students to think critically and to be participants in their own learning, rather than passive receivers of knowledge and information. The eight steps are summarised in Table 6.

Table 6: *An eight-step lesson model to integrate the ideas of critical pedagogy for music education*

Step 1	Honouring their world	Teacher engages the student in problem solving by creating an experience that presents a need to know.
Step 2	Sharing the experience	Students and their teacher process the experience. They share feelings and reflect.
Step 3	Connecting their world to the classroom	Teacher connects the experience using comparable concepts from the arts culture, or students' out-of-school experiences.
Step 4	Dialoguing together	Teacher presents lesson content. Students gather the evidence they need to solve the problem.
Step 5	Practicing the content	Teacher provides students with an opportunity to practise the content. A homework assignment or quiz might be included at this step.
Step 6	Connecting word to world	Teacher invites students to find alternative solutions and new ways to use the information presented. Students have the opportunity to create something new.
Step 7	Assessing transformation	Students and their teacher reflect on and evaluate the work completed. An assessment rubric may be applied at this step.
Step 8	Acknowledging transformation	Students and their teacher celebrate the new learning through presentation, exhibition, or some other form of demonstration.

Note: From "Jubilate: A music curriculum for the adolescent soul," by Abrahams, F., Jenkins, L. J., & Schmidt, P., 2002.

Constructivism

Constructivism is a learning style based on the constructivist theory that maintains that learners must construct an internal, personal representation of knowledge. The literature supports the view that a constructivist approach is highly effective with the use of ICT (Becker, 2000; Ertmer et al., 2006; Gibson, 2001; Jonassen, 2006). The richness and utility of this representation are dependent on the degree to which learners integrate new knowledge into their existing knowledge base. Since personal restructuring is required, knowledge cannot simply be transmitted. An intellectually active learner striving to build a meaningful personal representation of experience must construct it. This aligns with the notion in critical pedagogy of moving away from the banking strategy where knowledge is simply fed to students like depositing money in a bank. The constructivist learning setting is therefore rich and authentic since the context becomes part of the constructed knowledge.

Collaborative learning, through which students can share views and strategies and thus develop multiple perspectives, is encouraged in the constructivist environment (as cited in Bond, 2003, p.12). This environment is conducive to effective teaching in any music education setting.

Scott (2006) describes constructivism according to principles of:

> knowledge and beliefs construed from learners' experiences, access to these experiences, knowledge and beliefs during the learning process, shared inquiry to enhance the social nature of the act of learning, reflection and metacognition to construct knowledge and meaning, and assessment of one's learning. (p. 17)

Prestridge further supports the link between "teacher beliefs associated with constructivist approaches and using ICT as a partner to facilitate creative thinking and learner-centred activities" (2012, p. 451).

Although constructivism started out as a philosophy of knowing, if it is viewed as an educational theory, it can be compared with other educational philosophies such as proceduralism which is the belief in the importance of using agreed procedures. Papert expands his exploration of constructivism and names it constructionism. He maintains that "learning to learn is significant to making things in learning" (cited in Ackermann, 2001, p. 1). In doing this, he acknowledges the importance of tools and media in the context of human development. His approach also aids us in the understanding of how different media helps us understand how ideas are formed and transformed when processed by different minds and perspectives to create learning. According to Ackermann (2001), Papert's constructionism is both more situated and more pragmatic than Piaget's constructivism although they both acknowledge that children are the "builders of their own cognitive tools, as well as of their external realities" (Ackermann, 2001, p. 7). Both Piaget and Papert are developmentalists because they share the view that knowledge is constructed in an incremental process. Papert reminds us that connectedness improves understanding. In saying that he always reminds us of the "fragility, contextuality, and flexibility of knowledge under construction" (Ackermann, 2001, p. 8).

A constructivist approach for the music classroom

The focus of this thesis is to question and investigate the digital means and conditions under which students construct their own knowledge within a music context. The relevant literature is rich in examples of constructivist approaches implemented in music classrooms as music instruction naturally lends itself to this approach. Christopher Ward (2009) is one researcher who advocates "ICT as an integral part of the creative process" (p. 154), as he describes a music composition project based on action research with middle and secondary school students. He has found that his multi-levelled and open-ended lesson approach motivates students to go beyond the information given and to show more independence during discussion and evaluation activities.

Researcher's background, beliefs and biases

"To fully describe how participants view the phenomenon, researchers must bracket out, as much as possible, their own experiences" (Creswell, 2007, p.60). I maintained a watchful awareness not to let my own experience as a secondary school music teacher lead the interviewees or influence my interpretation of their experiences. It did, however, provide me with a means to build a positive rapport with the respondents, because I had a similar teaching background to them.

My approach to technology has always been pragmatic and positive. I believe that technology can enhance and improve the learning experience for students if it is used for the sake of supporting learning to open up new possibilities of creation and understanding. With my background as a facilitator, I have had the first-hand experience of the challenges teachers face when they are confronted with new technology. In this context, my bias might be leaning towards being a technology protagonist, rather than an opposer. I refrained, however, from letting on what my point of view was when I interviewed the respondents.

Population, participants, and sampling technique

Pilot study

Initially, a pilot survey was circulated on the Musicnet listserv in 2007 to test interest and identify possible respondents for the purposive sample. Ethics approval was requested from the Ethics Committee of the University of Waikato before sending out the pilot survey.

Once ethics approval was granted, participants were invited to take part in the research through the Musicnet listserv. Interested candidates were requested to complete a short online questionnaire. Of the initial 48 respondents, 13 were willing to make themselves available for a face-to-face or virtual (Skype) interview. The selection criteria for this sample included:

- Availability of teacher;
- Decile rating of the participating schools;
- Geographical area where the school was situated; and
- Gender of the student body.

First dataset

Interviews

The first 13 interviews were conducted face-to-face, with one exception where the respondent was interviewed on Skype because of the geographical location. All these interviews were recorded as audio files and transcribed afterwards as text documents. The interviews required about an hour to complete.

Sample selection

The participants were selected through a purposive sampling technique. The selection was done to ensure that the respondents were able to describe and share their experiences in an “articulate, expressive, and reflective manner”, and that they were willing to participate in the research (Palinkas et al., 2015, p.3). In accordance with these criteria, teachers who fitted the research criteria profile and who volunteered their time were selected. To ensure a representative sample, the decile ratings, geographical location and gender representation of the respondents’ schools were taken into consideration, but the schools were not identified by name to ensure anonymity and equality.

Decile rating

Decile rating is a system that is used in the New Zealand education system to classify schools by socio-economic status. The rating is based on how the school measures against other schools in the area. Five socio-economic indicators are used to determine this rating. These are:

1. Percentage of households with income in the lowest 20% nationally
2. Percentage of employed parents in the lowest skill level occupational groups.
3. Household crowding
4. Percentage of parents with no educational qualifications
5. Percentage of parents receiving income support benefits.

Deciles determine some operational funding and a range of resource funding. The decile ratings of schools influence their eligibility for a range of operational and resource funding from the government (Ministry of Education, 2017).

Even though the availability of the participants was the most important criterion, the decile rating of the participating schools was considered to ensure that the sample was representative of the whole socio-economic spectrum portrayed by the decile rating of schools (see Figure 3).

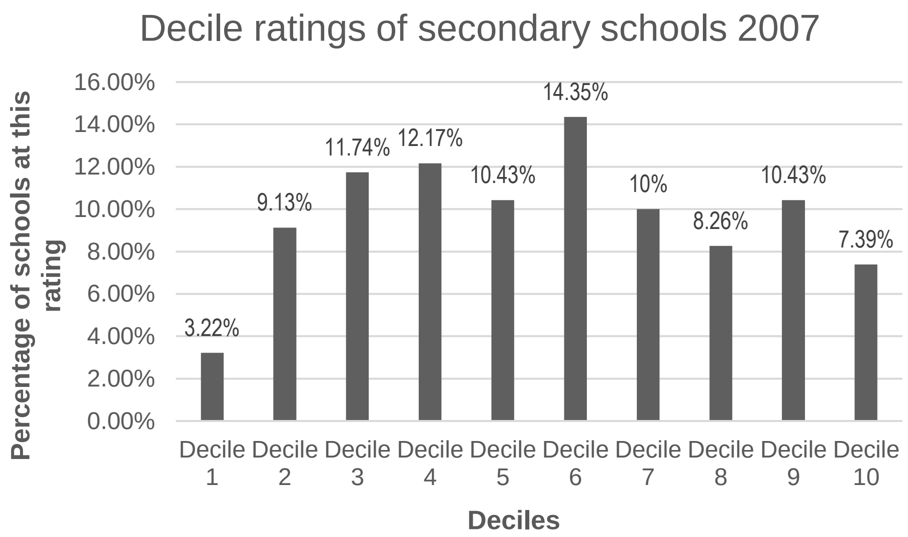

Figure 3. An overview of decile ratings in NZ schools at the time of collecting the first data set.

Regional representation

The regional representation of schools was taken into consideration, as most of the candidates were based in the top five regions according to 2007 population figures (see Figure 4).

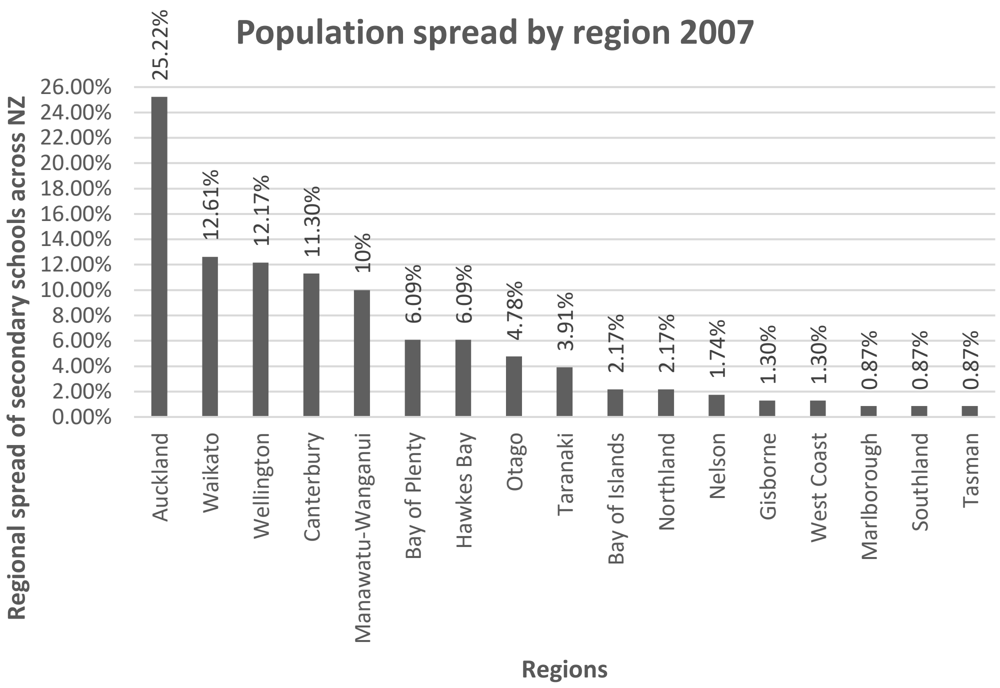

Figure 4. Population spread across New Zealand in 2007

Gender representation

Schools in the sample were representative of the average spread of gender representation in New Zealand secondary schools (see Figure 5).

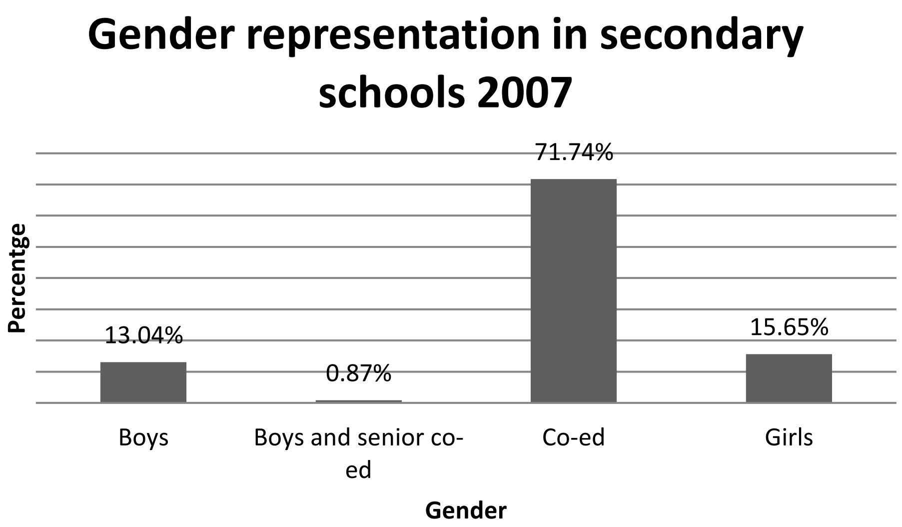

Figure 5. Gender representation across New Zealand secondary schools

Final sample

The final selection of respondents included teachers from girls' schools, boys' schools, a correspondence school and co-educational schools, with a range of decile ratings from two to ten. As explained before, decile ratings refer to the socio-economic status represented by the community in which the school is situated. The Wellington, Auckland and Christchurch regions were best represented, but the sample included respondents from Hamilton, Palmerston North and Dunedin. Table 7 provides a summary of the geographical location, decile rating, gender representation, and respondent code of the school in the research sample.

Table 7: *Sample breakdown stating location, decile rating, gender representation, and abbreviation of the surveyed schools*

	Location	**Decile rating**	**Gender**	**Respondent code**
1.	Hamilton	4	Co-ed	T1
2.	Wellington/NZ	No decile rating	Distance educator; co-ed	T2
3.	Christchurch	2	Co-ed	T3
4.	Dunedin	7	Co-ed	T4
5.	Wellington	9	Boys	T5
6.	Wellington	10	Co-ed	T6
7.	Hamilton	8	Co-ed	T7
8.	Wellington	6	Boys	T8
9.	Wellington	8	Girls	T9
10.	Wellington	7	Co-ed	T10
11.	Christchurch	6	Boys	T11
12.	Auckland	NA	NA	E1
13.	Palmerston North	NA	NA	E2

Data collection

The methods of data collection used for this thesis include an internet questionnaire to identify possible respondents to include in the sample, open-ended interviews with the respondents and an online survey in Google-form format to ensure data triangulation. The perspectives of 11 teachers and two experts from the music software and educational resource industries were collected in 2008 through

open-ended interviews

Interview preparation

The respondents received the interview questions per email before the scheduled interviews to give them an opportunity to get an overview of the purpose, focus and depth of the questions.

Development of interview questions

The interview schedule was adapted from an existing schedule with a similar focus (ECAR, 2005). See Appendix I for the original schedule.

Interview schedule

The interview schedule had four sections: background, skill and use, technology use in the classroom, and future, concluding with a closing question. These sections provided an initial starting point for the coding process to identify common themes.

Second dataset

The same data collection process was followed for the second dataset, excluding the exclusion of the pilot survey. The same participants were interviewed four years after the first interviews, in 2012, using the same interview questions.

Online survey

The second dataset was compiled in 2012 from data collected in an online survey format. The data was collected in a Google form which had been sent to the respondents electronically. This technology allowed responses to be captured, collected, and stored in an online Google spreadsheet. The reasons for this choice were for ease of use, access, and collaboration in an online environment. The Google form was shared with all the respondents as a link in an email.

Once the teachers had completed the form online, the data was captured in a spreadsheet generated by Google Sheets. The spreadsheet collated the data in a format that could be coded immediately, instead of having first to transcribe the interviews from audio files into a word-processed format. Some respondents replied in a spreadsheet version of the survey if they experienced difficulty in accessing the online version of the form, but the result could easily be transferred to the online document.

Sample design and ethical considerations

All of the initial interviewees were located and contacted anew before the survey was circulated to determine their availability for a follow-up survey based on the same research questions as during the initial face-to-face interviews. Only one person was completely unavailable, as she had relocated overseas. Where possible the same respondent was interviewed or, as was the case with a teacher who had retired in the meantime, the new teacher in the same role was contacted. If the person had moved on to another teaching position, the first choice was to interview that person and not just the replacement teacher in the same role. The transcripts of the first interviews were shared again with all respondents either to refresh their memory or to give them an idea of their predecessors' thinking and practice. This was done to ensure transparency and reliability of the quality and integrity of the data.

The initial ethics approval was amended for the second sample to include the necessary changes. The Ethics Committee of the University of Waikato approved the amendment to the original application. This amendment did not require a second ethics proposal because the candidates were mostly the same and the nature of the research had not changed.

Changes to the interview schedule

The rapid development of mobile technologies over the last five years has made a big difference to how teachers work and how they utilise their leisure time, therefore necessitating an extra question about the use of mobile technologies for the second dataset.

Data processing

First dataset

Transcribing interviews and importing into NVivo

The interview recordings were first transcribed into a word-processing document. Each of these documents was then imported into NVivo to make coding possible, using the built-in capability of the software. Relevant text in the transcripts was highlighted and coded in-text (in vivo). The procedure ensured a fast and efficient method to code while reading.

The structure of the interview schedule was used from the onset to identify main focus areas. In Table 8, the interview questions are given in the left-hand column, and some emerging focus areas are listed on the right.

Table 8: *The interview schedule with identified focus areas*

Interview questions	Emerging focus areas
1. Background 1.1 What is your role in supporting/training the teachers and students in the use of computer technology in the music classroom? 1.2 How would you provide the technology support specific to the secondary school music programmes?	• Industry support for teachers • Industry support for students
2. Skill and use 2.1 How would you rate the current state of student technology skills? 2.2 What kinds of computer technologies do students like? 2.3 What types of computer technology do you provide for use in the music classroom? 2.4 What types of technology skills are teachers less confident with? 2.5 What are the best technology skills that teachers possess? 2.6 From the industry's point of view, what is the most difficult hurdle to overcome regarding the use of technology in the music classroom?	• Technology skills of students • Technology skills of teacher • Student technology preferences • Technologies supplied • Obstacles
3. Your use of technology in the music classroom 3.1 Do you think skills are transferred from the entertainment to the academic realm? If so, how? 3.2 Do you think students find the use of technology helpful in the music classroom? If so, why and if not, why not? 3.3 Do you have any specific examples of students using technology creatively or in an innovative way in classrooms? 3.4 Do you think students prefer to learn in an integrated environment? If so, why and if not, why not?	• Transferable skills • Student perceptions • Student innovation
4. Future 4.1 If you had the time and resources to design a fully integrated music program making excellent use of technology, what would it look like?	• Vision/wish list • Goals

4.2 What is your short-term goal regarding the use/ integration of technology in the classroom? 4.3 If you could change three technology components in the classroom, what would they be?	
Closing: Is there anything you would like to add that was not covered during the interview?	Other

The section titled ‘background’ collected information about the teacher’s technology support role and how that support was provided to students. The ‘skills and use’ section looked at determining the skills levels of both the teachers and the students. Teachers were asked to be frank about their competence levels and to give their impression of the students’ skills levels. The third section moved to the ‘how’ questions, relating to how technology was used in the music classroom. The section also included the examination of high-end student users. The final section concluded with prompts to disclose the vision, future goals, and immediate changes that teachers would like to see happening in their respective classrooms. The responses to these questions provided a rich dataset, giving insight into a wide variety of scenarios and the teachers’ challenges and observations about their own classroom experiences and individual practice.

Coding interviews as part of the analytical process

The interviews were all recorded and transcribed verbatim. These transcriptions were then read and scrutinised to discover the emergence of recurring themes. A coding structure was designed during the process of reading through all the transcriptions. This coding structure was based on a tree node structure with parent and child nodes to enable the identification of emerging themes. The nodes were structured and captured in NVivo, a qualitative analysis software program.

Tree nodes to identify categories

The tree node structure proved a valuable technique to simplify how themes were identified. Parent and child nodes could be dragged around to change their positioning in the hierarchy in NVivo without compromising the coding. The software could also show the most prominent nodes in a section adjacent to the text which made it easier to identify themes and commonalities between the nodes. The tree nodes were adjusted by dragging the nodes around in the tree hierarchy to manipulate the structure. As the nodes were created, a note could be attached to describe each node's purpose. The procedure ensured consistency during the coding process.

Developing categories

From the tree node structure, certain categories started to emerge. The categories started to develop when nodes with similar content were grouped together.

Criteria for categories

The criteria for the various nodes and categories were documented in a coding structure that is given in Appendix F. These criteria were added to NVivo as notes to maintain consistency throughout the coding process.

Second dataset

Question design and coding

The interview questions were designed around a model adapted from a qualitative interview question model, which was published as an appendix to the sixth and seventh studies of the EDUCAUSE Centre for Applied Researches (ECAR, 2005/2006). The four main sections as mentioned earlier focused on technology background; skill and use of technology; use of technology in the music classroom; and future technology use. A sample of the Google form is available in Appendix H.

Data entry

The Google spreadsheets were imported into NVivo and coded using the same method as for the first dataset.

Word cloud

After the coding was complete, a word cloud was generated for each category/theme to provide a visual representation of the nodes at a glance using a function in NVivo. These word clouds are included in Chapters 4 and 5 at the start of each new category.

Data presentation

The data from the two sets are presented in Chapters 4 and 5 with detailed descriptions of the responses. A comparative analysis of the data is done in Chapter 6. This analysis compared the findings of both datasets to identify similarities, differences and new developments in teaching practice and technology use across the four-year period. A thematic network was used as an analysis tool to produce a final thematic synthesis. The process is described in detail in Chapter 6. The three-tiered structure of the thematic network organised the themes into basic, organising, and an overarching global theme.

Quality assurance

Rich, thick descriptions have been done throughout to ensure transferability of the data collection and coding processes. To further ensure the reliability of the data, the codes have been described to ensure consistency between all the transcripts and the two datasets. The respondents were also asked to check the interview transcripts for accuracy and to ensure transparency of the data that what was captured.

Chapter summary

This chapter situates the research within a research methodology framework and describes the strategies for selecting a purposive sample of available teachers across schools ranging in decile ratings and geographical locations. It describes the data collection methods and the mechanics of setting up interviews with the respondents. It also describes how a second round of interviews were conducted with the same respondents where possible. The transcripts of both datasets will inform Chapters 4 and 5 as the data is presented.

Chapter 4

"The goal is to turn data into information, and information into insight."

Carly Fiorina (Hewlett-Packard Co.)

This chapter is a summary of data gathered between 2008 and 2009 during semi-structured, face-to-face and Skype interviews with eleven secondary school teachers and two industry experts. All interviews were transcribed and then coded in NVivo. The structure of the coding matrix (see Appendix F) was developed from the interview transcriptions. Five categories were identified: *infrastructure*, *skills and knowledge*, *inside the classroom*, *support*, and *ways forward*. Each was further divided into subcategories where appropriate. The data presentation in this chapter is structured around the categories and subcategories (NVivo parent and child nodes) given in Appendix F with a description of each category followed by anecdotal data from the interview transcripts.

Data collection process

The data was collected from thirteen respondents. Ten of the interviews were undertaken face to face. Two of the respondents were not available for a meeting but agreed to have their interviews on Skype, and one interview was conducted by telephone. All interviews were recorded and subsequently transcribed verbatim. Each respondent received a copy of the transcript for checking. This was done to ensure accuracy, particularly with the Skype interviews where internet connectivity was sometimes intermittent, resulting in unclear responses. Transcriptions of each interview recording were made shortly after the data collection.

Interview schedule

The interview schedule was organised into five sections. These sections were not intended to pre-empt any themes that might emerge but were based on qualitative interview questions from an earlier study conducted by the EDUCAUSE Center for Applied Research (ECAD, 2005). See Appendix D for the revised interview schedule. I selected this outline because it provided a current, focused, education-specific framework that had been tried and tested. It is accepted that the interview sections were similar to the subsequent themes that emerged, but the starting structure was not used or intended to pre-empt any thematic outcome.

The data from the first set of interviews is presented in the same order as the interview questions. For ease of navigation and maintaining respondents' anonymity, the following abbreviations are used for teachers: T1 to T11. The two industry experts are referred to as E1 and E2. Also refer to Table 7 on p. 104.

The five interview sections focused on the background of the interviewees (*Background);* the way interviewees perceived technology and what they thought about their own skills, as well as those of the students (*Skill and use);* how technology was applied in music classrooms *(Use of technology in the music classroom);* what the interviewees would like to have and be able to do in their programmes (*The future);* and a *Closing section*. Appendix E shows the modified interview schedule for the industry experts.

NVivo

The interview recordings were transcribed, and the text imported to a qualitative data analysis program NVivo (www.qsrinternational.com) that was used for coding and analysing the data. Nvivo is a program used in the social sciences for qualitative research analysis (Johnston, 2006). It enables researchers to focus on "examining the meaning of what is recorded" (Bazeley & Jackson, 2013, p. 2) rather than on time-consuming processes of functions such as sorting, matching and linking.

NVivo's coding structure is based on a hierarchical tree model with parent nodes that can branch out into more detailed child nodes. These can be a collection of references about a specific theme, place, person, or other areas of interest.

> A Node is, broadly, a category. Nodes can mean concepts, processes, thoughts, ideas, products, geographical places and even people. Nodes become increasingly important as a study develops and its concepts and theories mature. Data contained in a node can be anything from a single letter to a complete document. (Edhlund, 2011, p. 115)

The development of categories in relation to the interview schedule is given in Figure 6. The blue boxes represent the sections in the interview schedule, and the grey boxes represent the final categories used in my coding structure.

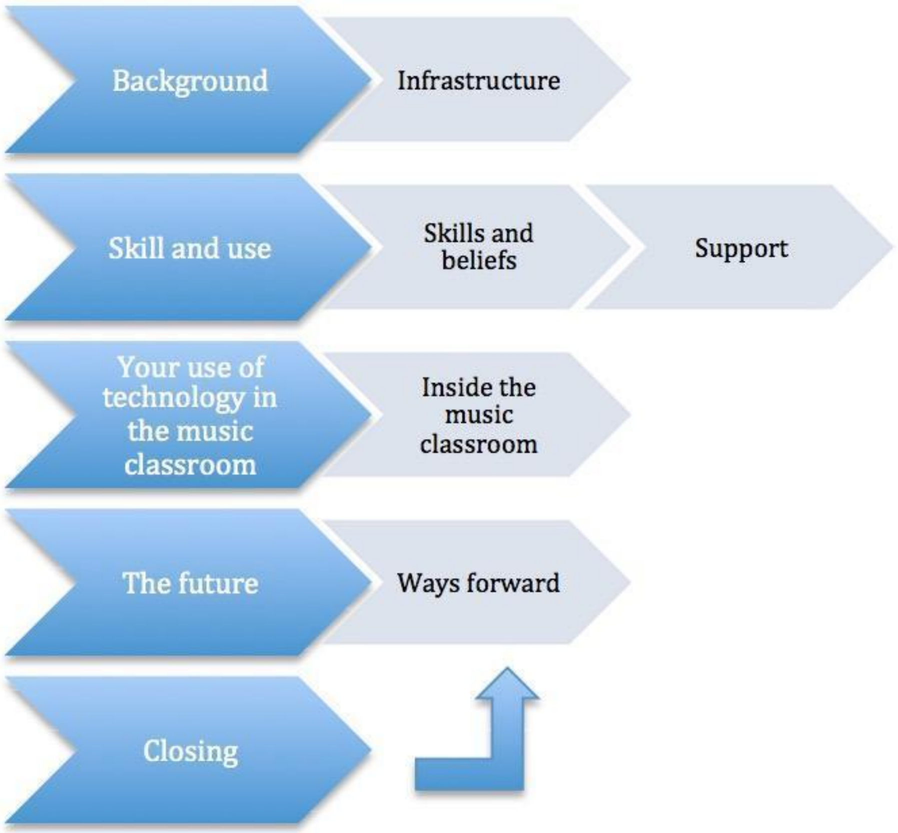

Figure 6. Development of categories in relation to the interview schedule.

Coding

NVivo allows for a relational structure to be developed based on recurring concepts identified during the coding of interview transcripts. My coding matrix (see Appendix F) gradually developed and grew with each additional transcription. The first section of the interview schedule, *Background*, developed into an *Infrastructure* category. *Skill and use* were split to create two distinct categories:

1. *Skills and knowledge,* which probed the skill and knowledge levels of both teachers and students, as well as the beliefs of teachers around ICT adoption; and
2. *Support,* that investigated the types of ICT support needed by and provided to teachers and students.

Referring to Figure 6, *Your use of technology in the music classroom* was shortened to *Inside the music classroom,* and the last two sections of the interviews were combined in the *Ways forward* category.

Five categories

During the coding process, five broad categories were identified: *infrastructure, inside the music classroom, skills and knowledge, support*, and *ways forward*.

The coded text from each category was used to create a word cloud in NVivo as a snapshot presentation of the data. A word cloud gives a visual representation of words from the coded transcripts. The size of the words is based the frequency of recurrence in the text. This identifies the key ideas in each category at a glance.

Infrastructure

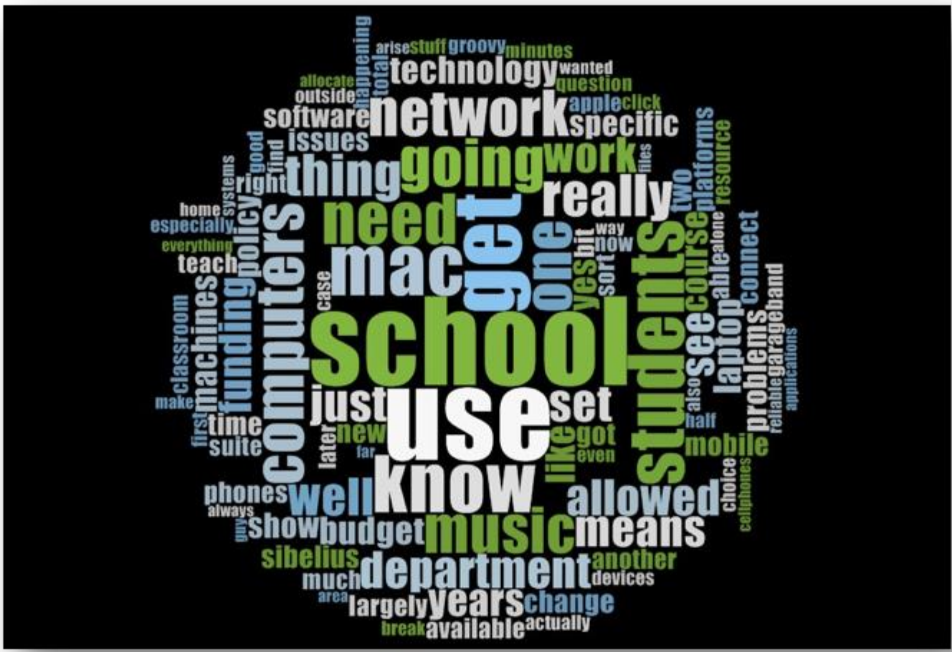

Figure 7. Infrastructure coding depicted as a word cloud.

The first category to be explored is infrastructure. The most prominent keywords in this category are school, use, technology, network, students, technology and funding (see Figure 7).

This infrastructure category developed from responses about the physical ICT environment in schools and how music departments managed their networks, servers, connectivity, access, devices and policies around students' use of ICTs. In the early stages of coding, this area was labelled governance, but it gradually developed into more than information about access to, and restrictions of networks. Six parent nodes were identified from the transcripts, demonstrating the variety of components involved in ensuring that both the physical and virtual learning environments in schools were user-friendly and accessible to students and teachers. These nodes are portrayed in Table 9 with number two containing the child nodes BYOD and mobile devices.

Table 9: *Infrastructure category*

Category	Parent Node	Child Node	Description
Infrastructure			Network, server, connectivity, access, devices and policies pertaining to ICTs
	1. Budget		School, department
	2. Devices		Any device with the capability to connect to the internet or to operate software as a program or application, including mobile and student-owned devices
	2a→	BYOD (bring your own device)	Student-owned devices
	2b→	Mobile devices	Tablets, phones, MP3 players and laptops
	3. Equipment		Electric, fixed, projecting, photo, video
	4. Network		Wired, wireless
	5. Operating systems		School-wide and specific to the music department – Apple Mac and Windows
	6. School policies		Policies regarding the use of devices and the conditions of access

Budget

Budget allocations for purchasing computers were a significant issue for music departments. According to T6 they "have scavenged most of [their] technology from other departments and other areas of the school" because they had no budget for buying computers for the music department. In another school, T9 reported that they had "some money for new computers, but ... it meant that half of the suite was still running on quite slow, old PCs". They reverted to using the second-hand computers from the ICT Department after these had been discarded after three years of use. On the other hand, T5 wished that the school would "take responsibility for the [recording] lab, so it doesn't come out of our [Music] budget".

The two industry experts (E1 and E2) were well aware of the financial implications of setting up decent ICT equipment. E2 acknowledged that "although the technology is getting cheaper and getting more reliable... it's still a large investment", and E1 also implied that acquiring computers configured specifically for the needs of music students would be expensive, concurring that the configurations required in a general computer lab used for computer studies or digital technologies were somewhat different to what would be required for a Music hub. For example, sound and graphics capability often needs to be fairly high-end and robust because of the requirements of notation and mixing software programs used in music departments.

Devices

This node reflected contentious and revealing insights into the position schools have taken towards the use of mobile devices. This node was created to capture comments around devices other than desktop computers, that have some capability to connect to a network or the internet and are easy to carry around. Two child nodes were identified, namely BYOD (bring your own devices) which are devices owned by the students and not the school, and mobile devices.

BYOD (bring your own devices)

In this first data set, there was very little mention of BYOD for students. E2 referred to the reluctance of schools to allow "outside equipment clicking into their systems" and remarked that this sometimes limited the interviewee in "what I would like to do or how I would like to teach or what I would like to make available to students". E2, who was working part-time in schools, commented that only full-time staff were allowed access to a school laptop and that "there is a school policy that says you may not bring in your own one".

Mobile devices

Mobile devices refer to laptops, tablets, mobile phones and MP3 players. E2 reported that in the particular school s/he was working in at the time, it was a daily practice that "if a student is caught with a mobile phone it is confiscated… and taken off them". The only way to accommodate a student who had something to share on a device like an iPod was for the teacher "to turn a blind eye" in the music department. It was frowned upon in the rest of the school for students to have or use any mobile device during class time.

The opposite of this practice was found at a distance education provider where students were required to send in their sound files via an MP3 recorder which was provided by the school, or alternatively to attach sound files to e-mails which were sent to the teacher of the courses the students were enrolled for. Given that the mode of tuition is different with distance learning, it was expected that students could access mobile devices when and as needed. It was often the only way to make contact with students living in remote areas.

One teacher (T10) even said that iPods were seen as "the resident evil" by the school authorities although s/he was trying to encourage the practice of students being allowed to use their own devices "because I have a problem with non-mobility". This teacher continued to develop a policy specific to the music department to endorse the use of iPods. The iPods were used by students who recorded technical exercises on their instruments during lesson times and then played this back when they were practising. The MP3 players were also connected to a sound mixer to mute a track or enhance a certain track for practising purposes. These recordings were very useful in the absence of a practical tutor or itinerant Music teacher. The same teacher acknowledged the fact that students were not encouraged to use mobile phones "even though these phones are powerful devices and that it's just a matter of trust that the student would use the devices in ways that are acceptable and legitimate." One example of this practice was a student wanting to take a video of his mate whilst practising scales on the guitar in order to replicate his technique.

T11 referred to the school's policy of not allowing the use of cell phones “between the hours of 8:30 and 3 o'clock”. This teacher also commented that without a specific need arising, the policy would not be amended. “I guess what I'm saying is that should the need arise then we would do it but of course the need can't arise if the students can't use their cell phones, so it's a catch twenty-two”.

Mobile phones seemed to be a very contentious subject in most schools. T7 reported the following:

> They're not supposed to use phones in school, so they don't ... They're not supposed to have a phone on or in their pockets. They're supposed to be off and in their bags. The school's rule is that they're not supposed to have any music-playing device like an iPod. (T7)

However, this same teacher sometimes bent the rules in order to copy some songs onto the students' devices for instrument practice. The teacher also commented on the usefulness of smart phones with cameras to capture something explained to one group of students and then sharing it with the whole class via the computer or printing it and distributing the hard copy.

Making use of the phones as recording devices was one way in which students used their mobile devices, according to T8. They were also allowed to record part of a composition on a mobile phone, and the teacher commented that “I make an exception if it’s actually contributing to class work”. T9 referred to students using their phones to make backups of their work. The teacher continued to report how they found the cell phones to be very useful for “getting hold of people... [for when] choir practices had to change, and we've got group texting and things like that set up. So, we're using it to our advantage as well as to the students' advantage”.

Equipment

Teachers sometimes mentioned sound equipment or non-computer technologies when they responded during the interviews and this node allowed for capturing that information: “we also have other technologies as in sound equipment, PA systems and videos” (T6).

Music departments had to make the best of computer equipment that was handed down to them from other departments in the school or from the Administration area when their computers were upgraded (E1). At the time of these interviews E2 was not using a data projector on a regular basis and accessing YouTube was banned in the school s/he was working in. T7 had just acquired a data projector a couple of weeks before the interview, and his/her excitement at having unlimited access to it was evident. This teacher also attempted to enable the students by adding a thumb drive to their stationery list, so they could copy and access their work from several locations in the school. T5 mentioned that s/he had used an interactive whiteboard at a previous school but that the current school had no interactive whiteboards.

Network

Access to the school network, whether wired or wireless, proved to be a challenging issue in music departments. As T11 put it: “a tension exists between repairing and maintaining the school computer network - functionality - and supporting creativity”. At the head of any network sits a server that provides various access points and accessibility options to users. This in itself caused numerous headaches for the teachers and students at the user end. As T5 reported, “the server has basically fallen over this year and students can't log on, can't save”. It seemed that for some music departments it was beneficial not to be part of the wider school network at all. “They [the students] can't log on with their own log-ons they use in the rest of the school on the PC network because of the way things are set up here, so I have to log them on”. T9 commented that they were networked for printing only. “Other than that, we have stand-alone machines. We're not on the internet. We've kept away from that - so it's sort of helping with the authenticity thing". It seemed that being network-independent was the preference of many of the teachers.

Operating system

Computers and laptops in all the music departments surveyed ran on either Windows or Apple Mac operating systems. This had certain implications for their interoperability with school networks as schools that had already invested in a server to support one operating system were reluctant to introduce machines running off another system. In the majority of cases schools preferred to have a Windows server, and although Music teachers often found that Apple computers were more suitable for seamless multimedia editing with the built-in suite of apps, it was rare to find a whole suite of Apple computers in a music department. In the event of the odd Apple Mac computer available, the computers were stand-alone and not connected to the server or, in most cases, to the internet.

The fact that Apple Mac computers were not readily available in schools did not mean that Music teachers were unaware of the possibilities that these held. Seven teachers commented specifically on the advantages of using Apple Mac computers. T10 had one Apple Mac computer and two Windows computers in the music department. "Apple Mac is what I first have to get them used to and then I teach them the applications that run on that, which in this case is largely Sibelius and Garageband". Garageband and Guitar Pro were two programs which this teacher had specifically promoted on Apple Mac computers because of their catering for students from a musical background that is not notation-based. T4 recounted how recording and editing student performances were easily done in iMovie. This teacher was supporting the students to make their own music videos for their compositions. According to T6 and T7, their music departments were the only spaces in the school where Apple Mac computers were used.

School policies

Most of the feedback around school policies referred to internet access and mobile devices, especially mobile phones. This node overlaps slightly with the mobile devices node, although the focus here is wider than mobile devices only. One of the industry experts (E2) had two really good examples of how school policies actually hindered effective teaching and learning. To have internet access, the students had to be registered with the technician the day before access was required, which was a barrier. Website filters prevented music teachers and students from accessing online videos on YouTube. The policies and consequent practices concerning mobile phones were mostly that of no tolerance or immediate confiscation.

Inside the music classroom

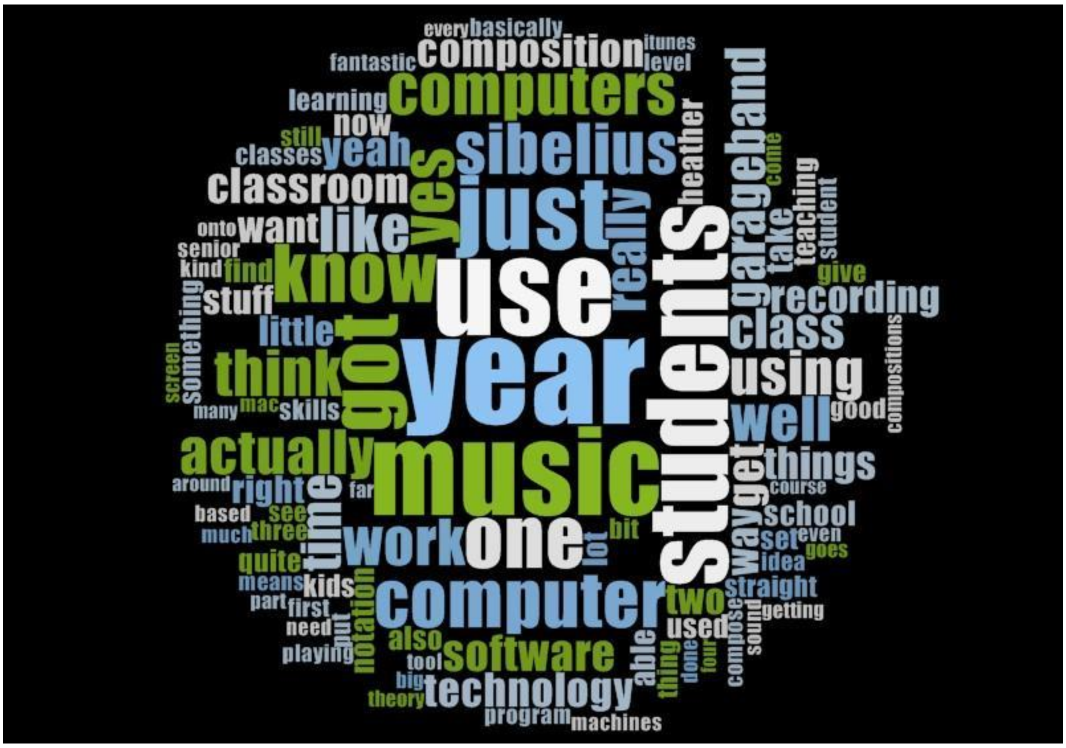

Figure 8. Coding for Inside the music classroom depicted as a word cloud.

This word cloud (Figure 8) is a visual representation of the data coded against the category that examined common practice in the music classroom. The most common keywords from the transcriptions were students, music, computer, use, Sibelius, know, technology, work and software.

This was by far the largest category with the most identified nodes, eighteen in total (Table 10). There were no child nodes or subcategories in this category. The large size of this section was anticipated as it reports on classroom practice in terms of ICT integration and utilisation.

Table 10: *Inside the classroom category*

Category	Parent Node	Child Node	Description
Inside the music classroom			What happens inside the classroom in terms of ICT integration and utilisation
	1. Advantages		The advantages of using ICTs in the classroom
	2. Barriers		Anything preventing teachers and students from utilising ICTs in their daily teaching and learning programmes
	3. Class sizes		Student numbers and grouping
	4. Classroom setup		The organising of furniture, equipment and student rotations
	5. Composition		Composing with ICTs
	6. Creativity		Creating presentations, video, recordings
	7. Delivery format		Access to teaching content
	8. Disadvantages		The perceived negatives of ICTs
	9. Frequency of use		Access to ICTs and consequent usage
	10. Integration		The level of ICT integration in classroom practice
	11. Internet		Accessibility and robustness of connections
	12. Notation		Notating with software programs

	13. Other hardware/Sound equipment	Amplifier, microphone, equaliser, mixer, USB controller, MIDI keyboard, MIDI interface
	14. Performance	Performing music with the support of ICTs
	15. Recording	Recording with ICTs
	16. Research	ICTs supporting research in the classroom
	17. Software	Programs used for learning and teaching music skills
	18. Teaching programmes	Specific mention of ICT inclusion in teaching programmes

Advantages

Composing was the component that teachers singled out as one of the aspects of their music programmes that benefited the most from technology support. T11 recalled how a decade ago it was common for a bursary student to take a full year to complete two compositions. With the assistance of composition software such as Sibelius, this process has been accelerated significantly. A variety of reasons were mentioned by other respondents about the benefits of composition software: it is easy to record and capture ideas (T2); Sibelius is great for developing composition skills (T3); listening back to ideas (T9); instant feedback (T9); and it helps with problem solving by listening and sharing with peers (T9). T2 liked the way music-writing software enabled students' notation to be precise and legible: "students can present their work in a clear concise way and in a way others can read. Composition skills are improved, because they can put ideas down and record them easily" (T2). T4 agreed with the possibilities that Sibelius provides for students' composition activities: "to me the reason why we're using ICT is because it enhances the learning possibilities for the students and it opens their horizons way more than what is available within the school setup. So, with Sibelius they can compose for an orchestra and hear it whereas we don't have the facilities for them to do that here".

Garageband was another program singled out as being very useful to students because it enables them to blend new and existing ideas, providing a starting point to manipulate quality tracks, even if they lack the specific technical instrumental ability. This means that they can create at a level that is much more advanced than their own playing skill. The software also provides a means for students to create soundtracks for videos in a fusion of sounds and ideas. T4 described how “the technology gave them the capacity to realise their ideas and their creativity… by enhancing their capability and thus enabling them to do more”.

Music performances have to be recorded for assessment purposes at NCEA levels one, two and three according to moderation requirements of the National Qualifications Authority of New Zealand (NZQA). The ease of video recording students and the ability to edit these videos in iMovie were specific advantages of using ICTs for T5. Another benefit T6 named was the way technology provided support for students who were new to learning music. “Students who are not traditionally trained, who are just picking up music for the first time or introduced to technology at the same time, find that the technology actually helps them on their way”. T7 noted how the technology enabled him/her to move around more freely in the classroom and how s/he could use a phone camera to capture something explained on the whiteboard and then print it so that students had the original teaching notes to refer to.

E2 used a simple PowerPoint presentation set to play in a loop to introduce her/his workshop and to capture the students’ attention and interest with the combination of visuals and sound.

iPods were useful for downloading songs and listening to these for instrumental learning. The teacher also used them for assisting with aural testing by recording the test and giving students the device to complete the test by themselves without the input of the teacher:

> I sometimes give a kid an iPod. I use the Bentley test at the beginning of every year for every single class. Every class, every year, and if a kid misses out ‘cause they weren’t here that day, the next time I grab an iPod and I say ‘go into a practice room’ and I’d give them the Bentley test. So, they now have the interface and they can use it, they can do it. They don’t need any input from me apart from giving them the tool. (T7)

Barriers

Time was the number one factor mentioned when teachers discussed the barriers to ICT integration and learning new skills. E2 described a typical situation as “needing time to sit and play and practise and deal with frustrations or being able to walk away when you can and let it mull and come back to it”.

The lack of internet access was another stumbling block in the way of teaching lessons with ICT components. Network and wireless access meant that part-time teachers and trainers experienced difficulties in connecting to certain online content because of specific network filtering and restrictions. Physical accessibility played a role in music classroom spaces which had traditionally already been overcrowded to accommodate instruments, sound equipment and desks, with the new addition of cabling and ICT equipment making it even more cluttered.

Timetabling and the length of lesson times impacted on how much teachers and students could achieve during a single lesson period. The human barrier also played a strong role when teachers were unwilling to engage with new technologies or lacked the curiosity factor necessary to engage with new directions. T2 mentioned that some students “hate[d] computers” and would therefore not engage in activities that required some ICT interaction.

The lack of enough work stations for a whole class meant that T7 had to be very creative with his classroom management strategies to incorporate a rotation system so every student could have a turn with a computer, a keyboard and a guitar. T3 rotated students between the computers and practical music-making activities to address a similar issue. This resulted in high noise levels which in turn distracted the students trying to work on the computers. “More sedate written or research activities involve the students being in two classrooms at once and … sorting out problems (management and technological) tends to suck up most of the lesson time” (T3). T9 reported on the time it took to switch playback settings back to the MIDI keyboards instead of the computer’s MIDI settings when students had changed these after using the computers. This task had to be completed routinely to ensure that the settings were ready for the next group of students.

The lack of quick access to support and professional development was highlighted by T4:

> there's very little out there in the way of actual workshops or training or people that you kinda' could ring up ... and of course being a sole charge department doesn't help either because I'm the only person in the school that has expertise on the programs, so I know more than our IT people. (T4)

The prejudices against Apple Mac computers and allowing these on the school network also proved a challenge for this particular music teacher.

Frequent interruptions to both teaching and learning activities led to frustration in T5’s classroom. Switching from being the teacher to the ICT support person, whilst attempting to keep the students on task at the same time, proved to be a challenge.

Class sizes

Class sizes appeared to vary between 25 and 30 students at Years 9 and 10 and then the numbers dropped to smaller groups of between 9 and 20 at the senior levels. The junior classes posed some challenges when the student-computer ratio was higher than 3:1. T9 managed to convince the school to cap their Year 9 class at 26 by likening it to a cooking class - “if you only had 26 ovens in your cooking class, you would only allow 26 students to cook”. Three teachers had composite classes for Year 12 and 13 students because of the small number of students in the senior Music classes.

Classroom setup

T10 gave a detailed description of how s/he worked around the limitation of having only four computers in the music department:

> We're a bit under-resourced so for all our students here we have four machines. Three in the MIDI suite and one in the recording studio I'm setting up, which means that they are rostered on a rotation basis to machines. It's also fairly close physically to where my office is. So, I can get to them quickly. At the moment I do general teaching in class which is via data projector where I give demos and then immediately after that the rotation kicks in. Although there are three computers in the MIDI suite, I send the students in there in pairs so the one will peer over the shoulder of the other one and they'll confer. (T10)

Access to computers in the music department rather than a computer suite was a preference expressed by T11, although s/he was limited to only 10 computers in the Music suite. This teacher overcame the limitation by rotating the students in groups to focus on a variety of activities such as composition, working on manuscript paper, playing keyboard or guitar and having itinerant lessons. T3 had 11 Windows computers, each with Sibelius and a piano keyboard to input music for composition tasks.

One teacher (T4) had to be innovative to access Garageband in a school that wouldn’t allow any Apple Mac computers on the network. This teacher requested a Macbook instead of a Windows laptop under the TELA scheme and made this laptop available to students for recording and composing in the classroom. The teacher also rotated the students through different stations for learning their instruments, composition and other work on the computer, although no internet access was possible with the network restrictions the school had in place. There were four computers in the school library with Sibelius licences, but these computers were not reserved for the Music students and experienced heavy traffic, especially during lunchtimes.

An Apple Mac suite with 8 eMacs and Sibelius was the only access to the music department where T5 was stationed. There were no other computers in the rest of the department, and this computer suite was separate from the Music rooms.

Having both a junior and a senior music classroom meant that T6 had 20 computers available for junior students to access mostly Garageband. The senior classroom provided access to 15 computers with Sibelius, Garageband and Auralia were available on all of them. Some computers were connected to electronic keyboards although the teacher preferred the students not to use these for notation input whilst composing.

Collaboration amongst departments meant that T7 could double the access to eight computers s/he had in his/her Music classroom. The Visual Arts Department next door had seven computers, and they were happy to share these with the Music students as needed. The solution for them was also to make use of a rotation model:

> If I have a class of twenty-five or thirty (which I do in Year 9), I split them into a class with three groups, and I've got enough guitars, keyboards and machines with Garageband to have them two at each machine for up to twelve on each of those things. If I have a trainee or some sort of help having an itinerant [teacher] around, then I will get those guys working with the computer or the keyboard group and I sit with the guitar group, and then they rotate. They will do twenty minutes on each of those things. There are two sets of headphones [for each computer], and the computers are now physically spaced out so that two [students] can sit around them. The students actually come in and go straight to those machines, composing or arranging stuff or making backing tracks for their performances. (T7)

T8 reserved the three computers in the department for the senior students and did not let the juniors touch them. In this case, there was no option for the students to rotate and get some computer time. The juniors were taken to a computer lab once a term for their music technology lesson.

Composition

Composing with the assistance of digital technologies had a marked effect on the way students produced their final compositions.

One of the first advantages mentioned was that:

> students can now realise the impact of their musical ideas on paper. They can synthesise ideas much more and test the result. They don't have to have the same understanding of things like transposing instruments as the software does it all for them. (T1)

Students who didn't have a strong music theory background were able to play and record their ideas in Garageband and then "self-generate extensions onto that idea" by listening back to the recording (T10). Garageband also helped to extend the ideas of students (whose listening taste was mostly Death Metal) to create a blend of classical ideas in order to create a composition unique to them. It enabled students to produce compositions at a higher technical level than the students' own abilities would allow for (T10).

Training in composition software posed some problems. If students were introduced to such programs for the first time when they had to produce a composition at NCEA Level 1, T5 noted that it meant "deadlines get pushed out and pushed out because I'm running this dual process of trying to teach them software as well as the composing process". In another case, the software was more of a hindrance than a help because "all they've ever done is sit at Sibelius and play their compositions on a keyboard and it's arrived on screen for them… if you ask them about anything to do with notating music, they are just incapable of understanding anything" (T8). The same teacher was of the opinion that students should generate their musical ideas first before they try to realise them on the computer. "I think we've got to realise that the computer is just a tool for writing it out. It's not something that's going to help you compose" (T8). It was interesting to find that T9 had the exact opposite opinion about using the keyboard to key in compositions: "we're lucky in that a lot of the students have had some sort of [electronic music] keyboard and don't struggle too much with the piano keyboard interface for inputting their notes".

Creativity

Students made use of technologies in the music classroom to enhance other media or to create backing tracks for their own practical performances. This did not happen frequently, but both T7 and T9 described how their students created backing tracks for their own performances. T7 also described an end-of-year task for his/her Year 10 students where they had two full days to design and produce a presentation in collaboration with the Media Studies students. The end product was a multi-media project using a combination of software and apps, including iDVD, iMovie, Quicktime and iTunes.

Delivery format

Digital technologies have the capability of providing interactive formats where students can get immediate feedback or collaborate online. E1 made use of websheets in Sibelius to create interactive worksheets for students. E2, however, found that the default format for creating support material for teachers was to make it photocopiable rather than designing a CD-Rom which might not work effectively on both Windows and Apple Mac operating systems. Both T8 and T9 encouraged students to save their compositions on the school network, but also to make printed copies for assessment purposes.

Disadvantages

Teachers listed only a few disadvantages of using ICT for teaching. The biggest issues were technical support for hardware and server problems, especially if the problems were too complex for teachers to troubleshoot themselves, or if they had to wait a considerable length of time for a technician to attend to the problems. Of lesser concern was the students' own capability to use the technology, especially for students who had a traditional or classical background and had to learn how to use certain software programs before they could engage in the learning and composing activities. For these students, the teacher felt that technology was more of a hinderance than an enabler (T6).

Frequency of use

T7 reported how students had a set routine to "go straight to the machines as they all have individual education plans based on their own strengths", so they knew exactly what to do once they walked into the classroom because the computers were used in every lesson, resulting in an established routine. T8 restricted the use of the only three computers in the classroom to the senior students, so these machines were used infrequently. The justification for this practice was that the three stand-alone computers contained the senior students' work and that the teacher felt the need to "just protect their work and not allow anybody in there fooling around". These computers were not connected to the school network. The junior groups at the same school were sometimes "taken down to a computer room to do a little exercise... as part of their technology unit".

Integration

Most of the teachers interviewed were supportive of an integrated learning environment for their music students. T7 welcomed the prospects and added value but stressed that students still required the basic music literature knowledge

> The mix is good. It's a bit of a weird thing because if you have the technology, it fine-tunes the idea and makes it more legible in some cases, but it still requires the basic skill set.

When T4 was asked whether students preferred a technology rich environment to a more traditional music class, the response was very clear:

> I think it's actually a very balanced way of learning because we do the hard-out theory stuff, and the historical stuff and the practical stuff but it's very much hands-on and playing as well. I think it's giving them an incredibly holistic approach to music. (T4)

T5 added a visual element to his teaching and found that technology could support both auditory and visual learning styles when teaching music theory and harmony. Instead of trying to play the examples on the piano, visual flashcards with sound examples supported the teaching in an immediate way. Another teacher (T6) described the setup of their classroom as fairly integrated where students could switch seamlessly between computers, musical instruments and paper resources.

An instance of integrating multi-media was described by T7 where the students incorporated photographs, music, video footage and titles to prepare a short introduction for each of the outfits at their World of Wearable Art fashion show. The Year 10 students composed a movie soundtrack and then integrated the mood music with a short video. As T9 described it, “it was hopefully learning [music] theory in a different way to sitting down with a theory book”. This relates to the practice in critical pedagogy where students and their teacher celebrate the new learning and acknowledge the transformation through presentation, exhibition, or some other form of demonstration (Abrahams, Jenkins & Schmidt, 2002).

Internet

The internet was used for carrying out research, accessing YouTube and for downloading MIDI files and songs from iTunes. In T8’s class, the senior students had to obtain permission to go to the library during class time if they required internet access because the computers in the Music room was not on the school network. It wasn’t clear whether this happened frequently.

Notation

Sibelius was the software used most frequently for teaching notation. E1 acknowledged that students who played the guitar were usually more comfortable to notate with guitar tab and use Guitar Pro software rather than Sibelius. At T9’s school, they taught the Year 9s in Music Option from the onset to use notation software in order to make it a user-friendly interface for the students right from the start of their course:

> We believe that notation is part of music education and that we want our students to become as literate as they can in Music. Some guitar or drum-based students find it difficult, but most are willing to give it a go. (T9)

This was done to prepare the students to complete more advanced activities when they progressed to senior music classes.

Other hardware/sound equipment

E1 mentioned that s/he was frequently asked to set up hardware and to support teachers to set up MIDI keyboards. This was reinforced by T6 who said that what was most challenging about the hardware was "putting the bits together and plugging in keyboards."

Performance

Computers were used for editing performance assessment for students with editing software like iMovie. None of the teachers mentioned any performances where the computers were used as part of the performance, either as an instrument or as a virtual recording studio or DAW (digital audio workstation).

Recording

The skills required to make sound recordings and use sophisticated recording equipment were outside the scope and the budget of most respondents. T5 was fortunate enough to have access to a studio equipped with Pro Tools at the school, but it was very rarely used because it was not seen as a priority as the curriculum didn't require any recording proficiency from the students. This directive from the department head was "...if you want to do work in the studio, that is over and above and outside of what the department is doing, so, therefore, you need to do it in your own time". One department (T8) owned a four-track recorder which only one student used for recording a composition for four guitars. T9 was of the opinion that, "while I don't agree with spending huge amounts of money on a recording studio, I would like to have just a little space set up where especially our rock band students can master the work that they record". It seemed even if the teacher had a keen interest, budget and knowledge constraints prevented teachers from making this a priority.

Research

Research skills were mentioned by one teacher (T10) in relation to the NCEA Level 3 music achievement standard (AS 90499) for research. The teacher ensured that certain aspects of the process of doing research were brought to the attention of the students such as “getting into the habit of analysing what they’re doing, where they got the information from, how to write it down, how to source things and how to make references”.

Software

A variety of software programs were used in the music department s that were surveyed. Industry expert E1 provided teachers with support and techniques for Band-in-a-Box, Garageband, Auralia, Musition, Sibelius and Groovy Music when they purchased these programs for their music departments. Part of this support included completing the licensing process so “it’s not just the audio, MIDI and technical side, it’s the registration side that can be a problem too”. The other industry expert (E2) used Sibelius to create online and paper-based resources. These study guides could be purchased in hard copy or as downloadable files and provided relevant study material for music standards.

Sibelius and Garageband were the most commonly-used programs, with a few departments using additional software like Pro Tools, Auralia and some of the standard Apple applications such as iTunes and iMovie.
The list in Table 11 names and describes the most common programs encountered in music classrooms at the time of this study.

Table 11: *Software used in the music classroom*

Software program	**Purpose and application**
Band-in-a-Box	Band-in-a-Box is an intelligent automatic accompaniment program.
Garageband	Garageband is a sound mixing application and supports users to create their own customised tracks.
Auralia	Auralia is a comprehensive, interactive ear-training package.
Musition	Musition is a comprehensive music theory and fundamentals package for music students of all ages and abilities.
Sibelius	Sibelius is a program for learning and teaching music notation, composition, and music theory.
Groovy Music	An interactive suite of programs suitable for primary-aged students.
Pro Tools	Pro Tools is a digital audio workstation.
Finale	Finale is a music notation and composition software program.
iMovie	iMovie is a video editing software application for Apple Mac and iOS.
PowerPoint	PowerPoint is a software package designed to create electronic presentations consisting of a series of separate pages or slides.
Keynote	Keynote is a presentation software application developed as a part of the iWorks productivity suite for Apple Mac, similar to Microsoft Powerpoint.
QuickTime	QuickTime is Apple's multiplatform, multimedia technology for handling video, sound, animation, graphics, text, interactivity and music.
iTunes	iTunes is a media player, media library, online radio broadcaster, and mobile device management application developed by Apple Inc.

Teaching programmes

Teaching programmes were designed in many ways, especially for the year 9 and 10 programmes. E2 taught part-time and offered whole-year course options for the Year 9 and 10 students (performance music) and a one-term compulsory vocational taster course for both year groups.

The Year 9 students at T9's school started their Sibelius training right away by copying out a Bach chorale in Sibelius. Their course was designed so that by the time they had completed the chorale, they had also mastered all the basic skills needed for operating the notation software, and they could start focusing on using the program creatively. The copying of the Bach chorale relates to practicing the content in a critical pedagogy process (Abrahams, Jenkins & Schmidt, 2002). These students followed a programme of three music classes a week for the full year. Their teacher (T9) was also planning a Music Technology course "offering them the principles of music and setting up a recording studio, setting up a sound system and using a sound system for a performing arts situation". This course was designed to cater for students who were struggling with the set works, aural skills, and score reading aspects of the Music course, with a more hands-on approach.

The music programmes offered at the school of T5 had a strong orchestral and scholarship programme, and this teacher found that the Year 11s had no lead-in time to learn Sibelius software before they started with NCEA. This meant that the students were under pressure to learn the software as well as the composing process at the same time when they started NCEA level 1. The Year 9s were offered a one-term module with three periods a week. The Year 10s could do it as a full-year option, but neither Year 9 or Year 10 had access to computers in the Music classroom.

T7 introduced his most literate Year 9 students to Sibelius once they had completed their music literacy workbooks, which provided them with the necessary notation and score reading skills to advance to Year 10 and NCEA Level 1.

The Year 9 students had Music for two periods a week throughout the year at T8's school, concentrating on basic theory skills. They also completed a technical unit learning how to use amplifiers, microphones and electric instruments. Sibelius use was reserved for the senior students in this music department.

Skills and knowledge

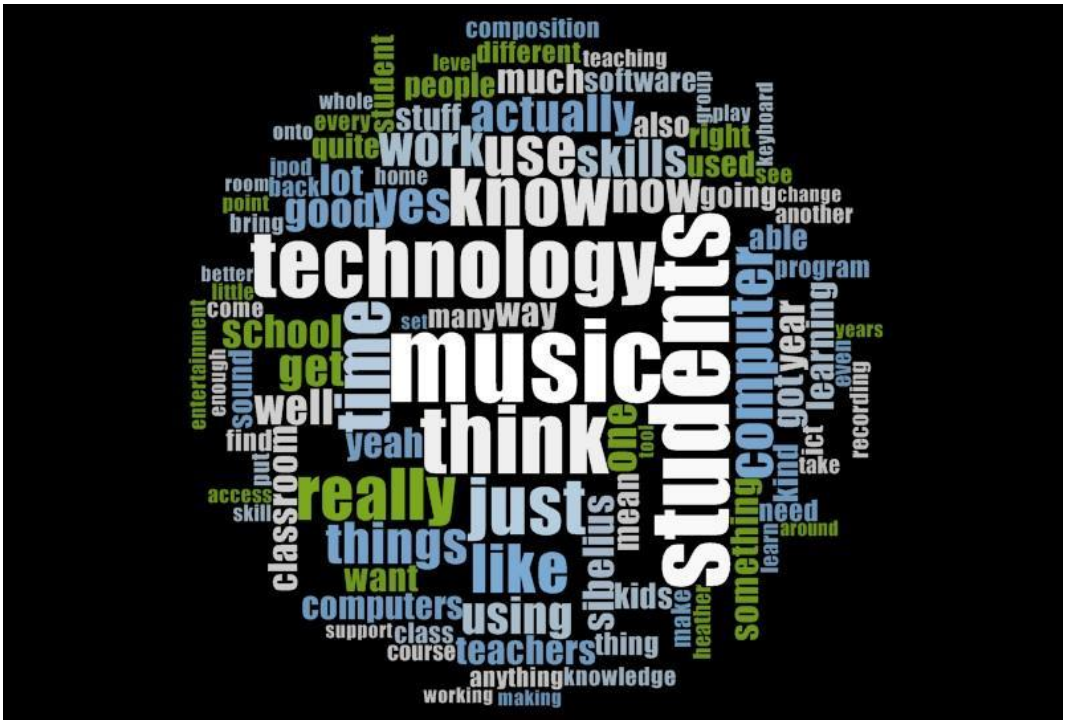

Figure 9. Skills and knowledge portrayed as a word cloud.

This category described the ICT skills and knowledge of the industry experts, teachers and students and unearthed some of their attitudes towards and perceptions of ICT. The word cloud in Figure 9 highlights the most prominent keywords such as music, technology, skills, know, students, computer.

Table 12 shows the three parent nodes identified in this category. They are the technology skills of teachers, students and the industry experts. Technology skills of students were further divided into four child nodes: competency levels, innovative use, student perceptions, and transferrable skills. Teachers’ skills were split into three child nodes: competency levels, beliefs, and technology needs.

Table 12: *Skills and knowledge category*

Category	Parent Node	Child Node	Description
Skills and knowledge			Teacher and student skills, beliefs and knowledge around ICTs
	1.Technology skills of industry experts		Skills specific to industry experts
	2. Technology skills of students		Student skills and knowledge around ICTs
	→	Competency levels	The natural ability of students with ICT
	→	Innovative use	ICT application going above and beyond the expected
	→	Student perceptions	The way students perceive technology from a teacher's perspective
	→	Transferrable skills	ICT skills used for leisure activities to be applied for learning (entertainment skills)
	3. Technology skills of teachers		Teacher skills and knowledge around ICTs
	→	Competency levels	The natural ability of teachers with ICT
	→	Beliefs	Professional and pedagogical beliefs regarding the use of ICT in education
	→	Technology needs	Specific training needs of teachers

Technology skills in the industry

The two industry experts' skills covered mostly knowledge about software programs such as Sibelius and facilitation skills for providing training workshops for teachers in the use of these programs. One of the experts, a trained teacher, brought a strong pedagogical perspective to the resources that s/he developed to support teachers and students. These study guides were designed as NCEA Achievement Standard resources.

Technology skills of students

Student technology skills influenced classroom pedagogy as well as the way teachers customised and personalised their teaching programmes.

Competency levels of students

The students brought a wide variety of previously acquired or existing ICT skills and competency levels with them to the music classroom. While some students preferred not to learn with the technologies on hand, most students were keen and competent users of ICT, with skills equalling and often exceeding those of their teachers. Students were also more open to learning new skills than the teachers and often figured out how to do things through trial and error. They were keen to experiment and try new sound combinations or unusual textures with the existing software. T3 reported that his senior students were very capable and often solved problems in an illogical and chaotic way!

Innovative use

When teachers were asked whether students used technology in innovative ways, they shared a few interesting examples. These instances sometimes occurred outside the scope of the music programmes, but they were still interesting to document. E2 talked about a very capable music student who applied his composition skills to an online game he was developing. Although this suggests that the student is a gaming enthusiast, it also highlights the connections that students make from their perspective. Another teacher (T10) had a group of students creating backing tracks for the school production which they enhanced with additional live musicians as and when they were available for rehearsals (T9).

There were a few examples of interesting composition techniques that included recorded sound clips. T4 set the students a composition task on the Hutt river. One student created an ostinato pattern by making a recording of boulders dropping into the river. A group of students then collaborated on the composition using Garageband, and because none of these students were musicians, they mixed existing loops and collaborated to produce a piece of music which would not have been possible without the technology. The students elevated the recorded sound sample by manipulating the pitch and rhythm with computer software to use it as part of a new composition or soundscape, utilising both found and manipulated sounds to create an interesting composition.

Students in T6's music programme recorded their performance reflections on video, added snippets of their performances and then mixed them into a documentary video. As part of their performance assessments, T9 set her/his Year 10 class the task of creating a two-minute podcast about learning key signatures. They used Garageband to record their ideas and tips.

Student perceptions

Teachers had several opinions on how they thought students perceived the use of technology in the music classroom. E1 pointed out that "in the case of notation they could capture it once and then they... extrapolate that idea in lots of ways". For T2, using computers was more in the style of the students because they liked a range of learning environments "and many are now so screen based, that using computers is more in their style" (T2). A few teachers (T4, 6, 8) commented that they had some students who preferred to work without technology because they felt the students found the technologies to be frustrating, distracting or that it separated them from the composition process.

Transferrable skills

The interview question about transferrable entertainment skills prompted the teachers to comment on the technology skills students brought to class, skills which students had attained in their leisure time through activities that interested them. E1 thought that students did this very well and they often shared the knowledge with the teachers. E2 did not deem this important as the skills were not part of the curriculum requirements or what was expected in his/her role as a technology expert. T1 observed that “today’s students do not separate the use of technology in their everyday lives from their learning”. The separation was conjured in the minds of teachers, not students.

T11 believed that the entertainment skills of the students were underutilised that they easily adapted to the technology available in the classroom with some wonderful end results.

The Barbershop tutor played, sang and recorded all the song parts in T4’s school. These sound files were loaded on the Music teacher’s computer for the Barbershop students to download to their mobile phones and iPods, so they could learn their parts on the go.

Technology skills of teachers

Teachers’ skills and knowledge around ICTs influenced their perceptions of its value. They measured the advantages and disadvantages of digital technologies in their teaching programmes against their own capability and self- efficacy of ICT.

Competency levels of teachers

The interview questions about teachers’ own ICT competency levels provided subjective answers. It prompted them to verbalise their perceptions of their own ICT skills. E2 described how it found a happy balance between confidence, capability and necessity: “you would basically plan your programme around what’s available at the school, around what your personal comfort zone and skills are like, and then the students’ needs as well”.

Teacher beliefs

Teachers’ attitude towards ICTs reflected their willingness to learn and their general mindset towards ICTs. Interesting observations came from the two industry experts who could be more objective about teachers’ attitudes than the teachers themselves. E1’s opinion was that Music teachers were really working under pressure and that they often didn’t explore new things because of time constraints, not unwillingness to learn or resistance to IT. E2 contradicted the previous opinion and described teacher's' deliberate decision not to embrace technology in the classroom.

> I think there is a whole group out there who have made a conscious or unconscious decision really not to go down that path and this could be for a number of reasons. It could be for personal preference; it could be because the school won't actually have the technology or perhaps the finances to support it. Different schools cater for different needs, for different pathways and I personally believe that it's impossible in Music teaching these days to be everything to everybody. (E2)

Personal preference and interest played a very important role in influencing teachers' attitudes, this being evident from the following comments from T2 and T3. T2 was very keen to learn more because "students these days really relate to technology and we have to keep pace" (T2). On the other hand, T3 commented that s/he did not like to use computers for music theory, that s/he didn't have time and that s/he would rather "do other things in the little leisure time I have, for one, playing music!". This teacher admitted that it is his/her "real feeling that technology is too dominant a force in our society".

T4 described her/his personal growth and how her/his attitude towards using computers changed in the Music classroom. "I was quite wary of computers, and I did have kind of an in-built resistance about electronic stuff". This teacher made a deliberate effort to become involved and to learn more with the students: "just through the process of using them, watching the kids use them...I actually think that whole prejudice thing is gone and now I've seen them as an important part of the programme" ('them' being ICTs).

Traditionally, music departments in New Zealand secondary schools have been designed around a classical Western tradition, resulting in some reluctance to embrace alternative ways of reading and making music:

> I think there is a certain amount of resistance within an echelon of music teachers that see music ICT as a gimmick… to be avoided at all costs, because music is about working on manuscript and it's about playing, so therefore we don't want computers! (T5)

The comments from T8 supports this statement: “I feel as a music teacher that my job is more to make music and enable other people to make music. I’ll pay somebody else to do all the technological stuff”.

Deflecting any personal barriers was often the starting point to show resistance. Teachers’ perceptions about the usefulness of technology in the classroom went hand in hand with perceived barriers. E2 named the human barrier as the biggest one when people were unwilling to engage or spend time with the technologies. T3 identified the lack of a proper understanding of music technology as the weak link in his/her school, but at the same time commented: “I’m not convinced it leads to better learning”.

Technology needs

When asked about their personal technology needs, teachers identified a few skills which needed enhancement, so they could better support the students they taught with the available technologies. Teachers wanted to be better informed about sound recording systems and processes and the software that supported these. They acknowledged that it was not a high priority if the school didn’t have an existing sound studio because of the implied costs to the school.

Support

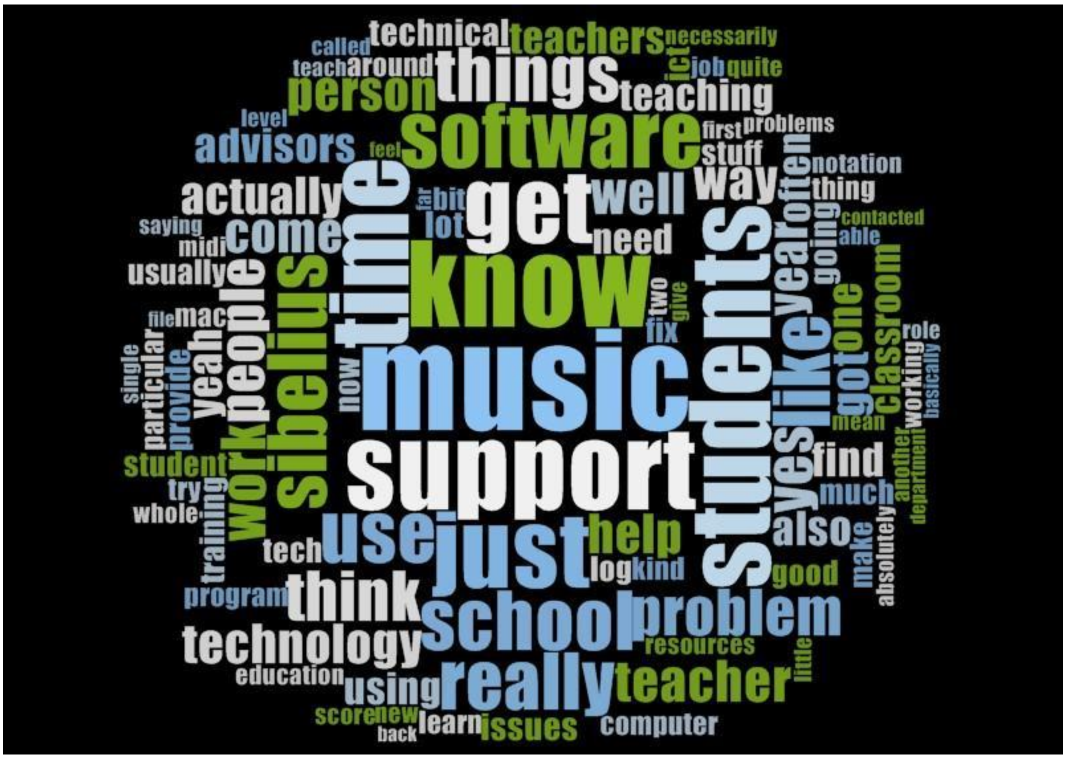

*Figure 10.*Support portrayed as a word cloud.

The *Support* category (Figure 10) unpacked the technical ICT support required by and provided for teachers and students. Prominent keywords in this category were music, time, support, software, know, students, Sibelius, think, and technology.

Table 13 lays out the six parent nodes identified to explain the technical support available for teachers and students.

Table 13: *Support category*

Category	Parent Node	Child Node	Description
Support			ICT support provided for and needed by teachers and students
	1. Industry support for students		Examples of support from the industry for students
	2. Industry support for teachers		Examples of support from the industry for teachers
	3. Online help		Online support for teachers
	4. Support role of teachers		How teachers are expected to support students with ICTs
	5. Professional development		Availability of PD opportunities
	6. Technical support		Availability of third-party technical support

Industry support for students

One of the industry experts (E1) supported students in learning to use specific music software through creating worksheets with the software. These worksheets were first given to the teachers to work through, test for workability and moderate for accuracy. They were then shared with the students. The other industry expert (E2) identified a need for resources to support senior music students with the external NCEA achievement standards. The work then branched out to units of work aimed at Year 9 and Year 10 students to prepare them in anticipation of NCEA assessments with a strong focus on appropriate terminology and music literacy.

Industry support for teachers

The way the two industry experts supported teachers differed substantially. One expert (E1) provided specific technical support with a helpdesk service for teachers to call or e-mail. The service was also accessed by the technicians working in schools, as they were often unfamiliar with most of the music software. The expert would provide support by visiting the music teachers in their classrooms:

> Teachers don't always have control and so if they have a tech problem it's not necessarily that they can fix it because they don't learn to fix it and they become very reliant on the tech companies who come once a week on a schedule and if they miss him, they're stuck again. That's one of the problems for me that's a big frustration for teachers. (E1)

These sessions often included support for teachers on Apple Mac computers, giving notation tips, installing accompaniment software and providing Garageband training:

> Mostly it's notation software but I actually find often when I'm working with a teacher I offer them (for instance if they're working on a Mac), I offer them help with general operation just because there's no school for it and so they have to learn and you have to provide for them and make them comfortable, not make them feel stupid about it so they can learn. So, it's mostly musical, mostly the notation. Sometimes the accompaniment software: Band-in-a-box, Powertrax, so, audio. Occasionally I'll help with Garageband although that's not really my area but if a teacher's got a Mac and can't use Garageband I'll just show them how to use it very quickly. Yeah, and also hardware. I do quite a lot with hooking up keyboards so that the keyboard can talk to the computer for them. (E1)

Another frequent request was to configure the hardware for MIDI controllers and MIDI keyboards. This expert helped teachers to register and install the licensed software. E2 focused on developing study guides for operas and other music works performed by the New Zealand Symphony Orchestra. Some of these guides were made available on the New Zealand Symphony Orchestra (NZSO) website.

Online help

Teachers subscribed to online support for the Musicnet listserv and the website, Arts Online, on Te Kete Ipurangi (http://artsonline.tki.org.nz/). The Sibelius website (www.sibelius.com) also provided reliable information and problem solving for teachers with sophisticated notation and software queries.

Support role of teacher

The support role that music teachers filled seemed to be extensive and varied. The level of support they provided depended heavily on the teachers' personal skill levels. Most music teachers had to provide both technical support for students and colleagues and musical expertise as the subject expert. Two of the teachers interviewed had previous music industry experience and training, one as a sound engineer (T9) and the other as a Microsoft system engineer (T10). This background experience equipped them to support their students when they experienced network issues or problems with recording. The rest of the teachers were either reliant on their own skills or on the limited and sporadic technical support provided by technicians. The distance education provider (T1) provided mostly just-in-time support for students on a needs-only basis. Although T1 had access to a technical team, they did not have the software-specific knowledge for troubleshooting problems and just-in-time advice that music students and fellow teachers often needed. T4 relied heavily on a reciprocal model to teach and learn from the students and to discover new possibilities with them rather than pretending to be an expert at the onset.

Where possible, teachers were keen to upskill junior students to be proficient users by the time they reached Year 11. One of the teachers (T8) relied completely on external training to help students with understanding the notation and composition software, but this was an exception. Unfortunately, this training only happened once the students reached Year 11, so they did not have a gradual phasing-in period to become familiar with composing software.

Professional development for teachers

Because of time constraints and teaching demands meant that teachers were mostly self-taught in terms of software operation.

Technical support

The specialised nature of music software, MIDI hardware, and keyboards often meant that the technicians in schools were unable to service music departments sufficiently. One teacher (T11) had to wait six months for the Sibelius software in the department be upgraded. By the time the upgrade happened, a newer version was already available.

There was the usual mismatch of technical support requests and the actioning of these which led to understandable frustration. E2 reported how the technician had to activate internet access for students a day before the lesson and if for some reason this didn't happen, the planned classroom activities had to be abandoned:

> if you want your class to have internet access, you have to provide a list of students to the technician a day in advance for which period you want access available, and I personally find that a huge barrier. Particularly, for whatever reason, it has happened in the past that the technician didn't actually action the list and your class lesson might be planned - well, it's obviously planned around something that needs internet access - and all of a sudden things go down the tube. (E2)

T11 reiterated this frustration, wondering "who prioritises and manages ICT requests once they have been logged?".

Ways forward

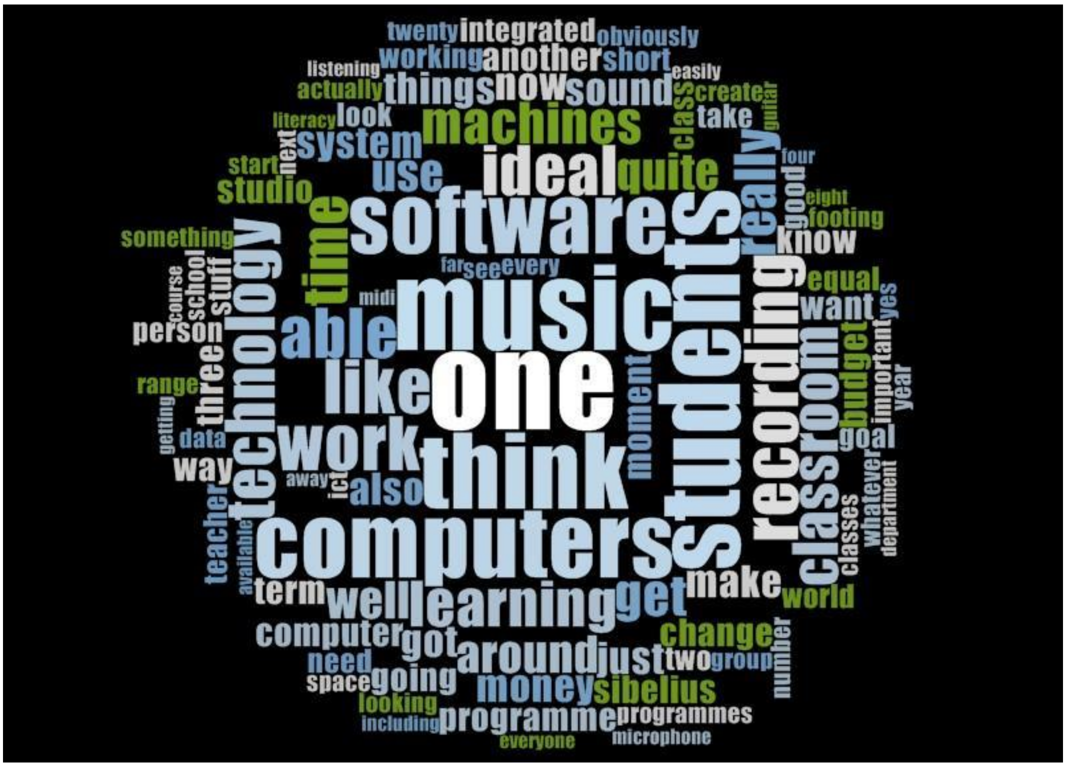

Figure 11. Ways forward.

Figure 11 is a visualisation of this node featuring prominent keywords such as music, think, computers, learning, classroom, recording, ideal, technology, and work.

The last category *Ways forward* identified three ways for teachers to move forward (Table 14). *Goals* described specific, short-term, attainable targets set by the teachers regarding their use of ICTs. *Vision* referred to some aspirational thinking and planning for the future. *Wish list* gave an idea of their immediate needs for improving their use of ICT and heightened capability.

Table 14: *Ways forward category*

Category	**Parent Node**	**Child Node**	**Description**
Ways forward			Teachers' plans, aspirations and wish lists
	1. Goals		Specific, attainable targets and goals set by teachers regarding the use of ICTs
	2. Vision		Aspirational thinking and planning for the future
	3. Wish list		Immediate needs for improvement of ICT capability and use

Goals

Teachers responded freely and without hesitation when they were prompted to talk about their department goals. T1 wished that technology use would become the norm rather than the exception and that music literacy could be taught through self-paced mastery learning supported by the technology:

> A fully integrated music programmes would include the essential tools including Sibelius. The focus would be too on Music literacy where students do self paced mastery learning. There would be a component of sound processing too. i.e. recording and communicating musical ideas.(T1)

T2 wanted more technology to "make things interesting for students and to motivate them to learn and achieve". T3 wished to become more familiar with sequencing software to integrate this into the music learning programme. T5 identified the need to model to the Year 10 students what would be expected of them going into Year 11 and for his/her Year 11 students to become "competent and confident in the use of the software". These students would also be encouraged to combine and integrate assignments for English, Media Studies and Music where appropriate, and to see the possibilities that this integration could offer. T6 suggested that one way of creating a fully-integrated environment would be to have computers in the practice rooms "so that students would actually be able to record and practise and compose at the same time". T9 wanted to have all her/his computers on equal footing regarding software versions and speed. S/he wanted to upgrade their recording desk to twelve channels to get decent sound equipment, so students could listen to recordings in a shared space.

Vision

Teachers were happy to share a vision for their music departments and teaching programmes.

E2 gave an interesting account of the diversity that learning and teaching music in the secondary school environment:

> I think there are three distinct pathways at the moment for students in music education. There's the academic one, which is traditionally how we have been brought up and what we are comfortable teaching or what I am comfortable teaching. There is the performance side which I think we have all learnt to handle and that can be technologically quite intense although it doesn't have to be. And then the third way is really the industry pathway for those who are looking to move into things like event management, sound and lighting, and professional recording. I think to get a teacher who can cover academic, performance, and industry is virtually impossible. (E2)

T11 commented that the ideal programme would be one that actually had a way of allowing students from Y9-13, regardless of their ability levels, to work at their own pace, in small groups, regardless of the social-streaming system of year levels from Y9-13. The ideal would be to have a programme that was fully integrated, standards-based and had technology embedded in every aspect of the teaching and learning.

T4 commented on the way we might see performances evolve in the future:

> I think the way the future will be is you will have your integrated stuff. You will have composers and musicians that will be putting stuff together electronically which they will then reproduce on stage in a live performance.

T7 wanted to see interactive connectivity with each student at their own work station but with a central dashboard so the learning facilitator would be able to support and monitor each student as they were working individually. A similar scenario was described by T9:

> In the ideal world, you'd want soundproofing and individual work stations that could then be integrated into a whole classroom when it was time to share. The teacher could walk around and visit or have a console up front to look at.

Wish list

Teachers were asked to share a list of requirements to improve their immediate situation. Table 15 reveals their wishes.

Table 15: *Teacher wish list*

Teacher	**Requirements for improving teaching practice**
T1	• sound processing, i.e. recording and communicating musical ideas • a more flexible method of learning delivery • an interactive method of dialoguing with students
T2	• more computers and more software, including digital cameras and data projectors for all staff
T3	• a stand-alone recording suite • 25 site licenses for the most current version of Sibelius with an excellent sequencing software package
T4	• a new computer for my work as a teaching professional • Pro Tools • Three additional Apple Mac computers for the classroom
T5	• a computer suite big enough to teach a whole class how to compose on Sibelius • an introduction to the software program for students
T6	• A support person who could deal specifically with technical support • more classroom space • upgraded software
T7	• a permanently-mounted data projector • more computers • an Apple TV
T8	• more computers, as long as there is still space for the harpsichord
T9	• in the ideal world, I would have 26 savvy, smart, quick machines but I would put in a budget for six faster ones • I would like to have just a little space set up where especially

	our rock band students can master the work that they record ● I would change the building to make it suit the needs of students
T10	● more than one teacher in the department ● a lab approach to student learning ● A well-equipped sound studio
T11	● an overhead projector or LCD display ● MIDI capability for instruments other than guitar and keyboard ● some sort of voice recognition software for composing ● better ICT support ● Better facilities to accommodate more students
E1	● it would be really good to see schools allocating computers specifically for Music so that we get given the proper hardware to work with
E2	● compatibility between Windows and Apple Mac (interoperability of programs). 'If you create something on one profile or system, how to make it work and transferrable on various devices and in other environments'.

Summary

This chapter presented the data gathered from thirteen transcribed interviews. A coding matrix was used to structure this summary of the data according to five categories organised into main categories with subcategories. Anecdotal quotes were shared throughout the descriptions to support the qualitative authenticity of the research intervals. The next chapter will describe the content of the second data set which was collected during 2012.

Chapter 5

"Maybe stories are just data with a soul."

Brené Brown (2010)

Introduction

This chapter sets out information gathered for the second data set during 2012. The same interview schedule was used as for the first interviews. This time the questions were posed as a questionnaire in a Google Form. These were sent out to the respondents instead of having face-to-face interviews. It streamlined the data gathering and analysis process. Clarification of unclear or ambiguous answers were done by emailing the respondents. This change in method was not detrimental to the quality of the data.

Where possible, the respondents from the first interviews were contacted for a follow-up interview. Some of the respondents were no longer available because of employment changes or retirement. In these cases, their successors were approached. Only three new respondents were interviewed. Table 16 shows the difference between the first and second respondent panels and provides the reasons that necessitated the adjustments. The reasons for making these adjustments were purely pragmatic. The respondents in the first dataset already had an understanding of the nature of the research. Most were keen to contribute further and did not mind filling out the Google form rather than having an interview.

Table 16: *Comparative list of respondents*

First data set: respondents	Second data set: respondents	Original respondent / replacement	Reason
T2, T3, T4, T5, T7, T9, T10, T11, E1 and E2	T2-2, T3-2, T4-2, T5-2, T7-2, T9-2, T10-2, T11-2, E1-2 and E2-2	Original	
T1	T1-2	Replacement	First interviewee was no longer teaching
T6	T6-2	Replacement	First interviewee had moved abroad
T8	T8-2	Replacement	First interviewee had retired

Presentation of Data - the second data set

The second data set was collected in a Google Form format because this method allowed for collecting data in an asynchronous manner without the time and location affordances of face-to-face interviews. A Google Form collects all the responses in a spreadsheet. This method reduced the need to make transcripts, although the responses had to be reformatted to enable coding in NVivo. A second Nvivo project was created for this data set. It meant that the data could be described and analysed independently from the first data set, allowing for a comparative analysis of the two data sets. A similar coding matrix to the first one was used for the second data set (see Appendix 7) with some minor adjustments.

Focus areas in the second data set

The focus areas in the coding matrix are identical to those in the first data set. One parent node, online platforms, was added in the *Inside the classroom* focus area. Although the structure of the matrix is almost identical to that of the first data set, some of the nodes were more pronounced in the second data set than in the first, and others were far less prominent.

Infrastructure

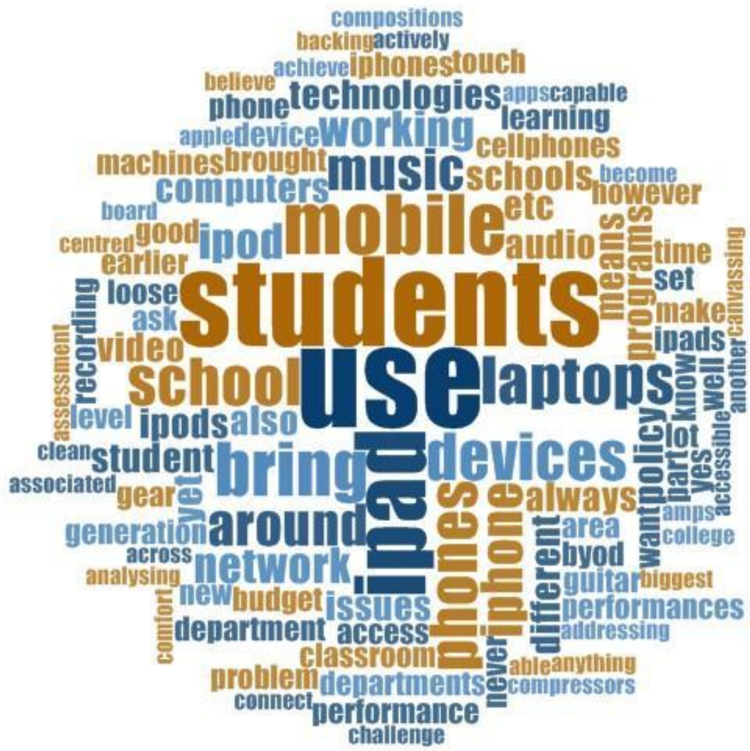

Figure 12. Infrastructure focus area depicted as a word cloud.

Figure 12 is a word cloud representing the most prominent aspects of the data coded against the *Infrastructure* focus area. The most prominent keywords in this focus area were: students, use, mobile, devices, laptops, iPad, school and bring. The coding matrix for *Infrastructure* is identical to that of the first data set.

The six parent nodes in *Infrastructure* were: budget, devices, equipment, network, operating system, and school policies (Table 17).

Table 17: *Infrastructure (second data set)*

Category	Parent Node	Child Node	Description
Infrastructure			Network, server, connectivity, access, devices and policies pertaining to ICTs
	1. Budget		School, department
	2. Devices		Any device with the capability to connect to the internet or to operate software as a program or application, including mobile and student-owned devices
	2a⇢	BYOD (bring your own device)	Student-owned devices
	2b⇢	Mobile devices	Tablets, phones, MP3 players and laptops
	3. Equipment		Electric, fixed, projecting, photo, video
	4. Network		Wired, wireless
	5. Operating system		School-wide and specific to the music department
	6. School policies		Policies regarding the use of devices and the conditions of access

Budget

Financial constraints seemed to be an ongoing issue, and four teachers said that budget constraints limited opportunities for students. From the comments teachers made, it seemed that technology was now seen as a priority and that ICT was commonly given a separate budget line in the Music Departments' budgets, and not funded from school-wide funding. T6-2 reported that their aim was "to slowly incorporate different technologies into the classroom within our budget".

Devices

This is one of the areas where there was a noticeable shift in accessibility. During the first interviews teachers and students had limited access or permission to use handheld devices. The use of mobile devices other than laptops was either restricted or completely banned.

BYOD (Bring your own device)

None of the teachers interviewed for the first data set mentioned having a BYOD policy or an established practice around students bringing their own devices to school for learning purposes. It was apparent from new evidence that this practice was no longer foreign or as restricted as was the case four years earlier. Out of the thirteen respondents, ten had a comment about teaching with the support of student-owned mobile devices. Only one teacher was not familiar with the acronym. T9-2 admitted that their school infrastructure was not set up well for BYOD yet, but that it was something the school was considering implementing in the near future. Eight teachers commented on the way students' personal devices were used for learning. The examples varied from the way personal devices freed up computers for other students (T5-2 and T8-2), to allowing students to work on software not owned by the school and using iPods and phones for analysing music (T6-2). T5-2 welcomed this flexible approach because it meant students could access the work they did at home from school on a familiar device.

While T3-2 preferred not to allow students to bring their own devices, his/her motivation for this stance was unclear, as it was an internal rule, not a school requirement: "[I] prefer not to, but I don't have a can't policy. I just like to be able to understand what they are doing" (T3-2). This reaction could be a remnant from years of ingrained resistance to technology use for this particular teacher. T7-2 was frustrated by the fact that "visiting tutors and students can't connect their laptops or iPhones without a lot of mucking around". This implied that their wireless network did not all for specific user profiles. T2-2 reported that their school was considering introducing BYOD, but they were still grappling with the technical details around a downloading policy. T10-2 emphasized that students were aware that they had to follow the rules of engagement and that the IT Department had to check any device before it was allowed on the school network. Students enrolled at the distance education provider had to provide their own devices, but these did not require access to a shared server, and therefore it didn't pose any of the problems or threats faced in a classroom.

Mobile devices

E1-2 mentioned that students often made use of mobile apps on their phones and that the school had a policy of *use it or lose it*, which meant they could use the devices for their learning but not to phone or text during lesson time. Nine teachers used iPhones and iPads in their classrooms for a range of activities like capturing study notes, accessing calendars for assessment dates, and accessing, creating, and producing audio and video content.

Equipment

Teachers mentioned a wide range of ICT and sound equipment in this category. It seemed that there had been improvements made to how music students could access equipment and that they were well supported in their music learning programmes. Both E2-2 and T8-2 had interactive whiteboards in their music classrooms. T2-2 had acquired an Apple TV for data projection, and video streaming and T9-2, as well as T5-2, made use of data projectors in their classrooms. T5-2 also listed a range of sound equipment which was frequently used such as guitar processors, guitar amplifiers run by software, compressors, delays and equalizers. Not all of these fit strictly under the ICT umbrella but can be accepted as technology used in music making and production. T8-2 made use of digital technologies to record student performances.

Network

Only two teachers noted frustrations regarding the coverage and setup of their school network. Even so, T7-2 remarked that network problems were "not a particularly frequent occurrence". It was encouraging to learn as this might be a direct result of the ongoing support that the Ministry of Education had been providing since 2004 through the School Network Upgrade Project (SNUP). This project enabled all state and state-integrated schools in New Zealand to have their ICT networks upgraded and their wireless connectivity improved (School Network Update Project, n.d.), as well as making ultrafast fibre connections accessible.

Operating system

A few departments had moved to Apple computers since the first interviews, although the majority still seemed to have computers running on Windows.

Five teachers were using Apple Mac computers in their music departments. Out of these five, one of the departments was running on three systems: Microsoft Windows, Apple and Linux (T10-2). T8-2 encouraged the school to bring Apple Macs into the music department, and this teacher "has actively trained students and staff around the use of these machines". T11-2 was eager to switch to Apple Mac computers, but school policies enforced a very long waiting period, so consequently, the initiative was dismissed. The music Apple Mac laboratory was still running in T5-2's school, and T7-2 had the skills to be the network administrator for the 22 Apple Mac computers in his/her music department.

School policies

The only mention of a school policy in this data set was found in the experience of E2-2 and stated that students were encouraged to use their mobile phones for learning.

Inside the music classroom

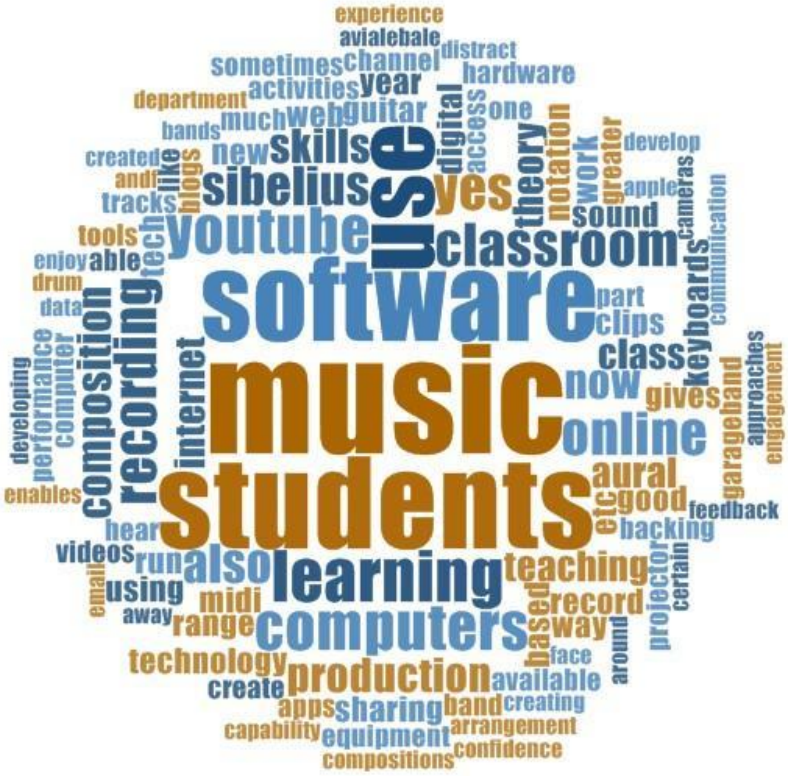

Figure 13. A depiction of the most common keywords for *Inside the music classroom* focus area as a word cloud.

This focus area *Inside the music classroom* highlighted the prominence of keywords such as music, students, software, classroom, learning, recording, online and computers (Figure 13).

Nineteen parent nodes (see Table 18) were identified and described. Node number thirteen, online platforms, was added in this dataset.

Table 18: *Inside the music classroom (second data set)*

Category	Parent Node	Child Node	Description
Inside the music classroom			What happens inside the classroom in terms of ICT integration and utilisation
	1. Advantages		The advantages of using ICTs in the classroom
	2. Barriers		Anything preventing teachers and students from utilising ICTs in their daily teaching and learning programmes
	3. Class sizes		Student numbers and grouping
	4. Classroom setup		Organising of furniture, equipment and student rotations
	5. Composition		Composing with ICTs
	6. Creativity		Creating presentations, video, recordings
	7. Delivery format		How teachers deliver the learning content
	8. Disadvantages		The negatives of ICTs
	9. Frequency of use		Access to ICTs and consequent usage
	10. Integration		How well ICTs are integrated in classroom practice
	11. Internet		Accessibility and robustness of connections
	12. Notation		Notating with software programs
	13. Online platforms **(new node)**		Delivering learning programmes in an online environment
	14. Other hardware/Sound equipment		Amplifier, microphone, equaliser, mixer, USB controller, MIDI keyboard, MIDI interface
	15. Performance		Performing music with the support of ICTs

	16. Recording	Recording with ICTs
	17. Research	ICTs supporting research in the classroom
	18. Software	Programs used for learning and teaching music skills
	19. Teaching programmes	Specific mention of ICT inclusion in teaching programmes

Advantages

Using ICT gave students options to learn differently: “it offers alternative ways of working which therefore gives them options as to how they develop their work. They can work to their strengths and interests. No one way is the 'right' way” (E2-2). Music technology enabled students to transcend their limited knowledge and experiences (T4-2) and provides common ground with how they learn and communicate outside the music classroom (T5-2).

Teachers found that the use of ICT supported learning in general and meant the “students can work to their strengths and interests” (E2-2). It provided students with the means to discover that the “literacy and numeracy skills of music can be relevant and interesting” (T11-2). ICT supported the independency of the learners. “They can do so much on their own - recording songs, creating backing tracks, learning new material, sharing compositions - all very easily with very little intervention from me” (T7-2). “Online applications and tests are great and easy [to use], and it is a great tool for peer assessment” (T9-2) to enhance formative processes.

Music technology was seen as especially useful for assisting students in their composing tasks:

> Students love to hear their creations come alive with the use of music software. It inspires them to persevere and achieve at a higher level than previously. Sibelius enables students to experience what it is like to compose for a full orchestra which is something they would not be able to experience in real life. Garageband also enables student who have limited music literacy skills to utilise their aural skills to create music beyond their capacity to notate. (T4-2)

Teachers still offered a blend of paper-based and ICT-based activities to students and the students were keen to test out new apps and programs (T5-2). “It makes sense to them to use a range of tools that best do the job they want” (T1-2). Having a sufficient number of devices available has improved time efficiencies in the classroom:

> I now have enough computers and iPads to run a class of 30 students at the same time - what a time-saver. I can now run a class project all together without having to split the class into groups and rotating them around available computers. (T5-2)

Barriers

The perceived barriers from the highest to the lowest number of mentions by respondents were: infrastructure and connectivity (6), software and music programs (5), technical knowledge and maintenance (5), time (2), and student attitudes (2).

- T4-2 said students needed much more time with Sibelius and Garageband than what was available, but budget and resource constraints kept the teacher from providing them with more accessibility
- T6-2 commented about getting students to have a better understanding of the music programs
- T2-2 struggled with an unreliable internet connection and the students’ negative attitude towards ICT
- T11-2 reported to have limited access to computers in other parts of the school
- T1-2 wished for equitable access to broadband internet across the school and to have access to a reasonable level of technical expertise to assist the students in a range of ICT tools
- T3-2 identified getting equipment to work properly and the maintenance as the biggest barrier to using ICT regularly

- E1-2 listed the fear of technology not working, having equipment that is not built to specification for music software, portability of files, connectivity, and lack of time to learn the new technology as the most common barriers
- T7-2 was frustrated by network problems (luckily not a frequent occurrence) and guest login to the network for visiting tutors
- T5-2 identified software and hardware issues
- T9-2: cost issues
- T10-2 and E2-2 agreed on the frustrations created by an unreliable network
- T8-2 put students unwilling to take risks with the technology and their lack of understanding of basic program and systems operations as the biggest technology integration barrier

Class sizes

Most teachers identified the number of available computers rather than the class sizes they had to deal with as frustrating which implies that the shortage of devices was no longer such a pressing issue or a hindering factor in the delivery of their teaching programmes.

Classroom setup

When teachers named the types of technology they used in the classroom they often included a reference to sound equipment. In order to get a sense of what technology students could access, the table below separates the ICTs from the sound equipment. Only the respondents with specific comments are listed in Table 19.

Table 19: *Types of technologies used in the music classroom (second data set)*

Respondent	**Sound technology**	**ICTs**
T2-2	Full recording studio	A 21st-century learning hub
T3-2	A stand-alone PCV with MBox and associated software	● 17 personal computers running Sibelius 6 and Mixcraft ● Data projector ● 16 computers attached to keyboards for compositional purposes
T4-2	No reference to sound equipment	Sibelius and Garageband
T5-2	● electronic keyboards ● guitar processors ● guitar amps run by software ● jamhubs ● sound systems ● sound compressors, EQs and delays	● iPods ● iPads ● Wireless connectivity
T6-2	● stereo ● speakers ● electric equipment	Computers
T7-2	No reference to sound equipment	● A network of 22 Apple Mac computers running iTunes, Safari, Garageband, Auralia, Sibelius, Band-in-a-Box, Office, Web Metronome and Logic. ● teacher uses iPhone with a range of specific music apps such as Garageband, Guitar Toolkit, Remote, School of Rock, Pianofly and iReal b ● teacher's laptop is connected to a projector ● wifi network for internet access, file sharing and AirTunes
T8-2	Sound equipment for listening and recording	● Smartboard ● Sibelius ● Youtube ● Internet services for downloading music

T9-2	• recording studios with 18-track capability • high-quality equipment for playback of recordings • six studios for audio manipulation, editing and mixing/producing	• composition room with 31 computers • one classroom with handheld devices for aural, theoretical and musical knowledge/ research work
T10-2	• PA systems • Analog and digital processors	• MIDI keyboards • MIDI guitar • Apple Mac computers with bundled software • iPad • iPod touch • mobile phones
T11-2	• band's PA system • classroom PA system • keyboards	• data projector • set of computers with Sibelius 7
E2-2	No reference to sound equipment	• 14 computers with internet access and specialist music software • keyboard lab with teacher console • CD player and iPod

Composing

Students found it exciting to use Sibelius and Garageband for composing and found the possibilities offered by the notation software empowering:

> Music technology enables students to transcend their limited knowledge and experiences. E.g. Sibelius enable students to experience what it is like to compose for a full orchestra which is something they would not be able to experience in real life. Garage Band also enables students who have limited music literacy skills to utilise their aural skills to create music beyond their capacity to notate. (T1-2)

T1-2 facilitated collaborative compositions between distance students who had never met face to face. The students received continuous personalised feedback and feedforward as they submitted drafts of their work to the teacher. The students enjoyed using the software for composing and music arranging tasks (T3-2), especially when they were able to "hear the results of their labour". The upshot of this was that "students achieved highly at NCEA level using the software" (T4-2). The composition tasks that T5-2 set for the Year 9 and 10 students required fairly sophisticated music production skills to complete a track. T8-2 had a student who composed a film score in Sibelius. The junior students in T9-2's department were all required to create a soundtrack in Sibelius. They showcased the talented students' work by playing "some of these clips in assemblies and prize-givings at the end of the year" (T9-2).

Creativity

Nine of the respondents identified composing as the most creative component that could incorporate ICT.

Delivery format

E2-2 used PowerPoint presentations in units of teaching and learning. T1-2 had to provide specific support to distance education students about presenting their work in appropriate file formats for easy access and printing of scores. This teacher also had to focus on "a more flexible method of learning delivery customised to students' learning needs" other than print-based resources, following a blended approach with online and printed resources. Anecdotally this has led to more enrolments and better engagement for the online students in this course. In order to be more flexible around delivering resources to students, this teacher has also developed resources in digital booklet format to assist students in their music literacy skills regarding reading notation.

Disadvantages

T5-2 noted that students were easily frustrated when the technologies did not work as intended and that they would quickly revert to a non-digital alternative as required, for example, "if the guitar on the iPad does not play as intended, they pick up an acoustic guitar". E2-2 found it a disadvantage to be reliant on the internet and the school network because "when the server is down, students cannot access their work".

Frequency of use

T7-2 reported that s/he didn't use Sibelius as frequently as Garageband which resulted in often having to learn and relearn the same things, pointing to a lack of self-efficacy. Their programme focused more on the use of GarageBand which was the software of choice for the students. T3-2 commented on how often s/he used YouTube examples which implied that they had fast enough internet speed to stream video to a class of students.

Integration

Some deliberate acts of integration were mentioned by the teachers. However, T3-2 pointed out that in their Music classroom they do certain activities away from the computer such as theory and aural training because the computer can distract students from developing a range of skills. This teacher liked to keep the approaches to learning varied with a mix of computer and paper-based activities. E2-2 conducted a survey with students, and in the feedback, students stated that they enjoyed "the mix of activities which included more traditional teaching approaches to the possibilities offered by computers, keyboard lab and using their own instruments" as well as the interactive whiteboard. T1-2 taught in an online environment where students were already making use of technology as a starting point to access the course content. Work was either uploaded as a digital file on the learning management system (LMS) or e-mailed between the student and teacher. This teacher shared that it made sense to the students "to use a range of tools that best do the job they want - sometimes it may be paper-based and other times ICT-based". T7-2 described a well-integrated classroom environment with a network of 22 Apple Mac computers running music software. They used an iPhone with a range of specific music applications to address specific learning needs. The teacher's laptop was connected to a data projector that was used throughout the day. They accessed the internet, shared files and used AirTunes on a wireless network servicing the whole music department.

Internet

Nine of the respondents stated that they had access to the internet in the music departments they work in and seven respondents acknowledged that they regularly use YouTube to find relevant musical examples (T3-2). E2-2 posted performance videos on the school's YouTube channel so parents could watch their children's performances and T7-2 uploaded the students' performance videos on YouTube for assessment and moderation purposes with other teachers. T5-2 made use of tutorial videos on YouTube to assist the students when they wanted to learn new software skills. T1-2 referred the students to TED-Ed (ted.ed.com) to access online lessons and videos. T8-2 downloaded music scores and recordings of music in the public domain from the Petrucci Music Library (imslp.org) for analysis and score reading purposes.

Notation

Teachers only mentioned notation in relation to software programs such as Sibelius. No reference is made to teaching notation on manuscript paper, suggesting that there was also less emphasis on teaching notation skills in isolation. Students were still required to transcribe music examples in external exams without access to computers or notation software. The Achievement Standards that test aural skills and harmonic procedures are paper-based to this day and require students to notate their answers by hand.

Online platforms (new node)

Some teachers shared interesting ways of how their students were collaborating online and how the teachers were mentoring their students in these spaces. Although E2-2 was not yet using Moodle as a teaching platform (Moodle is a free and open-source software learning-management system), s/he had aspirations to attempt this in the near future. T1-2 and T2-2 mentioned students making blogs to share their learning and to host their compositions. T10-2 used FirstClass (an online collaboration suite) to post resources for students so they could access these from home. T2-2 listed online virtual groups and e-portfolios as another way that students shared their learning online. T5-2 created a Facebook page for the Year 13 Music Technology class. "In this forum, they can ask me relevant questions and receive timely advice and direction particularly on the weekend when they may be recording at home".

Other hardware/Sound equipment

E2-2 supported teachers with the use and installation of hardware such as MIDI interfaces and piano keyboards. T1-2 used USB keyboard controllers. Both T11-2 and T1-2 made use of digital video recorders and digital cameras in their music department. T10-2 listed MIDI keyboards, a MIDI guitar, PA systems and analogue and digital processors. T5-2 trained his students to use hardware and MIDI instruments to record and produce songs.

Performance

The NCEA Achievement Standards that assess solo and group performance skills require performances to be recorded as evidence towards achieving the standard and it is a requirement for moderation purposes. All music departments do this but in a wide variety of ways. E2-2 used a Flip recorder (hand-held video camera) to record public performances and then made these recordings available to students and parents via the school's YouTube channel. At T7-2's schools, students were posting videos of their performances on Facebook and YouTube for assessment. They also recorded and uploaded performances of their compositions. T10-2's students would often broadcast their live performances on the school's radio channel, and T11-2 mentioned that their groups performed using sophisticated sound equipment and technologies. This teacher also interpreted entertainment skills in the context of performance skills. Students gained confidence through their performances to comply with the academic part of the programme by gaining literacy and numeracy skills required to read and write music.

Another teacher (T9-2) agreed that students brought all the skills they acquired during their leisure time to inform their compositions, performances and to produce audio tracks in the recording studio.

T4-2 encouraged students to produce their own CDs and music videos based on their compositions and performances. In addition to this, T8-2 encourage students to make videos of their performances for personal reflection purposes. This relates to the sharing experiences and reflecting on the process in critical pedagogy (Abrahams, Jenkins & Schmidt, 2002).

Students at T5-2's school had to improvise a plan when their band was suddenly short of a drummer just before a national band performance competition, RockQuest:

> They constructed the drummer's part using a MIDI drum software program. They practised with the recorded part and even got permission to use it during the competition. The re-constructed drum part was complex and sounded very close to the original. (T5-2)

Recording

Respondents mentioned that they used digital software programs to create audio and video recordings. E1-2 provided in-depth support to schools with the digital audio workstation, Pro Tools. Admittedly, the level of support was not yet the same as for Sibelius, but it was this expert's goal to improve her/his skills and knowledge of the software. T2-2 managed a full recording studio using Pro Tools.

T9-2 also had a fully functional recording studio which students used for recording compositions, live performances and sound production. Students could do additional Unit Standards in digital music, recording and live sound production at this school. The studio had the equipment to record 18 individual tracks simultaneously. They also had high quality equipment for playback and listening.

T8-2 held the view that recording technologies are a critical component of 21st- century music teaching. Only T10-2 did not make specific mention of the recording component of his/her Music programme. Capturing video and audio recordings was very important in the distance education environment (T1-2) where students connected with their teachers in an online environment or through e-mailed files. Students that enrolled for these online Music courses had to comply by using specific file formats approved by NZQA so that their work could be accessed by the teachers for assessment and feedback. This process has led to some frustrations and necessitated troubleshooting, but the shared learning management system has simplified the sharing and access process.

T3-2 had a designated recording space and recording equipment such as microphones on the wish list his/her music department. T11-2 also wanted to improve the sound recording capability on four dedicated computers and T4-2 admitted that recording software challenged his/her current skills set.

T5-2 offered a Music Technology course for students in Year 13 which included recording and live sound production modules. Students were required to use digital software and hardware and MIDI instruments to record and produce songs. Some of the students could produce quite sophisticated sound mixes. In T7-2's department, students recorded performances of their finished compositions. Students were allowed to use mobile phones to make these recordings and take photos of explanations on the whiteboard for their own study notes. T8-2 has introduced his/her department to technologies for recording performances with the appropriate sound equipment, but their wish list included a dedicated studio space for this purpose.

Research

Computers with internet access provided students with the opportunity to undertake research online. A few factors influenced the quality of this type of research, for instance: students' search skills and digital literacy - "the ability to discern between quality websites and rubbish" (E2-2); internet connection speed; firewall settings determining which sites were accessible or blocked; and access to devices in the music department. T1-2 had a research background and regularly undertook “online research to find solutions for student ICT needs, especially those [solutions] that are free or inexpensive.” T11-2 pointed out that having “time to research new technologies and getting feedback and advice from those who have already done it” was critical when introducing new technologies.

T11-2 encouraged internet searches in the Music classroom. T4-2 remarked that “research and key competency skills are highly transferable, as are problem solving and persistence”, all which could be acquired through activities that students engage in during their leisure time. In addition to the above, students also “gained searching skills when they searched for music using their mobile technologies” (T8-2).

T5-2 stated that the students were “trained in gathering information for various research activities” in their Music programme and T8-2 agreed that students’ “ability to search comprehensively on the web” was one of their best technology skills. T9-2 commented that the technology’s “easy/instant research capability is amazing”. This music department reserved one classroom with handheld devices for students to participate in a range of activities including aural training, music theory, and research.

Software

Teachers did not name but rather identified software by purpose or functionality in the second survey. These included aural and theory training software (E1-2 and E2-2); composing, notation and music production software (T1-2 and T5-2); collaborative software, Apple bundled software and presentation software (T10-2); recording software (T3-2, T4-2); MIDI drum software (T5-2); specialist music software (T8-2); and dedicated music software (T10-2). The software programs that received specific mention were: Band-in-a-box, Finale, iMovie, PowerPoint, Keynote, Quicktime, and Groovy Music. An amended list of software is provided in Table 20 which contains some additions to the previous list given in Table 11 in Chapter 4. The table also contains anecdotal evidence of how teachers used these software programs in their classrooms.

Teachers' impressions of students were that they were very skilled with most software and, if not, they could become proficient in a short amount of time. Students also loved to hear their creations come alive through the software and this motivated them to gain the skills required to work the software.

Table 20: *List of software programs used in music departments (second data set)*

Software program	**Purpose and application**	**Anecdotal evidence**
Garageband	Garageband is a sound mixing application and supports users' creating their own customised tracks	• "we use dedicated music software such as Garageband" (T10-2) • "my teaching role is to support students using Garageband" (T2-2) • "students need much more time with Garageband" (T4-2) • "my role with Year 9 and 10 students is to provide opportunity and training in music production software, primarily Apple Garageband" (T5-2) • "I am more comfortable using Garageband [than Sibelius]"; "I use an iPhone with a range of specific music apps such as Garageband"; "Our level of literacy is related to Garageband"; "We have a network of 22 Apple Macs running Garageband" (T7-2)
Auralia	Auralia is a comprehensive, interactive ear-training package	• "I support teachers using Auralia" (E1-2) • "I help staff and students to use the software - Auralia" (T2-2) • "We have a network of 22 Apple Macs running Auralia" (T7-2) • "My short-term goal is to gain aural training software such as Auralia" (T8-2)
Musition	Musition is a comprehensive music theory and fundamentals package for music students of all ages and abilities	• "I support teachers using Musition" (E1-2)

Sibelius	Sibelius is a software program for learning and teaching music notation, composition, and music theory.	• "students are excited by composition and possibilities offered by Sibelius" (E2-2) • "show teachers how to use Sibelius"; "occasionally I will do a lesson in Sibelius with a class of students"; "making Sibelius work"; "my short-term goal is to master Pro Tools, so I can apply the same Sibelius skills I have to Pro Tools" (E1-2) • "I have huge knowledge and confidence with Sibelius and taught Year 9 and 10 classes. Students are excited by composition and the possibilities offered by Sibelius" (E2-2) • "we use dedicated music software - Sibelius" (T10-2) • "supporting students in using Sibelius for composing, arranging and instrumentation" (T11-2) • "helping them [the students] use the software - Sibelius" (T2-2) • "providing class-wide guidance by displaying a Sibelius score on the data projector and showing the class how to edit it"; "in our music department we have 17 PCs running Sibelius" (T3-2) • "students are very skilled with most forms of software but need much more time with Sibelius"; Sibelius enables students to experience what it is like to compose for a full orchestra which is something they would not be able to experience in real life" (T4-2) • "We have a network of 22 Apple Macs running Sibelius"; "I still don't have particularly strong Sibelius skills, so I need to relearn the same things often" (T7-2) • "Sibelius is the most important program we use to help students notate their compositions"; "if students have their own laptops with Sibelius I encourage them to bring these to help free up our own computers" (T8-2) • "All our junior students create a video composition. We load the video clip into Sibelius and students compose as the clip plays" (T9-2)

Pro Tools	Pro Tools is a digital audio workstation	• "my short-term goal is to master Pro Tools" (E1-2) • "we have a full recording studio using Pro Tools" (T2-2)
iTunes	iTunes is a media player, media library, online radio broadcaster, and mobile device management application developed by Apple Inc.	• "students used iTunes to search for and listen to music available in the iTunes Store"; "When appropriate, I [the teacher] downloaded specific tracks for classroom use" (T7-2)
Logic Pro	Logic Pro is a digital audio workstation and MIDI sequencer software application for the Apple Mac OS X platform.	• Two teachers listed using this software program in their departments (T7-2 and T10-2)
Sonar	A digital audio workstation created by Cakewalk.	• This software was used only by T10-2
SoundForge	A digital audio editing suite by Sony Creative Software.	• This software was used only by T10-2
MuseScore	Free composition and notation software. It has a feature set comparable to Finale and Sibelius, supporting a wide variety of file formats and input methods.	• This software was used only by T10-2
Mixcraft	It is a complete recording studio, featuring unlimited MIDI and audio tracks, dozens of virtual instruments and effects, video editing, mixing and mastering, an easy-to-navigate streamlined interface, and over 7000 loops, sound effects, and drum samples.	• "we have 17 PCs running Mixcraft sequencing (T3-2)

Teaching programmes

This node focused on the way teachers delivered their teaching programmes and what constituted the average music course.

E1-2's main role was to support other music teachers through email, phone and by working alongside teachers in their classrooms and music departments. This support sometimes included a Sibelius lesson with students and their teacher.

E2-2 was teaching at the time of the second survey, so s/he could describe what was on offer at the school s/he was working at. This respondent taught Year 9 and 10 classes. The music programme included Sibelius training, online theory training on www.musictheory.net, and allowed students access to YouTube and the internet, access to a keyboard laboratory and practical tuition on a musical instrument of the student's choice.

T1-2 taught in an online teaching environment and utilised specific technology to enable ICT-based Music activities. These included the following:

- internet searches in a variety of browsers chosen by the students
- e-mail communication
- using online learning/teaching sites like TED-Ed (ed.ted.com) and uploading to online applications like blogs and YouTube
- tasks that required students to have a variety of technology skills to operate music production software, notation software, USB keyboard controller, digital video and still cameras, mobile devices such as iPad and iPhone, Web2.0 tools such as screen capture and screencast tools and MP3 microphones.

The nature of the distance education courses necessitated the use of technology as a starting point. Students were encouraged to share their work through a variety of file formats as an e-mail attachment or through uploading files to the learning management system (Desire2Learn).

T2-2's classroom was designed as a 21st-century learning hub. This meant that most of the learning was supported by technology and a wide range of software. The facility had a full recording studio, an Apple TV and student access to iPods. Students shared their work through online portfolios, and they collaborated in online groups and blogs.

T3-2 emphasised that s/he preferred to have a blended approach with a variety of activities, some using technology and others not (aural skills and music theory). This teacher found that technology distracted students from developing the required range of skills. Students had access to 17 PCs with Sibelius and Mixcraft for composing and sequencing. There was also a mixing desk with an MBox audio interface for mixing and recording audio tracks. Another 16 computers had music keyboards attached for composing activities.

T4-2 had no handheld devices in the classroom. Students worked mainly in Sibelius and Garageband to create compositions. The Year 9 and 10 classes were provided with opportunities to be trained in using Garageband by composing a piece, doing the sound editing and production, and then finalising the track as a completed product. The students collaborated in Google documents for various research activities, which implied that they had already moved into a blended learning environment.

T5-2 wanted to be more accessible to his/her Year 13 class of Music Technology students and created a Facebook page for the class to ask questions and receive timely advice in an asynchronous way. They focused on recording skills and live sound production in this forum. Students were trained to use digital software and hardware and MIDI instruments to record and produce their songs. They had access to iPods, iPads, a wireless network, electronic keyboards, guitar processors, guitar amps running on software, sound compressors, equalisers and delays.

T6-2 used some mobile devices in their programme such as an iPod and mobile phones. The students could access YouTube and watch clips in class on a data projector. Students were allowed to bring their own devices for listening and analysing purposes.

T7-2 stated that it had become a rarity to teach ICT skills on their own and things technology-related “were mostly incorporated into a task from the programme". This music department had a network of 22 Apple Mac computers running iTunes, Safari, Garageband, Auralia, Sibelius, Band-on-a-Box, Office as well as other software such as Web Metronome and Logic. They accessed the internet, AirTunes and shared files through a wireless network. The teacher also used his/her iPhone with a range of specific music apps such as Garageband, Guitar Toolkit, Remote, School of Rock, Pianofly and iReal♭.

T8-2 used an interactive whiteboard to display Sibelius files YouTube videos. Students could access the Petrucci Music Library to download music scores for free.

T9-2 described how the junior students created a soundtrack by uploading a video clip into Sibelius and then composed music to suit the video. This activity became so popular that senior students adopted it as part of their composition tasks. The students had access to a composition room with 31 computers and a recording studio with 18 simultaneous track capability and high-quality equipment for recording and playback purposes.

T10-2 used the collaborative software FirstClass to post resources which his/her students could access online outside of class time. S/he had made mobile devices optional although this had to be arranged as an exception to the school-wide policy which prohibited the use of mobile devices at this school. The department was equipped with MIDI keyboards, a MIDI guitar, analog and digital processors, Apple software, an iPad, and an iPod. Students could bring and use their own mobile devices.

T11-2 ensured that the students could take care of and maintain the technologies available in their music department. They had a suite of computers running Sibelius 7 as well as the usual sound systems for the classroom and for bands, a data projector, music keyboards and access to emails and the internet.

Skills and knowledge

Figure 14. A word cloud presentation of teachers' and students' technology skills and knowledge.

Keywords featuring in this word cloud are students, software, technology, ICT, and music (Figure 14).

This focus area described the ICT skills and knowledge of the industry experts, teachers and students and revealed some of their attitudes and perceptions towards ICT. Table 21 gives a breakdown of the nodes.

Table 21: *Skills and knowledge focus area (second data set)*

Category	Parent Node	Child Node	Description
Skills and knowledge			Teacher and student skills, beliefs and knowledge around ICTs
	1.Technology skills of industry experts		Skills specific to industry experts
	2. Technology skills of students		
	2a→	Competency levels	Natural ability of students with ICT
	2b→	Innovative use	ICT application going above and beyond the expected
	2c→	Students' perceptions	The way students perceive technology from a teacher's perspective
	2d→	Transferrable skills	ICT skills used for leisure activities to be applied for learning
	3. Technology skills of teachers		
	3a→	Competency levels	Natural ability of teachers with ICT
	3b→	Beliefs	Professional and pedagogical beliefs regarding the use of ICT in education
	3c→	Technology needs	Specific training needs of teachers

Technology skills of industry experts

Technology expert E1-2 claimed to be good at bridging the gap between the teacher and the technology. His/her own technology skills included content knowledge about Pro Tools, hardware such as keyboards and other interfaces, and software programs for notation, aural training and theory skills. This expert provided just-in time support when clients required this.

Technology expert E2-2 had self-taught Sibelius skills and a solid knowledge base which made for reliable teacher support. This expert listed word processing and document editing as useful skills as well as “the ability to discern between quality websites and rubbish”.

Technology skills of students

Students’ technology skills were mostly described in terms of their skill levels, comfort levels and general approaches towards technology in the classroom. Teachers mostly reported that students’ technology skills were advanced, very good or superior to the teachers’ own skills.

Competency levels of students

E1-2 described students’ interactions with technology on a wide continuum: “some students are very skilled, but others are not.” Students are, however, good at adapting to new technologies (E1-2). T1-2 agreed that students had a wide range of experience with ICT and that they were largely intuitive users. T10-2 mentioned that their technology skills were more centred around “the newer mobile technologies” related to apps on Android and Apple, resulting also in “transferrable skills which makes the learning of dedicated technologies in Music easier.” Students generally don’t like to show off their technology skills but prefer to have some pre-warning for sharing something in class. Other skills mentioned were general ICT skills such as using a mouse, basic word processing and typing skills in Microsoft Word and online searching skills (T2-2). T4-2 stated that students only needed the opportunity to try out the software to become proficient with most of the functionality in a short amount of time. T5-2 described a range of skills amongst his/her students:

> at the senior level, some students are able to perform only fundamental and rudimentary tasks, while others I can leave to do a complete drum and bass mic setup and recording session including mixing down the tracks. I would class 25% as very proficient, 50% as knowledgeable and 25% as having fundamental skills.

These proficiency levels included skills for sharing files, communicating via social networks and an ability to “figure out new software and programs” (T5-2). T7-2 listed basic ICT skills such as file saving and retrieving, internet use, and using the Microsoft Office suite. Interestingly, T8-2 reckoned that the students’ word processing skills were terrible. This teacher did agree that students were curious about finding things out for themselves and that they had the skills to do comprehensive searches on the internet. It was also acknowledged that students were now able to create sound and visual effects using ICT. T9-2 agreed that students had the intuitive ability to work out a lot for themselves around the technologies.

Innovative use

Many teachers cited that student were innovative in their use of ICT. Statements that supported this thinking were:

- “I have a student who created a film composition. This would not have been easy without the software being able to superimpose the visual over the top of the score. This enabled her to compose in real-time to the score” (T8-2).
- “All our junior students create a video composition. We load the clip into Sibelius, and the students compose as their clip plays. We play some of these clips in assemblies and prize-givings at the end of the year” (T9-2).
- “Collaborative NCEA composition between distance students who have never met face to face” (T1-2).

Other examples of creative and innovative use of technology were for band performances, where one group constructed a drummer’s part using MIDI software for practicing purposes (T5-2). Sharing digital portfolios, blogging, participating in online virtual groups and using notation software for instrumentation and arranging were also listed, although the details of exactly what the innovations comprised of were not stated.

Student perceptions

Interviewing students fell outside the scope of this research, but teachers were asked how they thought students perceived and interacted with the technologies. Mostly, teachers agreed that students preferred to use some technology in the Music programmes. Students enjoyed having choices between a range of activities, some with high technology involvement and others completely stripped of any computer technology. It also became apparent that students perceived technology to be a natural part of the learning environment and did not necessarily see it as something new and exciting, to the extent of "taking it for granted" (E2-2). It offered alternative ways of working which, therefore "gave them options as to how they develop their work" (E2-2). T8-2 commented that "they have it at home. School should be an environment that either matches their resources at home or improves it."

Transferrable skills

Teachers were asked if they thought that entertainment skills transferred to the academic realm and how they utilised this in their music programmes. Entertainment skills referred to informal skills students attained outside the classroom during leisure activities when they interacted with technology. They responded positively about the impact of informal or transferrable skills that students brought to the classroom. T1-2 made extensive use of the students' informal music learning and used it as the starting point for nearly all teaching and learning. Familiarity with other software and technologies made the learning of dedicated music technologies easier for them. Gaming developed certain digital literacies such as communication, critical thinking and creativity in students which made them comfortable around technology. T5-2 thought that the skills that students acquired when producing music both inside and outside the classroom benefitted their progress and development within the Music programme. T6-2 agreed that transferrable skills meant that students already had a good technical understanding of the technology and T7-2 remarked that students' familiarity with iTunes, YouTube and social media were all useful classroom skills. T8-2 noted that students gained skills when they searched for music to listen to on their mobile devices and that this improved their efficiency using the devices at school. T9-2 acknowledged that students brought these skills to their compositions, performances, how they produced audio in the recording studio, and how they used the songs they knew to analyse.

Technology skills of teachers

Competency Levels

Teachers' competency levels regarding technology use could be grouped into two categories: general approaches and specific ICT skills (see Table 22).

Table 22: *Teachers' general approaches and specific ICT skills*

General ICT knowledge	Specific ICT skills
"Finding ways around ICT problems and being able to implement workarounds" (T1-2)	Networking infrastructure (T10-2)
"Patience to persevere and have a 'can do' attitude" (T1-2)	Hardware optimisation (T10-2)
"I love things ICT and especially enjoy working with students in this area" (T1-2)	Presentation devices and software (T10-2); creating presentations (T8-2)
"Using a wide range of software and troubleshooting" (T2-2)	Multiple platforms (Windows, Apple Linux) (T10-2)
"I consider it the weakest part aspect of my teaching" (T3-2)	Dedicated music software such as Garageband, Logic, Sonar, ProTools, Soundforge, Sibelius and MuseScore (T10-2); operating specialist Music software such as Garageband and Sibelius (T7-2)
"Trialing and introducing new software and apps into the classroom" (T5-2)	Reasonably proficient with Garageband, Sibelius and the usual computer applications (T4-2)
"I have always been a Mac geek and have in-depth knowledge of the Mac operating system" (T7-2)	Running recording and public-address systems (T5-2)
"I can find information and/or recorded music (video or audio) easily whilst teaching a class" (T7-2)	Using music and desktop software for producing resources (T5-2)
"I still don't have particularly strong Sibelius skills, so I need to relearn the same things often" (T7-2)	Managing a pod of computers and iPods (T5-2)
	Video production (T5-2); editing videos (T7-2)
	Basic computer skills (T6-2); word processing (T8-2);

	Administrator for the department machines (T7-2)
	Programming (T8-2)
	Website creation (T8-2)

Teacher beliefs

Teachers were not questioned specifically about their beliefs around technology use in teaching and learning, but their comments implied some ingrained ideas and opinions that influenced their decisions about technology integration.

“Technology enables students to think lateral [sic], not lineal, and to explore and experiment rather than read the manual” (T1-2). T10-2 acknowledged that students enjoyed using technology, “especially if it is part of a raft of choices” (T10-2), and “as long as it is the best tool for the job” (T11-2). “It is sometimes nice to communicate without a computer in front of you” (T2-2), “but my students expect technology as it is the way I have always operated” (T3-2). T8-2 believed that it was important to ensure that students had a good understanding of how to use the technology well, as this helped them with the creative process, especially making it more efficient. This teacher felt that the Ministry of Education could do more to provide better technologies for classrooms. T9-2 noted that ICT had opened up a new range of exciting tasks like video and audio capturing and editing.

Technology needs

Teachers listed a range of needs around technology skills. These all implied some urgency for professional development or technical support. Here are the most prominent requests:

- sound mixing
- knowledge and skills to teach Music Technology Unit and Achievement Standards
- recording skills
- programming
- Flash and motion animation

Support

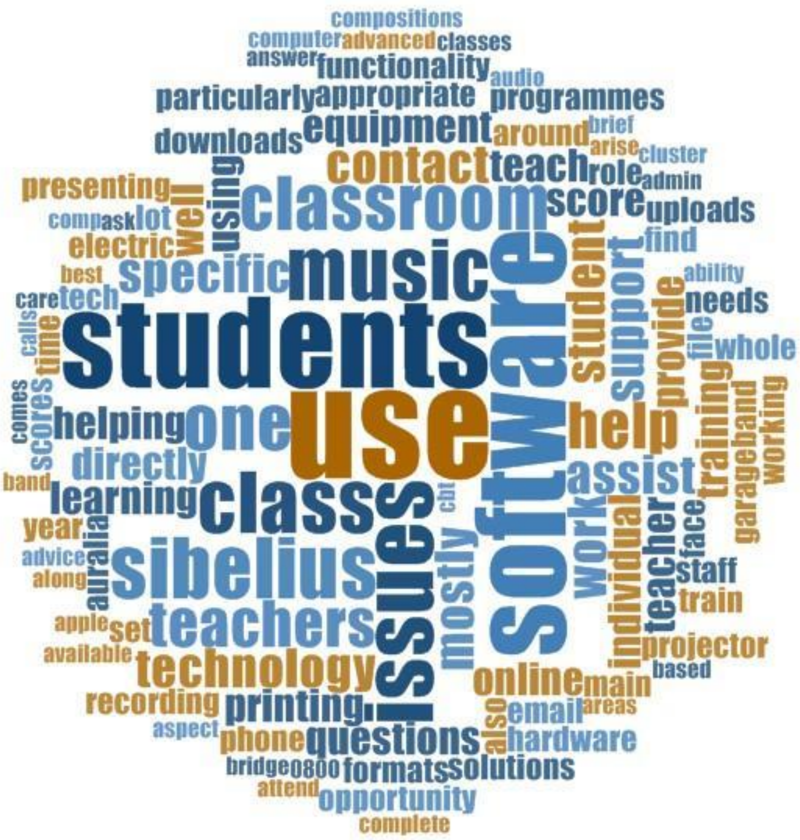

Figure 15. A word cloud presentation of the support students and teachers require.

Prominent in this word cloud (see Figure 15) are keywords such as students, music, software, issues, classroom, technology and help. Six parent nodes were identified. These are outlined in Table 23.

Table 23: *Support focus area (second data set)*

Category	Parent Node	Child Node	Description
Support			ICT support provided for and needed by teachers and students
	1. Industry support for students		Examples of support from the industry for students
	2. Industry support for teachers		Examples of support from the industry for teachers
	3. Online help		Online support for teachers
	4. Support role of teachers		How teachers are expected to support students with ICTs
	5. Professional development		Availability of PD opportunities
	6. Technical support		Availability of third-party technical support

Industry support for students

E1-2 described the level of support that s/he provided directly to students as sporadic. Teachers would sometimes ring the helpline of this expert's business and let a student talk to him/her directly, but other than that most of the support happened through emails. This expert would occasionally do a lesson in Sibelius with a class of students as part of a visit to a school.

Industry support for teachers

E1-2 supported teachers to use a variety of Music software programs such as Sibelius, Auralia, Musition and Pro Tools.

Online help

T5-2 found that access to YouTube training videos had many advantages: "virtually any software 'how-to' question can be answered with a search on YouTube - magic!" (T5-2). Another teacher (T10-2) who is also a qualified network engineer could provide the students with videos to help them with instructions and support as required.

Professional development for teachers

Only two teachers mentioned the need for time to learn new technology as a personal priority. They perceived recording, sound mixing, animation and programming as their weakest skills in need of development.

Support role of teacher

Teachers provided technical support to students in most schools. This ranged from simple just-in-time support and troubleshooting to setting up a complete computer suite with networked computers. The type of support they provided depended on the skill levels and interests of the individual teachers. T1-2 provided support to students and teachers in a distance education setting by answering questions about specific functionality of software, file uploads and downloads, solutions around presenting work in appropriate formats, and printing advice. T2-2 had a joint role as e-learning coordinator and therefore had responsibilities for training staff and students across the school. Within the music department, the focus for support was on software assistance with Sibelius, MuseScore, Auralia and Garageband, access to online music sites, hardware problems and printing issues. T8-2 was required to assist students in notating their compositions and to teach them useful software tricks and shortcuts in Sibelius.

T10-2 timetabled sessions with students to provide one-on-one student support at novice and advanced levels as required. This teacher ensured that students were acquainted with specific software if it was required to complete a task. Training material was designed if none was available online. T3-2 also made time for individual support to students and helped out in general if there was a need. T7-2 provided one-on-one support to students by assisting them at their workstations. Students all had individual skills and knowledge, so T9-2 chose brief interviews and tailored his/her support to their needs.

T11-2 put a premium on training students in the care and maintenance of technology used in the classroom. In bigger departments, the teacher in charge often provided training for the rest of the music staff (T2-2). In contrast to multi-teacher departments, the sole practitioner department heads were responsible for all student training related to music software, like T4-2.

Virtual support was provided to the Year 13 Music Technology class of T5-2. He/she created a Facebook page for this class to pose questions and receive advice when face-to-face contact with the teacher was not possible. This teacher also trained the Year 9 and 10 students to use Garageband.

Technical support

Only one teacher had access to a dedicated external technician who was tasked with the maintenance and care of all hardware and software in his/her department (T5-2).

Ways forward

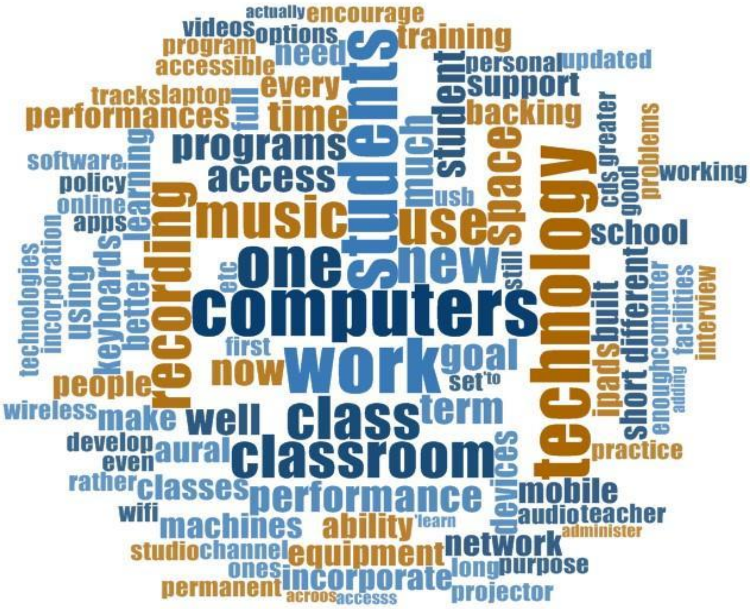

Figure 16. A word cloud depicting the most prominent keywords in the *Ways forward* focus area.

The most prominent keywords presented as technology, work, computers, classroom, students, recording, new and space (Figure 16).

In this node, there were three identified areas to describe the ways in which teachers would like to progress on their technology journeys (Table 24).

Table 24: *Ways forward focus area (second data set)*

Category	Parent Node	Child Node	Description
Ways forward			How teachers would like to progress on their technology journeys
	1. Goals		Specific, attainable targets and goals set by teachers regarding the use of ICTs
	2. Vision		Plans and aspirations for the future
	3. Wish list		Immediate needs for improvement of ICT capability and use

Goals

Goals described specific, short-term, attainable targets set by the teachers regarding their use of ICT.

In T1-2’s ideal music programme students would prioritise the use of production and/or notation apps to present their work. The use of technology in learning would also be the norm rather than the exception(T1-2). T10-2 would advocate for the introduction of mobile devices as a priority in the music department, even though it was going against the school policy. This teacher wanted administration rights on the local Music computers in order to provide more effective support when issues arose. Part of this support would be the creation of a subnetwork so mobile technologies could be used more effectively in class.

T5-2’s short term goal was to prepare the junior classes for using the technology when they became seniors and their time for learning new programs was limited. T6-2 wanted to slowly incorporate different technologies into the classroom as the budget allowed and was determined to learn to use them well. Lastly, T8-2 was in the fortunate position to have a brand-new Music block, and the goal here was to maintain these facilities for years to come.

Vision

Vision referred to some aspirational thinking and planning for the future.

T4-2’s vision for his/her music department would incorporate live playing, recording and the integrated use of music software. S/he would encourage students to perform and produce their own CDs and music videos based on their compositions and performances (T4-2).

T10-2 saw the future of his/her music department in a hybrid model of analogue and digital media that catered for varied experiences amongst learners. Opportunities for expanding from novice to technologically literate would be built into the programme. This teacher would also encourage awareness and technology integration in new and innovative ways.

T11-2 had the vision of changing all the computers to Apple Mac computers but s/he was realistic about the reality of cost implications and school policy blurring this prospect. T6-2 wanted to integrate different kinds of technology to make it “stimulating and fun” for students. S/he endeavoured to incorporate the different learning styles of students including audio, visual and kinesthetic.

Wish list

The *Wish list* focus area summarised teachers’ immediate needs for improving their ICT capability and frequency of use (see Table 25).

Table 25: *Teachers’ wish list*

Teacher	Item
T1-2	• an online site which students access periodically for ideas and sharing • a totally personal channel of communication with a teacher/mentor
T2-2	• reliable internet access • backup computers for unreliable ones • more time for training staff.
T3-2	• much more technical support • to develop better recording skills • designated recording space • better recording equipment, e.g. condenser microphones and noise-cancelling headphones • getting the new computers to work well with the older keyboards and sorting out the latency problems
T4-2	No response
T5-2	• the ability to have practice jam hubs and electronic drums so several bands could practice in the same space. • a class set of both iPads and desktops to take advantage of the unique capabilities of both devices. • a class-specific mobile network to push out notices and event information. • the ability to design new music apps and software programs to develop students’ learning. • diagnostic tools which could give me real-time data on students’ progress. This would help identify areas and skills which the students need to work on.
T6-2	• a new score-reading program that isn't so hard for students to operate.

	• better, updated performance gear. • more training in computer technology. • updated computers • an interactive whiteboard
T7-2	• much the same as it is now though the physical space would be more spacious with technology pods at every desk rather than isolated at the back of the room • a class set of fully networked iPads complete with Bluetooth keyboards would be wonderful
T8-2	• a full pod of computers enough for an entire class • a purpose-built recording studio. • students would have most of their written content delivered online, and all work would be done through the cloud to allow for better feedback. • increased computer:student ratio • access to personal videos of performances for reflection • to purchase aural training software such as Auralia
T9-2	• one classroom full of ICT equipment for compositions • 5-6 studios for editing, mixing and sound production activities • One classroom with handheld devices for aural, theoretical and musical knowledge/research work.
T10-2	• accessible labs for composition, presentation, and performance equipped with rich resources • a foundational sustainable network infrastructure to support technology and its options.
T11-2	• adding USB Keyboards
E2-2	• install aural/ theory programs on classroom computers • iPad for the performance teacher, so she has scores, backing tracks etc. downloaded and accessible when teaching • greater access to minus one backing tracks and backing CDs for performance • using the Flip recorder to record public performances and make them available to students and parents via our YouTube channel. • wi-fi laptop access for each student • use of Moodle or similar to deliver teaching • reliability and consistency of computer programs across the school

Summary

This chapter gave an overview of the data gathered for the second data set. Although the coding matrix did not change significantly, the content showed a shift in practice and priorities in comparison to the first data set. Access and connectivity issues were no longer a problem and teachers were more welcoming of technology as part of their teaching regime.

In chapter six the two datasets are analysed, each as a separate set. This is followed by a comparative analysis of the most prominent themes from the two datasets. This comparison is then used to create a thematic synthesis of the findings.

Chapter 6

"Learning is a process where knowledge is presented to us, then shaped through understanding, discussion and reflection."

Paulo Freire (1998)

In the data presented in chapters four and five, the developments and changes that have occurred between the two data collection events are highlighted. The most pressing question remains: Is technology accessed in music classrooms, and if so, how is this done? Why and how do teachers integrate technology into their teaching programmes?
This chapter will revisit the first and second datasets and draw a comparison between the evidence provided.

Comparative analysis

In order to answer this question, the following comparative analysis compares the five categories described in Chapters 4 and 5:

- governance,
- inside the classroom,
- skills and knowledge,
- support, and
- ways forward.

Each category is analysed to identify themes as they emerge across both data sets. The comparison focuses on similarities, differences, advancements, and changes identified over the four-year period.

Governance - affording and managing the technology

Managing and purchasing technology costs money. It is not surprising that budget issues are prominent in both datasets. A shift has occurred in schools planning for and improving the acquisition and maintenance of music-specific hardware and software by allowing budget allocations to be made specifically for technology used in music departments. This shift has enabled more deliberate planning and procurement and has resulted in equipment that is appropriate to the needs of the students. Teachers in charge of music departments have gradually gained more autonomy to make decisions specific to their teaching area since 2008, and this has also acted as an incentive to utilise technology that is up to date for running current music software and hardware. For this reason, teacher responses in the second dataset no longer reported on inadequately configured and out-of-date computers.

The availability of devices and how they are accessed have been an important focus in both datasets. With the rapid increase of device capability over the last ten years, the types of devices allowed in music departments have increased between the two data-collection events. These devices have increased the choices for students and teachers. The ability to access the internet, utilise software programs and combine music-specific applications has opened up new possibilities for teaching and learning.

The teachers in the first dataset listed MP3 players, laptops, and to a lesser extent mobile phones, as the three types of devices students used most. Teachers used their school laptops for administration and to prepare lessons and presentations. In 2008, MP3 players and mobile phone use was strictly controlled by school policies that either prohibited or severely restricted student usage. Schools were not ready to allow students to bring their personal devices to school and in some cases, music teachers had to get special permission for students to use these devices only for music classes. In the first dataset, the only reference to mobile devices was about how school policies prevented mobile phones from being switched on in class, or how phones were confiscated if a student was caught using one.

Mobile technology and tablet devices have developed significantly during the four years between the two datasets. The release of the iPad, as well as other tablets and smartphones, has put powerful microcomputers at the fingertips of students and teachers. The impact this has had on music departments has been noticeable. Information gathered in the second dataset showed that school policies had been relaxed and revised since the first interviews with teachers, to allow students to bring their own devices (BYOD) to school and to use them during class time for learning. Previously, websites such as YouTube were blocked and devices not belonging to the school could not be used on the school networks. Some of these practices seemed rather rigid and archaic for a 21st-century learning environment. In contrast to this, 2012 data revealed that seven teachers were using YouTube for tutorials, performance examples, and to post student work for assessment and moderation purposes. These relaxed permissions implied another policy change as YouTube was mostly banned in the music departments surveyed in 2008.

By 2012, school policies had been adapted to be more inclusive and to accommodate mobile devices as well as student-owned devices. The main frustration for students was not being able to connect their smartphones to schools' wireless networks. BYOD agreements were standard practice, allowing students to bring a range of devices they were already familiar with to school.

Schools also purchased and provided iPads, so students enjoyed the additional benefits of being allowed to record and take notes with these devices in a variety of learning settings inside and outside the classroom. Technology was frequently used to project images from mobile devices in 2012. One teacher formulated their school's practice in this way:

> We are a 'bring-your-own-device' (BYOD) school. We believe that students have a level of familiarity with their devices and can have access to files they create at school wherever they are. Secondly, schools find it a challenge to provide 1:1 ratio of computers to students and this is one way of addressing the problem of providing access for all students. (T5-2)

Peripheral equipment such as data projectors and interactive whiteboards were common and used frequently in 2012 in contrast to the situation in the first dataset. Most of the teachers did not have regular access to a data projector and only one teacher mentioned using an interactive whiteboard in 2008. By 2012 six teachers had been using their data projectors regularly, implying that these were part of the permanent equipment in the classroom. Other possibilities for data projection like Apple TVs had also been introduced by 2012 (T7-2).

Initially, music teachers tended to steer cautiously away from connecting the music department computers to a school network to have internet access. Connectivity was seen as more of a hazard than an advantage in 2008. Although the School Networks Upgrade Project (SNUP) had already started in 2004, music departments were not prepared to connect their computers to the school networks. The teachers' cautious approach had been based on a mix of pragmatism and ignorance; pragmatism to prevent managing frustrating scenarios caused by lost passwords or intermittent connectivity, and ignorance because they did not know what possibilities the connectedness opened up. In contrast to this, by 2012 most music departments reported having computers connected to wireless networks for printing, internet access and file sharing. The increased wireless capability of devices has simplified this practice.

The majority of computers in music departments were still running on the Windows operating system. Six respondents (T1-2, E1-2, E2-2, T7-2, T9-2, T10-2) reported in 2012 that they had access to some Apple Mac computers or handheld devices running on Apple's mobile operating system, iOS: "Students often make use of music apps on their mobile phones and some bring laptops" (E2-2). This comment highlights how mobile technologies have moved beyond the occasional use of a mobile phone to utilising a variety of devices running on an operating system other than Windows.

Teachers have been well aware of the qualities of Apple Mac computers and the advantages these machines provided with free software such as iMovie and Garageband. It was however rare to find a full suite of Apple Mac computers in any of the music classrooms in 2008. This was no longer the case in 2012. Five classrooms were equipped with Apple Mac computers, and two schools had a full suite of these with as many as 30 computers available simultaneously.

In summary, the themes uncovered in this category revolved around access to, connectivity to, and mobility of devices. By 2012, it was no longer sufficient for music departments to have wired, stand-alone computers that could only be used in one location. Interconnectedness and collaboration have become part of students' learning expectations and standard way of learning by then. The *Governance* theme reveals the importance of connectivity. Wireless access has become the norm in most schools, and access to high-speed fibre cabling has enabled fast internet searches and download speeds. Connectivity had been enhanced by the ease of access when students worked in cloud-based applications. A second category has highlighted the importance of handheld devices that offer ubiquitous access and freedom of movement to the user. BYOD policies have enabled students to use their own familiar devices for learning at school. This theme summarises the importance of how learners and devices connect and interact to provide seamless learning opportunities for the students.

Inside the classroom - teaching with technology

When devices and the consequent cost of maintenance and upgrades are properly managed, they have the potential to enable effective teaching and learning in the music classroom. Teachers in both datasets commented on the benefits that technology brought to the process of composing music. It was one of the few components of music programmes in which music software was used consistently across both datasets.

> The current HoD, she uses the computers in F3 which is a prefab outside, and it's a Mac suite with 8 eMacs on it who run Sibelius software, and we use that for our composition. (T5-2)

> One of the teachers yesterday had the kids typing up the motifs and the themes from their set works and then listing the features as part of the lyrics or extra staff text on the computers to save sitting at a desk and writing it, and I think the kids were really enjoying that side of it. So, it can be used in all facets and of course when you're composing; you aren't just working on composition, you're working on all aspects. So, we've tried to use it (technology) for a variety of aspects of the course but mainly for composition. (T9-2)

There had been a subtle shift in the four-year period during which student use became more sophisticated and refined regarding how they applied the software for composition activities. Upgrades and new developments in the composing software also meant that Sibelius accommodated film scoring by 2012.

> I have a student who created a film composition. This would not have been easy without the software being able to superimpose the visual over top of the score. This enable her to compose in real-time to the score. (T8-2)

Teachers' perceptions had developed alongside the software enhancements to enable them to acknowledge that technology could transcend students' limited knowledge and provide them with an enhanced learning experience. Because technology is a natural fit for how students already communicate and access media outside the classroom, it supports their strengths and can develop their natural interest in music.

In the second decade of this century, students are embracing technological innovations and seamlessly interacting with technology in their daily lives. Music and technology are intertwined in many ways, and technology is enabling individuals to be musical in a variety of ways, even without a formal musical background (Bauer, 2014, p. 7).

The data gathered about teaching and learning in music classrooms produced two distinct but opposing categories: the advantages of using technology for learning and the barriers that the same technology posed to prevent effective teaching and learning from occurring.

Advantages

More advantages were perceived in the second dataset than in the first, relating mostly to teachers' perceptions of how students prefer to learn. These benefits have emerged to play a role in motivating teachers to adapt their pedagogy and include technology in their teaching programmes. T8-2 was now supportive of the idea "to encourage the awareness and incorporation of technology in tasks".

Composing was already singled out in the first dataset as one of the areas benefitting from technology support. One teacher worked with the students online. "Students create individual compositions based on a totally personalised feedback/feedforward as they share ongoing drafts with me" (T1-2). Teachers further commented on how the technologies promoted creativity and extended possibilities for interesting instrument combinations and groupings in the students' compositions. Sequencing software increased choices for students coming from a less formal musical background. The software enabled teachers to be more inclusive when they designed the assessment tasks. Students were given a choice of approaches and technologies to complete the given composition activities.

Recording and editing audio and video material had gradually developed over the four years in many music departments. The mobility of handheld devices such as iPads meant that recordings could be made and edited on the same device to simplify the previous process when one had to transfer footage, convert files into editable file formats, and then edit the material in yet another software program. Digital audio workstations such as Ableton Live, FL Studio and Logic Pro have made it easy to mix and edit audio files without a dedicated sound studio. The ability of devices to connect to the internet has become the norm in most New Zealand schools, and music departments have now welcomed network and internet access.

Barriers

Barriers identified in the first dataset were high student-to-device ratios, insufficient budgets, and unreliable network and wireless access. These had been minimised in the second dataset, although they have not completely disappeared: “the most difficult hurdle to overcome is the reliability of the system, e.g. if the Internet is down, students can't access their work” (E2-2). However, teachers still perceived access to sophisticated technical support and targeted music software training as barriers keeping them from the smooth integration of technology in music programmes in 2012. T1-2 commented that the “extensive range of ICT tools students potentially access and bringing a reasonable level of technical expertise to assisting them” to be one of the challenges. Related to technical support issues is “getting equipment to work as it should and maintaining it in working order” (T3-2). Perceived barriers were mostly about infrastructure issues, but by 2012 these had been reduced with the upgrading of accessibility, adequate school networks and internet speed.

The availability of computer technologies in classrooms has increased considerably over time. For example, where one classroom had three computers reserved for senior students only, the same classroom was now equipped with a suite of Apple Mac computers which all music students were free to use. Students in the same school were also encouraged to bring their own mobile devices to class. This demonstrates how a proactive teacher was finding new ways to deal with budget constraints and outdated equipment by providing better access for all the students.

Teachers often grappled with rotation schemes when they couldn’t provide enough devices for individual student access in 2008. This issue also impacted on how they managed larger class sizes. In 2012 there were no longer complaints about how logistics impacted on classroom management because of a high number of students, because of the increased number of devices available to students. In 2008 teachers often had to make do with student-to-device ratios of 3:1 and higher. In some cases, they managed this scenario by reserving access to the computers for senior students. Ease of access was also an issue with computers set up in suites away from the music classroom or in a neighbouring department. Because these spaces were in high demand around the school, it often resulted in limited access for the music students, leading to feelings of frustration.

Apart from access to computers, peripheral equipment such as MIDI keyboards needed extra space allocated in already cramped music classrooms. The earlier dataset revealed the limited use of equipment such as MIDI controllers and teachers needed assistance to set these up properly. Later on, the range of equipment had expanded, and teachers and students became more sophisticated in the way they used equipment such as MIDI instruments, USB controllers and digital processors. A subtle mind shift had occurred for most teachers. They no longer saw the equipment as hogging physical space, but rather as an enhancement of their teaching space.

Of all the various components that music programmes comprised of, the composition process has benefited most by embracing technology for notating scores, selecting instruments, and listening to drafts. Although this is also the area where technology has been put to the best use since 2008, the second data set reveals that students have extended their skills to collaborate on compositions and to enhance their music production skills to include film scores. Teachers were still getting to know the software at the time of the first interviews, so training was high on their list of priorities. They also had the notion that students should not use the software before they (the teachers) were proficient users. This training issue seemed to have been resolved by time and experience, as there is no mention of specific Sibelius training needs in the second dataset. Teachers have made a subtle shift towards taking on the responsibility of upskilling themselves where possible. One teacher did experience students' "slow word processing skills and lack of understanding of basic programming and systems operations" (T8-2) as an inhibitor of sufficient progress when students were completing tasks.

Another interesting occurrence was that the internet was reserved mainly for doing research by accessing online information. There was minimal reference to the social benefits of online communities and discussion forums, although there was a move towards making asynchronous online support available to students to free up some classroom discussion time for the teacher. “I run a Facebook page for my year 13 Music Technology class. In this forum, they can ask me relevant questions and receive timely advice and direction particularly on the weekend when they may be recording at home.” For example, one teacher was making use of FirstClass (online collaborative software) to make resources available for students.

The software programs used in 2012 seemed to be very similar to those used four years earlier. Programs such as Sibelius, Garageband, Auralia, Musition, Protools, Band-in-a-Box were still commonly used. A new addition was Mixcraft, which is the Windows equivalent of Garageband. Table 26 provides a summary of the most prominent differences between teachers’ classroom practice in 2008 against those of 2012.

Table 26: *Most prominent differences in classroom practice*

Subcategory	2008	2012
Class sizes and devices	Student-to-device ratio often exceeds 3:1	Adequate number of devices available, so class sizes are no longer an issue
Classroom setup	• placement of technology and access to the devices cause frustration • computers are often in a separate space to the music classroom, e.g. an Apple computer suite with Sibelius software • different departments share computers • in some cases, only senior students are allowed to use the computers • setting up MIDI keyboards is a challenge to most teachers	• less frustration about accessing the technology • computers are accessible from within the department • the classrooms are equipped with enough devices and appropriate software • there is a variety of devices that students may choose from handheld, laptop and desktop computers • MIDI equipment now includes interfaces, keyboards and instruments • USB controllers and digital processors are freely available
Composing	• technology is used to synthesise ideas and test the results on the available software • technology supports the extension of student ideas • adequate software training for students is an issue • teachers are undecided about the advantages of using a music keyboard to notate instead of a mouse or keystrokes	• technology now supports students to collaborate on a composition • students have adequate software skills by the time they reach Year 11, so they don't need extra training • students continue to achieve high results with computer-devised compositions • students are comfortable and skilled to edit and produce their compositions in a sophisticated way
Internet access and research	• most music departments restrict access to the internet • when students have internet access, they use it to search for information and in some cases, watch online videos • research skills are mentioned once only	• internet access is the norm • students access online lessons and videos • assessment is done face-to-face as well as online and students interact with teachers through a learning management system or a social media platform like Facebook • students are supported to conduct effective internet searches • students have digital literacy

		skills to gather and produce quality research information
Performance	• performance assessments are recorded with digital technology • technology supports the editing of videos	• performance assessments are broadcast live on a YouTube channel • video recordings are used for student reflections • students use the available technology to substitute instrument parts for a live performance
Audio recording	• music departments can't afford the sophisticated hardware and software required for making good quality audio recordings • this is a sophisticated technical area of expertise that music teachers avoid because they are inexperienced	• most music departments have enough hardware and accompanying software to record and produce good-quality audio recordings • students are offered Music Technology as part of their music course
Software	• Garageband, Auralia, Musition, Sibelius, Pro Tools, iTunes, PowerPoint, iMovie and QuickTime • first dataset only: Band-in-a Box, Groovy Music, Finale and Keynote	• Garageband, Auralia, Musition, Sibelius, Pro Tools, iTunes, PowerPoint, iMovie and QuickTime • additional to software already mentioned in first dataset: Logic Pro, Sonar, Sound Forge, MuseScore and Mixcraft

The last subcategory identified common practice in secondary teaching programmes. Table 27 displays the dramatic shifts in practice that have occurred in four music departments in this thesis. The respondents from these four music departments volunteered additional information to the required answers in the survey.

Table 27: *Shift in practice in four music departments*

Teaching programmes	2008	2012
Teacher 5	• focus on orchestral skills and scholarship students • no Sibelius training in Year 9 and Year 10 • Year 9: students attend Option Music for one term with 3 periods a week • Year 10: full year course • no access to computers in music classroom	• blended approach: online and F2F teaching • Year 9 and Year 10: focus on Garageband and students work collaboratively in Google docs • Year 13 Music Technology course has a closed Facebook page • handheld devices are commonly used • wireless access available sophisticated sound equipment • BYOD school - students can bring their own devices • enough computers and devices to teach a class of 30 students
Teacher 7	• Sibelius is available only to the most literate Year 9 students • computers in the classroom are shared with the Art Department next door	• ICT skills are integrated in the Music programme, not taught separately • 22 Apple Apple Mac computers are available with wireless internet access • handheld devices such as iPhones, iPods and iPads are available for student use • students can access a variety of applications from these handheld devices
Teacher 8	• strong focus on basic music theory skills • a technical unit of work guides the junior students to gain basic sound production skills • Sibelius is available exclusively to senior students • no internet access in the music classroom • three Windows desktop computers in the classroom	• an interactive whiteboard is available in the classroom • Sibelius and YouTube is available to all students • the classroom is equipped with Apple Mac computers as well as handheld devices • students have access to recording equipment
Teacher 9	• students use Sibelius software from Year 9 during	• Year 9 students are proficient in using the composing

	three periods a week • a Music Technology course is in the planning phase • there is no designated recording space in the music department	software and capable of composing a video soundtrack in Sibelius • the music department has a fully functional recording studio • the teacher has an iPad available for student use • the music programme includes composition, performance and a Music Technology course teaching digital music making, recording and live sound production skills

Teacher beliefs and the impact on technology skills

A common thread throughout the two datasets is how technology has changed teachers' pedagogical practice by challenging their teaching values and personal beliefs about technology. The reasons why teachers found it so hard to embrace digital pedagogy were multiple and complex, and my data reaffirmed some common understandings around this topic (Archambault, L., Wetzel, K., Foulger, T. S., & Williams, M. K. (2010); Loveless, 2011).

Many teachers noted that they did not have the time to commit to learning how to operate new software programs or devices. There is an even deeper reason for this very common excuse. Teachers often have a deeply embedded belief that technology is not adding value to their teaching practice. Closely related to this belief is their scepticism about it having a positive influence on student outcomes and achievement.

Teachers who had started to adopt technology in their teaching programmes admitted to having the realisation that 'technology is here to stay' and that it could open up new possibilities for a student body that was growing more and more diverse as far as music background and traditional Western tuition went. They also acknowledged that technology offered students more choices for learning than traditional teaching methods and that students, when given these opportunities, were keen to experiment. Students, in general, are intuitive around technology and thrive on exploring new software and its functionality, independent of teacher-led instruction and intervention.

Motivation featured as a strong theme throughout this category as it relates closely to the fundamental beliefs of teachers. Technology challenges teachers to change their long-held beliefs and their embedded pedagogy. A model that is often used in education to support change management is Knoster's model that describes the factors involved in managing complex change (Knoster, 1991).

Change and how to deal with change is an inevitable consequence when teachers adapt their pedagogy to support technology integration. Knoster's model describes the factors that are required to enable change and identifies how people react during the change process in the absence of any of these enablers (see Figure 17).

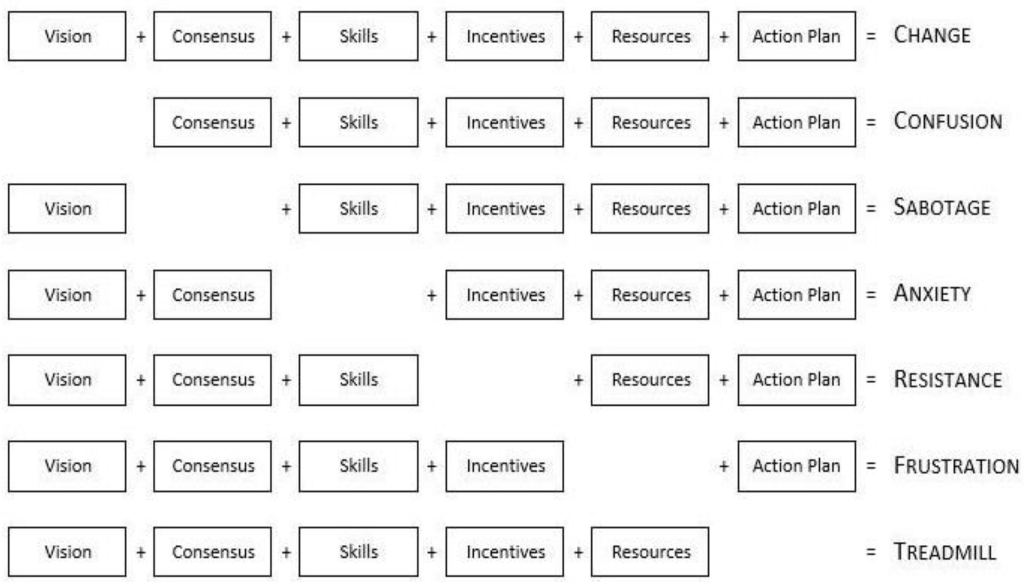

Figure 17. Factors in managing complex change (Knoster, 1991).

For example, if there is a lack of vision, it leads to confusion. When there is disagreement, people can start sabotaging the change process. A lack of required skills can cause anxiety, and without any incentives to change, resistance will increase. If the resources for change are inadequate, frustration will increase. Finally, the absence of an action plan will create a treadmill effect where the participants just do the same thing over and over without making any noticeable progress.

Knoster's model explains what might have jeopardised the motivation of music teachers during their attempts at technology integration in this thesis:

- lack of skills led to anxiety and discarding attempts to integrate technology;
- lack of incentives and evidence of how the technology improved student outcomes made for slow and gradual changes (insignificant);
- lack in number and quality of resources such as robust equipment, money to purchase these and enough devices for students led to frustration and consequent discarding of new ideas;
- lack of a common vision and action plan at organisational and departmental level led to confusion and false starts.

Teacher and student computer skills provided a simple backdrop for similarities and differences between the two datasets. It is important to take into account that the information about student technology skills was based on the perceptions of the interviewees.

In 2008 teachers faced difficulties about students not wanting to use computers because they hated them (T2); classroom management issues because of limited equipment (T3); technical problems and maintenance issues; political resistance from management (T4); and log-on issues for students because of inactive accounts or forgotten passwords (T9).

In 2012, students and teachers had moved on from the blockage of technical issues. Frustrations were caused by failing and outdated equipment, not a lack of motivation or skills. Some of the problems experienced in 2012 were caused by incompatible old and new technology such as upgraded computers but out-of-date keyboards, outdated or different versions of software across departments, and students upgrading their personal software versions but having to work with the older versions at school.

Technology skills of students

Based on the perceptions of the interviewees, they all agreed that students were more intuitive than teachers when they interacted with computer technology. Students might not always do things conventionally, but they were creative in their approaches to 'make it work'.

Typically, they were also more comfortable with using several technologies simultaneously to achieve the expected learning outcomes. One teacher described an activity for her/his junior class on Sibelius and Garageband to teach key signatures (T7-2):

> I set up my Year 10s to learn their key signatures. They had to make a two-minute podcast recording ideas and pitches or just sound. So that was sort of trying to get them comfortable with the (notation) technology and with the Garageband interface.

The NCEA Music Technology Achievement Standards provide a range of opportunities for students to use technology in a variety of innovative ways. Sampling and recording software now make collaboration between students possible when they are creating group compositions. Technology can be a welcome lifesaver in an emergency, as T9-2 described the drummer dilemma of one of the competing school bands.

> One of my senior bands lost their drummer before going to Rockquest. So, they constructed the drummer's part using a MIDI drum software program. They practised to the drum track and were allowed to use it at the performance. The drummer changed his mind at the last moment, so they did not get to use the drum track, but they had constructed a complex drum part that sounded very close to the real thing. (T9-2)

Composition work was mentioned most often when teachers were asked about their students' innovative technology skills in 2008. These skills had become more refined in 2012, as the following comment shows: "I have a student who created a film composition. This would not have been easy without the software, being able to superimpose the visual over top of the score" (T8-2).

Students perceived technology to be helpful and to aid them in completing tasks quicker than they would in the traditional handwritten way.

Composition drafts that could previously take a student a whole year to complete could now be finished in a much shorter time frame when notation software was used. It provided a professional-looking final product with the bonus of a playback feature for students to listen while they create:

> Music technology enables students to transcend their limited knowledge and experiences, e.g. Sibelius enables students to experience what it is like to compose for a full orchestra which is something they would not be able to experience in real life. Garageband also enables students who have limited music literacy skills to utilise their aural skills to create music beyond their capacity to notate. (T4-2)

Technology skills of teachers

Traditionally music teachers have taught to their strengths. If a teacher was not comfortable or competent to use certain technologies, chances were that these technologies were not applied during learning activities. Teachers have become more amenable towards the idea of integrating certain computer technologies in the music classroom since 2008. What this research showed was a gradual shift in teachers' approach to let students take charge of their learning, while the teachers stepped into the role of facilitator rather than instructor. Hennessy et al. (2005) described the gradual change of teachers incorporating more technology into their practice over a considerable period of time, as a "pedagogical evolution" (p. 186). Another development was their willingness to use the expert knowledge of their students when they lacked the expertise themselves.

Teachers were eager to become more knowledgeable, yet the reality of time constraints and other demands of the teaching job often derailed their best intentions. Music teachers in this thesis were most concerned and uneasy about their lack of sound recording skills (T2-2, T4-2, T8-2, T11-2). "I need much more technical support and would like to develop better recording facilities.

In 2008, resistance towards some of the aspects of technology integration was prevalent. The technology was perceived by some teachers as being more of a hindrance than a help to activities such as composing. One teacher believed that one should

> do all the musical things first and bring out all the ideas from inside of you before you go and sit at a computer because the computer sort of stultifies everything and I think we've got to realise that the computer is just a tool for writing it out. It's not something that's gonna help you compose. (T8)

Fortunately, the majority of teachers involved in this the research for this thesis have since adopted a positive 'can do' attitude towards learning new technology skills. Overall, there seemed to be a growing awareness of the necessity for professional learning development amongst teachers to enable them to assist and support their students in a timely and efficient way.

Support

The technical support role of the music teacher is often varied and demanding. In this theme, the nodes referred to the technical support that teachers provided to students and other staff members, as well as the technical support available to them as teachers.

Music teachers provided technical support to the staff and students in secondary school music departments. There is no evidence in either data set that schools provide expert technical support specific to music technologies and software. This consequently had a significant influence on the state and level of technology integration in music programmes, which in turn had direct implications for student learning:

> issues include the use of Sibelius software. This is the most important programme we use to help students notate their compositions. There are a lot of tricks, shortcuts etc. Students constantly refer to me to help them figure ways to help the software work for their needs. (T8-2)

Traditionally, a music department had been a place where sound equipment and amplifiers were found; therefore, some teachers had difficulty in making the distinction between sound production, recording, and computer technology. For example, when teachers answered the question about the types of technologies used in the music programmes, they often referred to guitar amplifiers and microphones. These electronic devices were, however, not included in the area of focus for this thesis, although it explains why ‘definition of technology’ was one of the focus areas of this theme.

Support from the music industry seemed to have been available to both teachers and students and had been consistent over the four-year period of the study. However, it is important to note that support had to be sought externally and teachers did not always have the time available to attend tailored workshops (T8) or even to ring an expert during class time when the need was most pressing. Just-in-time support for music software such as the Sibelius products was comprehensive but only available as an online discussion forum.

Ways forward - What’s new on the technology horizon?

It is encouraging that evidence from both datasets showed how important it was for all teachers to have future plans for development in their departments. These included a clear vision, specific goals, a wish list, and ways to advance technology integration, as important aspects of creating an environment conducive to 21st-century learning and teaching. Once teachers started to reflect on the advantages of using computer technologies in their music classrooms, the list became quite extensive. Teachers referred to concepts such as “inspiration”, “instant gratification”, “enhancement”, “opening horizons”, “enabling” and “developing” to describe the possibilities that these computer technologies brought. T5-2 noted: “The difference would be now that I have more computers and iPads and the software is becoming more intuitive. We are now spending more time making music rather than learning how to make music – it’s a lot more fun!”. This is ultimately the goal of any music teacher: to reach the point of making the music come alive.

Although considerable progress was made over the four years, teachers still had long wish lists, implying that they were striving to improve their practice and the learning environment for their students. What was encouraging, was the paradigm shift that had occurred in the mindset of teachers. Each one could provide a clear vision for future developments in their departments and ways to utilise their spheres of influence to realise their vision. Therefore, inclusion and integration of technology were happening with far less resistance than at the start of the research for this thesis.

Thematic Synthesis

The previous comparison provides a summary of the most prominent themes identified across the two datasets. A thematic network (Attride-Stirling, 2001) gives a graphic synthesis of the findings from both datasets and extracts a global theme from the thematic network.

Description

The three-tiered structure of a thematic network as an analysis tool consists of basic themes, organising themes, and global themes. This structure has a strong resemblance to the three basic elements of concepts, categories and propositions used in grounded theory.

Thematic networks are used as an illustrative tool to organise the text into a format that discloses information for the researcher and supports understanding for the reader. Thematic networks only assist in the analysis process and should not be seen as the analysis itself. The tool has proved to be useful for depicting the many layers of the data in a diagram. It shows how the different themes are interconnected and related. The eye is drawn from the outer perimeters to the centre, moving from basic themes into organising themes and then reaching the distilled global theme at the centre of the picture. Figure 18 shows the thematic synthesis of the findings presented as a thematic network and provides a visual synopsis of the thesis.

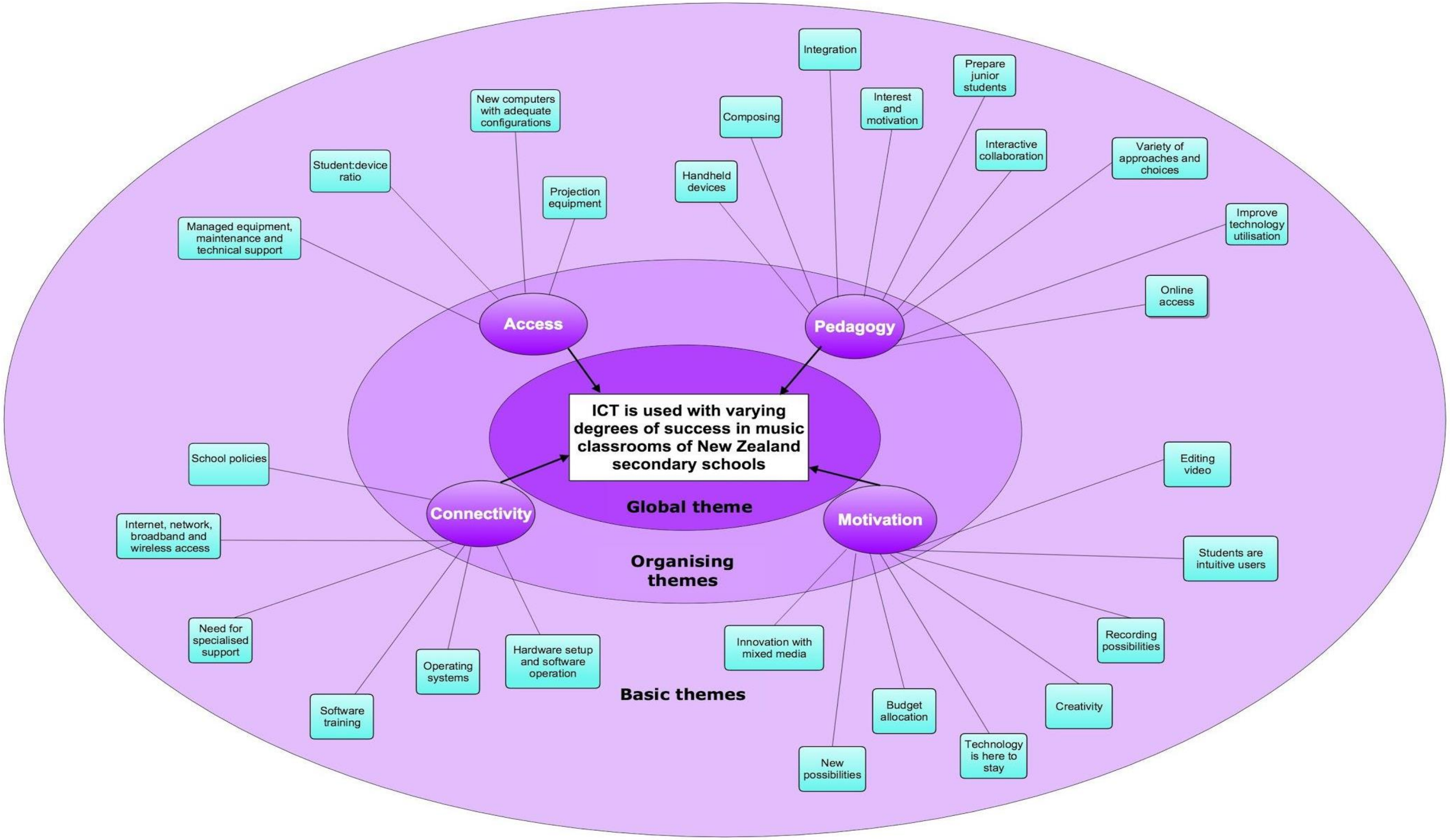

Figure 18. A thematic synthesis of the findings presented as a thematic network.

Process

In this thesis, multiple basic themes emerged from the five top categories of *governance, inside the classroom, skills and knowledge, support,* and *ways forward.* Four guiding questions were used to identify the basic themes from the data at the first level of the thematic network. These questions were identified as the recurring themes emerged. The basic themes, organising themes, and consequent global theme are described in Table 28 below. Each of the basic themes is grouped around an organising theme and coded accordingly with the letters A, C, P and M. As a thematic network uses an inductive method as its premise, the table should be interpreted both from top to bottom and then back to the top to make the most of how the information is organised.

Table 28: *Basic themes, organising themes and a global theme derived from the analysis*

<table>
<tr><th colspan="4">Guiding questions/statements to identify basic themes</th></tr>
<tr><td>How and where are devices located and accessed?</td><td>How is the technology connected and managed?</td><td>How is the technology used to enable music learning?</td><td>What are the positive influences on teachers' motivation to use technology?</td></tr>
<tr><td>• new computers with adequate configurations A
• a variety of projection technology is available and used daily: data projectors, interactive whiteboards and Apple TV (collaboration) A
• an equitable student-to-device ratio of less than 3:1 A
• equipment, maintenance, and technical support are purposefully managed A, C</td><td>• Windows OS is more popular and affordable C
• school policies are inclusive and open to using devices on school networks (communication) C
• internet, network, broadband and wireless access are widely available C
• software training C
• hardware setup and software operation C, M
• Need for specialised support as technicians don't have music software knowledge or MIDI setup experience C, M</td><td>• composing P
• students appreciate a variety of choices and different learning approaches P
• mobility of handheld devices P
• general wish to improve utilisation of technology P
• add interest and motivation P
• better preparation of juniors - start early P
• seamless integration P
• interactive collaboration P
• online access P, C</td><td>• promotes creativity M
• simplifies video editing M
• provides recording possibilities M
• students are intuitive tech users; like to experiment M
• innovation happens when mixing different media M
• tech opens up new possibilities M
• realisation that the tech is here to stay M
• specific budget allocations for music technology C</td></tr>
<tr><th colspan="4">Four Organising Themes</th></tr>
<tr><th>Accessibility (A)</th><th>Connectivity (C)</th><th>Pedagogy (P)</th><th>Motivation (M)</th></tr>
<tr><th colspan="4">Global Theme</th></tr>
<tr><th colspan="4">ICT is used to varying degrees in secondary music classrooms</th></tr>
</table>

Basic themes are ideas that belong loosely to the same group. This is portrayed in the outer layer of the graphic in the turquoise boxes. From these basic themes, four organising themes have been identified in the second layer in access, connectivity, motivation and pedagogy. The first two organising themes – access and connectivity – refer to the particular components of device access and connectivity. The last two organising themes – pedagogy and motivation – describe the abstract components of technology use: teachers' pedagogy and their motivation for using technology. The overarching global theme is displayed at the centre of the graphic. It emerged from this thematic network that ICT is used to varying degrees in music classrooms across New Zealand secondary schools. This is an echo of the hyphothesis that reads: technology adoption in secondary music classrooms is slow and often limited by teachers' teaching values and beliefs.

The four organising themes of access, connectivity, motivation, and pedagogy, provide a foundation for best practice and contribute to a developing framework for successful technology integration in music programmes. When technology is introduced in a secondary music classroom, and one of these themes are absent, the probability that technology integration will fail is high. The deeper the level of application of each of these four themes, the higher the likelihood of success.

Starkey's research (2010) related closely to the four organising themes that emerged in the thematic network. She described four categories similar to the organising themes in the thematic network. According to Starkey, students needed tools, presentations, access, and connections to learn effectively with digital technologies. Within the context of this thesis, the thematic network indicates that teachers and students need access, connectivity, motivation and pedagogy to succeed in a digital environment. The concepts of access and connectivity are similar to Starkey's concepts of access and connections.

Four elements of effective technology integration: a framework

This thematic synthesis identified four critical components for successful technology integration in music classrooms from the findings of this thesis. These four components aided the design of a music technology integration framework for teachers. The four components, accessibility, connectivity, pedagogy, and motivation were all deemed equally important in the two datasets. Table 29 presents this framework as a matrix to portray the implications of the presence/absence of one of the components. The framework is based on intrinsic and extrinsic influencing factors.

Table 29: *Technology integration framework*

Intrinsic		**Extrinsic**		**Result**
Pedagogy	Motivation	Accessibility	Connectivity	Effective ICT integration is possible
Pedagogy	Motivation	Accessibility		Possibilities and collaboration are impaired which leads to frustration
Pedagogy	Motivation		Connectivity	Real integration is undermined if access to devices is limited
Pedagogy		Accessibility	Connectivity	Little integration happens when the teacher's actions are not driven by beliefs, confidence and self-efficacy
	Motivation	Accessibility	Connectivity	If the pedagogy is outdated the same teaching is happening, just with new tools. This represents the Substitution level in the SAMR model.

The four components of accessibility, connectivity, pedagogy, and motivation in the technology integration model are now placed within the context of the findings of this thesis.

Accessibility

The organising theme, accessibility, focuses on devices and where and how these devices were accessed. There have been improvements over the four years regarding computer configurations. This meant that teachers' experience with music software and hardware had led to better decisions when they purchased new music programs and equipment. This finding emphasises the importance of adequate planning and research before a purchase is made. The nature of music software often requires hardware that is not necessarily part of a standard computer configuration to do basic word processing and browse the internet. Components like sound cards, core processors, RAM (random access memory) and high-resolution screens need to be considered for running music software. Sound mixing and notation software require a lot of RAM, and this has to be factored into the configuration of the devices.

Access does not only refer to using adequately configured devices, but also to where they are located physically. With the development of more powerful handheld devices such as smartphones and tablets, teachers no longer need a computer lab to teach a whole class. It is no longer a case of the devices being location-specific. This eases the pressure caused by timetabling, high demand, and access to spaces with fitted technology.

Teachers have realised that they need some means of projecting a single computer or tablet screen to a whole class. The audience could even want to share and interact occasionally with the projected images and information. This realisation meant that the frequent use of data projectors, interactive whiteboards and also Apple TVs had been prevalent. High-resolution monitors or LCD screens are becoming popular for their excellent visual quality, and built-in speakers, making the need for a set of desktop speakers redundant. Starkey (2010) supports the use of projection technology in this statement: "Teachers who used their laptops during lessons to present multi-media materials reported that this engaged students creatively and critically in their learning. Having the teacher presenting multimedia materials to the class can be a transmission approach to teaching. Students are likely to find the range of visual media more engaging than listening to a teacher standing by a board and talking or writing notes to be copied" (p. 35). This refers to the pedagogical changes required when a learning environment is infused with technology.

An Ofsted report (Ofsted, 2009) supports the advantages of using projection technologies. It reports that data projectors and interactive whiteboards are frequently used to make teaching visually engaging. It provides students with the means to share their learning when they have used ICT to manipulate digital media, to reflect on performances, and to compose music. Wise, Greenwood & Davis (2011) describe a case study where the teacher started to use a data projector alongside a wireless mouse, so he could sit next to a student and manipulate data on the big screen. This not only improved his/her mobility but also how the teacher interacted with the students while teaching, making the experience personal and targeted to the students' needs.

The student-to-device ratio has shrunk, and where schools used to have limited access to devices, they now have at least one device for every three students. This excludes the schools in which students bring their own devices. Under these circumstances, each student has a device, which greatly increases the teaching and learning possibilities for both students and teachers. What this tells us is that students need access to devices that can carry out the functions required for listening to, composing, interacting with and remixing music. Buabeng-Andoh (2012) writes: "Effective adoption and integration of ICT into teaching in schools depends mainly on the availability and accessibility of ICT resources" (p. 143).

With the larger number of devices available, maintenance and technical support for these devices are critical. A study in Ireland (Buabeng-Andoh, 2012) found that "about 85.3% of schools reported technical support and maintenance as a 'high' or 'very high' priority. It further claimed that it should be an essential element of the school ICT environment with proper technical support being made available to maintain hardware and infrastructure" (p. 144). Further to this, Korte and Hüsing (cited in Bingimlas, 2009) argue that "ICT support or maintenance contracts in schools help teachers to use ICT in teaching without losing time through having to fix software and hardware problems" (p. 241).

It is also critical that the type of support be adequate for the level of sophistication needed to maintain software and hardware unique to music teaching. As Gall & Breeze (2007) explain: “technicians were either unaware of the needs of music, lacked the necessary technical skills related to music-specific software and hardware or were unable to be present at the point at which the support was needed for the students to continue to work effectively” (p. 46), which was a common complaint from music teachers even when the school enjoyed the support of a technician. It is interesting to note that an earlier recommendation of Mills and Murray (as cited in Gall & Breeze, 2007) was that technicians and not teachers be the ones to solve the complex technical issues which may arise in a music classroom. Herein lies the dilemma of the music teacher when the technician is not experienced in dealing with music-specific issues. The teachers have to become the technicians themselves which often leads to other common frustrations around classroom management and workflow.

Connectivity

Connectivity in the 21st century is an expectation rather than a luxury. Technology has enabled connectivity on a global scale at breakneck speed. Connectivity in the education sector focused on the provision of fast networks in schools for quick access to the internet, the school network, and in most cases wireless access with mobile devices. Schools have been obliged to develop sophisticated policies and user agreements to keep up with the connective abilities of devices and student use of these devices. Students have also been allowed to bring their own devices to school. This has necessitated schools to teach students to be responsible digital citizens and to raise awareness of online safety and how to behave in an acceptable way when they interact online.

The wide choice of devices that can now be used for teaching and learning also means that the demand for technical support is more complicated than it was a few years before. A dedicated staff member or team is critical to ensure the smooth operation of devices and software and an informative, connected learning community. At the secondary school level, some expertise is often required for specific curriculum areas like the Arts. Although access to cloud-based programs has reduced the pressure on schools to ensure that software is up-to-date, the licensed software still has to be upgraded periodically. The licensing agreement for Sibelius, for instance, allows for a certain number of users on dedicated computers with no network access.

Along with the variety of device choice came the diversity of operating systems. It is more common to find devices running on a selection of operating systems such as Chrome, Linux, Windows, Apple Mac, Android and iOS. The development of smartphones and tablets has significantly changed how schools accommodate these devices for learning and teaching purposes. It is also evident that specific devices are more suited to certain activities. This has aided pedagogy to develop alongside the advancements in the technology.

Pedagogy

With connectivity, learners have more opportunities to collaborate. The collaborative learning process is much more dependent on input from the whole group to develop thinking and explore the scope of a task or project. With these explorations, the teacher's role often switches between that of facilitator, guide, observer, and expert. This role shift implies that the locus of control has shifted to students so that they can take ownership of their learning. Alongside ownership, decision making, and choices provide students with opportunities to reflect on their learning. Teachers who are open to technology-supported learning, quickly see the benefits of putting powerful tools in the hands of the students and giving them the freedom to be creative. This capability often sparks renewed engagement amongst students. Students can be surprisingly innovative when they have access to a broader variety of choices to present their newly-acquired knowledge.

Motivation

When students get enthusiastic about learning, teachers are energised to sustain this enthusiasm. Technology provides a unique tool for meaningful student engagement when it is put to proper use, for example, playing a high-quality video to students to introduce a new topic. This, in turn, sets the scenario for teachers to improve their professional knowledge while challenging their students with new activities. The motivation cycle stays alive as long as this momentum is maintained.

Conclusion

Chapter 6 has drawn a comparative analysis between the content of the two datasets to show the constants and changes in teacher behaviour and technology use over a four-year period. A thematic synthesis deducted four critical components for effective technology integration from the data. These components were used to design a framework for technology integration in music classrooms. The result is presented in a matrix to be used as a guideline to identify roadblocks during any ICT integration process in a music department.

Chapter 7

"Reasoning draws a conclusion, but does not make the conclusion certain, unless the mind discovers it by the path of experience."

Roger Bacon

The aims of the thesis revisited

This thesis started from an idea about the improvement of a sole charge music teacher's practice in a music department with access to limited resources in terms of computers equipped with composition software. It developed into a qualitative inquiry about teacher practice and ICT integration in music departments across New Zealand secondary schools. When the preliminary review of the literature was done in 2007, there was very little information available about technology use in secondary music classrooms. The researcher then set out to investigate if, how, and to what level ICT is integrated in secondary music classrooms in New Zealand.

The nature of the research required a phenomenological approach to describe the essence a lived phenomenon (Jansen, 2010). The data was collected following a qualitative methodology to collect personalised responses through interviews and surveys with teachers and music industry experts. The initial dataset from 2008 sparked the researcher's interest to initiate a second data collection point, four years after the first, to check on possible changes in practice and to deepen insights into the pedagogical practice of music teachers in Aotearoa. The follow-up research was conducted with the same recipients where possible, to establish continuity of thought processes and professional growth. The comparative data enabled the researcher to describe "variations, relationships, and individual experiences" (Mack et al., 2005, p. 3 in detail.

This thesis investigated whether teachers use computer technology in music classrooms. It considered the factors that influence technology use amongst secondary teachers and students in New Zealand schools. Five guiding ideas questioned the classroom practice of secondary music teachers. The answers to these questions described the teaching practice of these teachers and provided suggestions to improve existing pedagogy in classrooms. These five questions were:

- Do music teachers use computer technology in their teaching pedagogy?
- Why and how do teachers integrate technology into their teaching programmes?
- What are the major influences on secondary teachers' adoption of new technology?
- What are the changes and constants over the period of this study?
- How can the Technological Pedagogical and Content Knowledge (TPACK) framework improve technology integration in music classrooms?

A qualitative approach was selected to find answers to these research questions, for its richness in detail. The data collection methods were semi-structured interviews (first dataset) and surveys (second dataset). The first dataset wanted to capture a snapshot of teacher practice in music classrooms regarding their levels of ICT use and integration. The second dataset aimed to document if the practice of these same teachers has changed in the four years between the two datasets (2008 and 2012). The next section will revisit and discuss the research questions in the context of the data findings and also provide the outcomes of this thesis.

Are music teachers using computer technology in their teaching pedagogy? The answer to the first research question is a resounding 'yes'. Wise (2013) supports this finding in his research when he concludes that "teachers and students accepted that the use of digital technology was now an integral part of the activities undertaken in both general and performance music classes" (p. 305). Although New Zealand schools have come a long way since the start of the century and are now well-resourced, music teachers are still using technology mainly for lesson preparation and presentation purposes.

New Zealand schools have access to robust broadband infrastructure and the internal networks in schools are currently well-maintained. In this sense, there is no lack of computer technology in secondary schools. Although the use of technology is unquestionable, it is the depth of integration that varies greatly amongst individual teachers. Computer technology is often used as a replacement for an existing technology, which in itself does not require a considerable change in pedagogy. An example of this is when a composition task is given to students, and they are required to complete their drafts in a notation program instead of on manuscript paper. The task outline and achievement objectives might be identical to previous tasks which required no technology use. With this approach, no pedagogical reformatting is required. It is often at this superficial level of integration that teachers get frustrated if there is a hiccup with the technology and perceive it as a time-waster and extra burden on top of an already heavy teaching load.

Why and how teachers integrate technology into their teaching programs addresses a deeper level of integration based on more than mere availability and convenience. It is at this level that the information gathered in this thesis becomes exciting and complex because of its implications for practice. Where the first research question aimed to confirm the existence of this practice, the second research question explored the reasons for integrating technology into teaching programmes. These reasons are numerous and varied. One of the most common reasons that teachers use technology for teaching, is that they feel motivated to do so. The fourth element in the framework for effective technology integration described in Chapter 6, points to the importance of motivation during the integration process.

Motivation is the reason for doing something. Motivation needs momentum, and technology can provide the impetus to maintain the motivational cycle when teachers embark on the journey of technology integration. As soon as teachers experience some success on this journey, whether it be through heightened student interest or improved engagement, it inspires them to continue to adjust and improve their digital pedagogy. Motivation is entwined with teachers' pedagogical belief systems (Almås & Krumsvik, 2008; Ertmer & Ottenbreit-Leftwich, 2010; Tondeur, 2017; Vongkulluksn et al., 2018). It stretches further than surface-level enablers such as technology availability and access. It ties in with their self-belief and confidence levels to introduce and navigate these technologies with students. Self-efficacy is a strong motivator for teachers, but it is only developed through an iterative process where every new learning builds on a skill previously acquired.

Several primary motivators for using technology were identified by the teachers involved in this thesis. They maintained that once the realisation set in that technology was there to stay, it opened possibilities for creativity and innovation. Once teachers acknowledged these possibilities, they realised that it also provided new opportunities for students to experiment and innovate with mixed media. This demonstrated the critical pedagogy principal of connecting word to world as students found alternative solutions to use and present information. Wise (2013) supports this finding when he reports that "contemporary digital technology, particularly the sequencing and notation software… can facilitate sophisticated and complex outcomes in composition in a number of genres and styles of music" (p.306). This also ties in closely with Step 8 (p.99) of the critical pedagogy lesson model where the transformation that was brought about by the technology is acknowledged and celebrated (Abrahams, Jenkins & Schmidt, 2002).

Once there is enough motivation to embrace new technologies, pedagogy often follows closely. When looking at teacher pedagogy, it remains a moving target. The principles of critical pedagogy were used throughout the study as a measure to see if teachers would become facilitators of learning by encouraging freedom of expression and interpretation in their students. Pedagogy is identified in this thesis as one of the four elements that ensure effective technology integration in the findings in Chapter 6.

Thirdly, the major influences on secondary teachers' adoption of new technologies are belief systems and values. Pedagogy is heavily influenced by teachers' pedagogical beliefs. The influences on these beliefs include real and perceived barriers and enablers to the integration process. The literature provides a wide range of barriers to technology integration. The Galileo Network (2001) reports that inhibitors to the adoption of technology are teachers being overly conservative in their approach, technical barriers in schools, and the inflexible nature of school policies. Access to adequate hardware and infrastructure is frequently mentioned as a barrier (Dorfman, 2008; Gall, 2017; Hennessey et al., 2005; Ofsted, 2004; Trucano, 2005). Another barrier is inadequate budget allocation (Dorfman, 2008; Spector, 2013). The lack of differentiated and targeted professional development can inhibit teachers' self-confidence (Buabang-Andoh, 2012; Gall, 2017; Spector, 2013). The findings of this study identified similar barriers to teachers' adoption of ICT in music classrooms: high student-device ratios, insufficient budgets, weak infrastructure, lack of specialised technical support, and limited access to software training for music technology programs were all mentioned as barriers.

Positive influences on teachers' adoption of ICT motivate them to explore the possibilities and see the advantages of using technology in the classroom. In this way technology becomes an enabler to provide students with a range of options to choose from when they engage in creative learning activities. These enablers belong to two modes of influence, either intrinsic or extrinsic. The music technology integration framework developed in Chapter 6 (table 29) depicts these two modes of influence (intrinsic and extrinsic) in relation to four enablers of technology integration. The two intrinsic enablers are motivation and pedagogy, contrasted with the extrinsic enablers of accessibility and connectivity. According to the literature, extrinsic enablers are more obvious and easier to identify and address such as a robust infrastructure and access to the internet (Spector, 2013; Trucano, 2005). The findings support the extrinsic enablers with comments from teachers about the advantages of access to mobile devices, connectivity, digital audio workstations, and software for recording, editing, and composing. Intrinsic enablers are more elusive to identify or enhance. Trucano (2005) names pedagogical shift as an essential enabler.

Wise (2013) reports on students' digital literacy as an enabler for working creatively in a digital environment. He agrees with Crow (2006), that music technology has the ability to "cross boundaries within the context of *authentic* musical expression" (Wise, 2013, p.307). This belief supports the notion in constructivism that learners should be actively involved and participate in their learning (Scott, 2006).

Professional development has a strong influence on the quality of teachers' technology integration practice. If music teachers could find more time for professional development and access to learning communities, it could support more rapid pedagogical shifts than what is currently the case. Such a shift is not easily measurable and could, therefore, be deemed unnecessary or even avoided by reluctant adopters of technology. It is important to support teachers in their pedagogical practice and to provide ways to develop their knowledge and musical TPACK to improve their self-efficacy (Ertmer & Ottenbreit-Leftwich, 2010). With the correct guidance and targeted professional development, the depth of integration could gain some much-needed momentum.

The fourth research question addresses the changes and constants over the period of this study. A comparative analysis of five categories highlighted what was similar and what had changed over the four years between the two data collection instances (see Chapter 5). The categories that were compared, were *governance, inside the classroom, skills and knowledge, support,* and *ways forward.*

The governance category highlighted the importance of connectivity. Firstly, how the lack of a robust infrastructure impaired technology integration, and secondly, how the improvement of these systems paved the way for better procurement choices and more flexibility in the use of mobile devices. This flexibility was closely related to changes made to school policies. The most significant changes happened when music teachers were given more autonomy because of policy changes. These included a more relaxed stance towards the use of personal devices at school (BYOD), mobile device access and use for learning in classrooms. By 2012, infrastructure issues had mostly become a non-issue. Broadband access and wi-fi availability had improved connectivity in music departments. Internet access, wireless printing, and online collaboration had become the new normal. Although some teachers remained somewhat cautious about letting their students do research and work online, perceptions had shifted by 2012 from what they were four years earlier.

Budget issues were a constant concern across the four years, although vast improvements were made when budget allocations became more needs-driven and specific to music departments. This resulted in better planning and improved choices when new equipment had to be purchased. Teachers had also become more experienced in their understanding of the software and hardware requirements for music technology.

Because the five categories were interrelated, improvements in governance also brought about improvements to what happened inside music classrooms. The only constant about classroom practice was teachers' acknowledgement that ICT could enhance the composition process and support students to achieve a successful end product. Preferred software programs and applications remained constant in name but not in version numbers, such as Garageband, Sibelius, Auralia, Musition, Pro Tools, iTunes, iMovie, and QuickTime. In addition, the influence of the Internet was evident in 2012 with the development of Sound Forge, MuseScore and Sonar.

It was exciting to review the changes that occurred inside the music classrooms during the four-year period of this study. Teachers had become more aware of student needs and their preference for using technology for making and learning about music. This, in turn, brought about pedagogical changes, because an identified student need is a powerful motivator to adopt new ways of teaching. The teaching practice became more student-centred and responsive to the needs of students. This aligns with Scott (2006) as he emphasises the importance of a "shared inquiry to enhance the social nature of the act of learning, reflection and metacognition to construct knowledge and meaning, and assessment of one's learning" (p.17) when a constructive approach is taken.

Changes to the physical layout of classrooms and how students interacted with the available technologies were noticeable. Computer labs had all but disappeared by 2012 which made the cumbersome trek to classes something of the past for music students. Because the student-to-device ratio had improved considerably whole classes were able to work on the same project in the same space. As technology access had become ubiquitous, the occurrence of a reserved computer for exclusive use by senior students, had all but disappeared. The improved infrastructure in schools provided students with fast internet access. Digital audio workstations could be available to every student in the class, not just the few that could fit into the recording studio, if there was one on hand at all.

The need for a dedicated recording studio equipped with state-of-the-art equipment was far less pronounced in 2012 than in 2008. Mobile devices made recording and editing on the go possible. Some teachers had adopted a blended approach to how they supported students during and outside of class time. Students could access lessons and support material on Google Drive in their own time and this necessitated a change in pedagogy for teachers. One example was of students in a music technology group on Facebook. They used the social media platform to get feedback from their teacher, to review one another's creations and to access support material to enhance their learning. This all happened in an asynchronous manner, so convenience and accessibility contributed to the success of the group.

The fifth research question addressed the impact of the Technological Pedagogical and Content Knowledge (TPACK) framework to improve technology integration in music classrooms. This research suggested that music teachers were in need of some guidance to improve their teaching practice with the use of certain technologies. What is significant to report is that pedagogical knowledge is different for traditional music teaching to what it is for using technology as a support tool. Knowledge of the technology is critical for teachers and it is probably the most neglected knowledge area of the model. The lack of a standardised framework or baseline competency level for music teachers makes this a very complex and difficult knowledge area to develop and to measure. The TPACK framework could improve teaching practice by prompting teachers to raise their level of understanding about specific music-related technologies and the pedagogy that is required to utilise these technologies successfully.

Placing the findings in the literature

The findings of this research are broadly in line with previous research conducted on aspects of this thesis such as pedagogy, access to technology, connectivity and motivational factors. This thesis found that technology is used in secondary music classrooms in New Zealand. It found that the degree to which the technology is integrated varies from teacher to teacher. The reasons for these variations were complex and diverse, but one of the most influential factors was the teachers' pedagogical belief systems. Their beliefs and values influenced their pedagogical decisions regardless of how much access they had to technology. Closely linked to their beliefs was the influence their self-efficacy and skill levels had on determining how much technology was introduced in classrooms. These perceived barriers and enablers hindered or advanced their technology use with students. The findings of this thesis culminated in a thematic synthesis that provided a global theme as the overarching result and summary of the findings: ICT was used with varying degrees of success in music classrooms of New Zealand secondary schools.

The literature is now revisited once more, this time viewing it through the lens of the digital technology integration framework that was introduced in Chapter 6. The four components of this framework are pedagogy, motivation, accessibility, and connectivity. These components relate to the literature regarding ICT use in education and effective integration strategies. The four components highlight the importance of knowing the how (pedagogy), the why (motivation), and with what (accessibility and connectivity) that the integration process requires.

Pedagogical changes are critical to ensuring effective ICT integration (Bauer, 2014; Deaney et al., 2006; Hennessy et al., 2005; Loveless, 2011; Wise, Greenwood & Davis, 2011). These changes require teachers to commit to a process of reflection and a willingness to change. This thesis identified stressors that could inhibit pedagogical change such as time constraints (E1-2, T4-2), distrust about the added value that technology could bring to teaching, distrust about the positive impact of technology on student outcomes, and teachers' inexperience with technology. One of the biggest challenges that remains is "how to facilitate *digital transformation* in a musical context" (Wise, 2013, p.310).

Over time reluctant teachers have become more resigned to the idea that technology is not going away and they even admit to the opportunities technology provides for their students (Ertmer & Ottenbreit-Leftwich, 2010). T7-2 developed an integrated music programme with ICT skills embedded in the course, not taught as a separate component to embrace the opportunities. In 2008 the music programme in this school only provided the available Sibelius access to the most deserving and music-literate students. This example showed what a difference accessibility and changed pedagogy could make for students. Their situation changed from technology access being exclusive to a few selected students, to access freely available for all students in the music classroom (T7-2). This alludes to a student-centred approach where the teacher is no longer a gatekeeper but an enabler of choices. This shift was facilitated by the teacher's deepened understanding of technological, pedagogical and content knowledge. Although this example is positive in that it reports on a change in thinking and practice, the overall finding of this thesis concurs with Wise (2013) when he states that "the teacher participants do, in fact, use a range of digital technologies on a regular basis but the activities the students engage in using these technologies remain fundamentally *traditional* in nature" (p. 319).

Teacher motivation is critical to ICT integration and the findings in this thesis highlighted the factors that influence teacher motivation. Drossel et al. (2017) concludes that teachers' attitudes have the highest impact on their use of ICT. These attitudes are further influenced by their self-efficacy and whether they view the use of ICT positively. Teacher motivation is not easily defined in an ICT integration context as it has many different meanings for teachers (E1-2). What is clear from the literature is that ICT integration often fails if there is a lack of motivation to change existing pedagogy. Loveless (2011) emphasises that “the vision and motivation of educators are grounded in their beliefs about why they think their practice matters, and how they can best design experiences and environments for learners” (p.312). Peer pressure to try new things could also motivate teachers, primarily if the activities engage students to learn (Ertmer & Ottenbreit-Leftwich, 2010). Hitchcock (2017) outlines the power of intrinsic motivation to change the pedagogy of academics when it is underpinned by a strong philosophy and proper leadership regarding educational technology. Wise (2013) underlines the relational connection between teacher beliefs, their decisions regarding technology use, and what they consider to be important skills to acquire. This could range from replicating traditional activities with some technology input, to approaching creativity from the students’ viewpoint and using the technology to enhance their creative needs. He also remarks on the fact that there seems to be “an inherent conservatism in education” regarding technology use (Wise, 2013, p. 320), despite the prolific engagement with technology in all other aspects of society.

Many barriers to technology integration have been identified in this thesis as well as in the existing literature (Buabeng-Andoh, 2012; Dorfman, 2008; Spector, 2013; Trucano, 2005; Watson, 2006). When first and second-order barriers are removed, the reverse effect can motivate teachers to change their practice and be more accommodating in their beliefs about technology (Ertmer & Ottenbreit-Leftwich, 2010). The second dataset is proof of how the removal of these barriers influenced the respondents. First-order barriers that diminished from the first to the second dataset were budget constraints, access to and availability of devices, restrictive school policies, and inadequate infrastructure. Second-order barriers that diminished or disappeared were the scepticism around technology and whether it added value to teaching and learning, inadequate skills and consequent anxiety regarding self-efficacy, and resistance to change in practice and pedagogy. Teachers also feared that the technology might not be working and that this would make them seem inadequate or unprepared (E1-2).

Access to tools and equipment is the logistical aspect of ICT integration (Gall, 2017). The accessibility of devices and the technologies that enable these to be used for learning are very important to enable successful technology integration. In the second dataset robust infrastructure and connectivity, updated software and music programs, and sufficient technical knowledge and maintenance (T1-2, T6-2), are mentioned as being critical success factors. Teachers share their frustrations when they experience a breakdown in any of these components (E2-2, T2-2, T7-2, T10-2), inferring that they have become reliant on these systems.

The findings show that even with access to devices, there is one more component required to make ICT integration successful, and that is the interconnectivity (Watson, 2011) of these devices. This is only possible with a robust infrastructure and a fast broadband connection. The New Zealand government has provided the upgraded infrastructure to all schools with the SNUP project (Te Kete Ipurangi, 2015), so it is now a matter of how this connectivity is applied in a classroom context. Collaboration is an important feature of 21st century pedagogy. "An added dimension to this trend is an increasing focus on online global collaboration where contemporary digital tools are used to engage with others around the world to support curricular objectives and intercultural understanding" (Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A., 2015, p. 12). Collaboration is further enabled by the interconnectivity of mobile devices in particular, and with the increased availability of such devices in music classrooms, it is critical that this feature of the devices is utilised to its full potential with students.

Original Contribution

The original contribution of this thesis provides insight into music teachers' practice in a New Zealand context. It compares their daily practice and perceptions about the use of ICT in their music programmes over a four-year period between 2008 and 2012. The analysis of the findings culminates in a thematic network (Chapter 6, p. 216) that organises the analysed data in a hierarchy of themes. Basic themes are grouped and then reduced to organising themes, which in turn distil into a global theme.

Four organising themes emerged from a range of basic themes. The organising themes were access, connectivity, pedagogy, and motivation. Access included equipment such as projectors and computers, technical support and maintenance, and student-to-device ratios. Connectivity combined infrastructure, operating systems, hardware and software operation, and the policies that enable these systems and programs. Pedagogy grouped together aspects of teacher practice regarding handheld devices, composing, ICT integration, collaboration, technology utilisation, and how these aspects influenced their interest and motivation to adapt their teaching. Motivation organised the factors that inspire and excite teachers to integrate technology into their classrooms. These factors were innovation with mixed media, video and audio recording, as well as other motivating factors such as creativity and student capability.

The data paints a clear picture when it is scrutinised through the lens of a thematic network. What this network affirms is the importance of motivation and pedagogy during the technology integration process that is clear from the findings in this thesis. The result of identifying basic and organising themes is a global theme that reiterates the varying degrees of success that are achieved during ICT integration in music classrooms. From this reductive process, the four organising themes lent themselves to being developed into a simple framework. This technology integration framework (see Table 29) is based on the four organising themes of accessibility, connectivity, pedagogy, and motivation.

It is suggested that the technology integration framework be used as a practical guideline for music teachers who would like to address issues in their ICT implementation. This framework is simple yet effective as it provides a matrix that enables any user to identify gaps in the integration process at a glance. Effective ICT integration is possible when all four components are present in the process: effective pedagogy, teacher motivation, access to devices, and proper infrastructure. The absence of any of the four components leads to various problems. Ineffective pedagogy can be identified when the same teaching methods are followed as before, just with newer technology tools. This represents the Substitution level in the SAMR model (Puentedura, 2006). If the pedagogy doesn’t change along with the improved affordances of the technology, the teaching becomes forced and stagnant. Teacher motivation drives technology integration. If teachers’ actions are not driven by their pedagogical beliefs, self-efficacy and confidence levels, there is very little motivation to attempt any ICT integration. Sustainable integration is affected by the access students and teachers have to devices for learning. Closely linked to access is also the requirement that devices are well-maintained and in good working order to provide trouble-free operation. The final component in the matrix is connectivity. Learning is a social event and to integrate ICT effectively, this social aspect should be utilised and encouraged. Robust wireless access across classrooms mean that students are no longer bound to a specific location for Internet access. The portability of mobile devices provides teachers and students with more flexibility to learn and teach regardless of physical location. The interconnectivity of devices provides possibilities to collaborate on projects and share learning experiences. The absence of interconnectivity due to school policy restrictions or teacher beliefs impairs these options and should be reconsidered.

Limitations of the thesis

Research of a qualitative nature has certain limitations that are inevitable. The sample profile for finding participants was based on their availability, interest in the topic, and willingness to participate. Although many music teachers were approached, the final selection for the sample had to adhere to these limitations. Although a larger sample could have provided more data, the sample size was manageable to process the data.

The participants were already using technology in their music programmes at the time when they were selected for the research, and therefore one could reason that participants were biased by having pro-technology views and beliefs. It was a conscious decision to select participants who had some technology experience and available equipment they could use. If this was not the case, the datasets might have been much smaller and not useful at all.

The data collection process involved face-to-face, Skype and telephonic interviews. A one-hour time allowance was given to every participant to accommodate the busy schedules of the interviewees and the interviewer The interview schedule was adapted from an existing schedule (ECAR, 2005) used for gathering qualitative data about the use of technology. Once the findings were discussed, the addition of some pertinent questions could have been useful. Designing a more personalised interview schedule could have included specific questions about using technology for NCEA assessment activities and teachers' perceived TPACK. There might have been some discrepancy between the teachers' perceptions of their own practice and what they actually did. The interview data might have been supplemented by classroom observations.

This thesis could have included several observations over the four-year period between 2008 and 2012. This would have provided a gradual progression of the various influences that changed teachers' practice and circumstances. This thesis would then have been a longitudinal study describing the trends that influence the technology integration process. The nature of the circumstances did not, however, allow for these ongoing observations because of time and resource constraints of both the researcher and the respondents. The study nevertheless succeeded in capturing rich data.

Implications of the findings for teachers

The pressing issue remains: why do we need to integrate ICT into our teaching practice as music teachers? Is this even necessary to maintain credibility as professional practitioners? Can we afford to maintain the status quo of a classically-enforced music programme that requires students to understand the fundamentals of harmony and counterpoint, perform within the traditional realms of excellence, and provide compositions with astounding instrumentation and contrapuntal agility and genius? What is the fuss about all these technological enhancements to provide compositional flexibility?

These are all issues raised by educators from a classroom practitioner's perspective. Add to that the layer of expectation and conformity required by

NCEA assessment tasks and standards criteria, and the result is a conundrum of conflicting points of view and clashes in personal preferences.

There seems to be a vast divide between teachers who can imagine and appreciate the possibilities that ICT and digital technology bring to the music classroom, and those that blindly refuse to acknowledge any of its advantages. Is this more about the comfort zones of the teachers, or what is best for the students?

Much has been written and speculated about the disposition of the 21st-century student. Are they digital natives (Prensky, 2001) who approach technology with some in-born comfort level and understanding that comes entirely naturally to them? Is this a gross assumption that we as teachers use to reason away our discomfort with the newer technologies that confront us in the classroom?

It is critical for teachers to teach today’s students in a 21st-century manner. This way of teaching challenges educators to integrate educational technologies into their classrooms. Brown (2011) writes that "we are living in a connected world, and to disconnect students from this world the moment they walk into a classroom is doing them an injustice". Wise (2013) also reminds us that the students we currently have in our music classrooms have “an enormous range of musical preferences and references” (p.305), simply because they have access and listen to such a wide variety of music. It is critical that the current teacher pedagogy support a 21st-century teaching model, moving away from the banking model of education, a term that was coined by Paulo Freire (1996). This model used the metaphor of students as empty containers into which educators must deposit knowledge. It is now an outdated methodology, especially in classrooms where students have autonomy around their learning styles and choice of device.

The deliberate use of technology can enhance specific learning styles and support differentiated learning opportunities, especially in a subject area such as music that mainly engages the senses. For example, composition software allows students to use all four learning modalities: visual, auditory, reading/writing and kinesthetic. These modalities can then be monitored and supported as teachers take on the role of facilitator rather than instructor. Technology provides the tool for the teacher to manage and support learners through these individualised learning opportunities. Technology integration can further enhance performance and composing skills, amplify creative processes, hone analytical listening and intensify research in music programmes in New Zealand. The aforementioned are already happening in the USA (Tobias, 2012), England (Wise, Greenwood, & Davis, 2011), and Australia (Southcott & Crawford, 2011).

Music educators are coming to terms with a new way of teaching music that is probably very different from the way they were taught. Hennessey at al. (2005) refers to this 'coming to terms' process as pedagogical evolution. Professional learning networks and educational forums such as Musicnet, Music EDnet and Edutopia support rich discussions and resource-sharing opportunities for teachers who want to become better informed and more skilled in the use of available technologies. Social media and online platforms encourage teachers to explore and discuss the innovative use of technology in their music classrooms. MusTech.Net 2.0 and Dr Joseph M. Pisano's Twitter feed are two examples where these conversations and virtual exchanges occur. Other social networks such as Facebook, blogs dedicated to the use of music technology in education, and YouTube tutorials, provide insightful perspectives on the practice of music educators in New Zealand and abroad.

It is not only the teachers who benefit from the online world. Students can learn creative arts techniques from tutorial sites such as Lynda.com and Kadenze.com. Technology can be a strong motivator to students engaging in the various creative processes that music study offers. The technology offers different modalities and approaches when students engage in a specific creative process such as composition. Technology can provide students with a variety of choices to produce a typical end product such as a composition inspired by the students' cultural heritage. A simple user interface can speed up tedious tasks such as repeating the same passage, by simply copying and pasting it with notation software. Technology can level out the playing field, as

Ward points out: “Secondary school pupils can compose freely using ICT in the classroom, easing and ‘democratizing’ the creative process, enabling a high standard for all, regardless of formal musical training” (2009, p.154).

The use of digital music technology in the classroom not only enhances the teaching content and traditional methods but “also improves the efficiency and effectiveness of teaching” (Qionggang, 2009, p. 1947). Moreover, previous research points to the connection between the classroom and the world outside where digital technologies form part of the daily lives and interactions of students. A study conducted on 25 campuses in the USA found that college students use technology to access current news events, purchase products, make travel plans, manage their health and fitness and find accommodation (Head & Eisenberg, 2011). Technology is woven into most aspects of students’ lives. We are teaching digital learners in the 21st century. As research demonstrates, technology integration in schools improves outcomes for these digital learners: “the research evidence over the last forty years about the impact of digital technologies on learning consistently identifies positive benefits” (Higgins, Xiao, & Katsipataki, 2012, p. 3).

Despite professional development initiatives offered by the New Zealand government over the past two decades, music teachers still seem to be reluctant to embrace music technology fully into their teaching programmes. This reluctance seems to be driven more by the comfort levels and belief systems of the teachers, than by the learning needs of their students.

School policies and blanket decisions impact profoundly on device access and utilisation. The SNUP initiative in New Zealand schools has improved the access issues to a large extent (Ministry of Education, 2016) and the 11-year project has provided 2,431 New Zealand schools with the infrastructure to access fast and reliable internet. Along with these improvements, schools were also offered an upgrade to wireless systems (Ministry of Education, 2014).

Teacher self-efficacy drives what is allowed and attempted in classrooms. It seems that teachers often pursue the technologies they are comfortable with, rather than letting students explore possibilities. Music teachers in New Zealand secondary schools often experience high demands on their time. In addition to their daily teaching and administrative load: "major tensions of practice were found to arise from the boundary positions which teachers occupied at the interface of two worlds – the inner world of music and the outer world of the school – and from the complex demands of working in the three different areas of classroom, extra-curricular and itinerant music" (Donaldson, 2012, p. i). This is the nature of the job for any performing-arts teachers because they are required to prepare students for performances and other extracurricular events. Music teachers often have the disposition of being 'too busy' to pursue ways of integrating new ideas and technologies into their programmes. The technology integration framework introduced at the end of Chapter 6 might provide a way forward for teachers who feel stuck in their professional practice regarding the use of technology.

Future research

There are a few direct extensions of this research to be considered. More insight might be gained if the research included observations of the participants in action to see how they applied their technological pedagogical knowledge (TPK). Future research could investigate the impact of student voice to capture the students' perspectives on the teachers' practice and to draw a comparison between student and teachers' data. The input from students could provide valuable insights into how they would like to collaborate on student-centred and project-based activities in the music classroom. This information would inform teachers to be more accommodating and flexible in their pedagogical approach when teaching secondary students and would inform their MTPACK:

> Studies in music education that draw on the TPACK framework might also examine the extent to which technology can be an effective means for teaching music, and the types of preservice technology experiences that translate particularly well into in-service classroom applications. (Dorfman, 2007, p.536)

Broader issues that might benefit from research that extends this thesis could include studies to investigate how assessment tasks could be tailored to have a more generic approach with less prescriptive technology requirements at NCEA Levels 1-3. The New Zealand Curriculum is currently undergoing significant changes to include a renewed and more specific focus on the integration of technology across all levels and in all curriculum areas (“Supporting digital learning”, 2018, para. 1). In the light of these recent developments, it is critical for music teachers to find sustainable methods of technology integration.

The technology experiences of music students outside the classroom need to be considered when music programmes are developed to make a real connection with students and their everyday lives. It is no longer sufficient to teach formal Western traditions of notation and harmony when students have digital audio workstations at their fingertips and can program live music to a dancing audience. Teachers should make the most of technology to ensure that music students have the optimal learning experience supported by technology, an experience that is authentic, relevant, and creative.

Conclusion

Using a phenomenological approach, this thesis was ultimately about finding connections - connections between teachers’ technological, pedagogical and content knowledge, connections between humans and computers, and connections between the devices. We need these connections to make sense of a world where technology forms an integral part of the way we teach and the way we learn. Ertmer and Ottenbreit-Leftwich describe this mindset aptly:

> It is time to shift our mindsets away from the notion that technology provides a supplemental teaching tool and assume, as with other professions, that technology is essential to successful performance outcomes (i.e., student learning). To put it simply, effective teaching requires effective technology use. (2010, p. 256)

In conclusion, a statement about the renewed focus of the New Zealand Curriculum to include digital technology at all learning levels, captures the essence of this thesis. Our responsibility as teachers:

> is to ensure that all learners have the opportunity to become digitally capable individuals. The change signals the need for greater focus on our students building their skills so they can be innovative creators of digital solutions – moving beyond solely being users and consumers of digital technologies. (Te Kete Ipurangi, 2018)

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Appendices

Appendix A: Email questionnaire for pilot

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

[Date]

[Address of Institution]

Dear [name of staff member]

I am conducting research into the use of technology in secondary music programmes. I am interested in the way technology is integrated in these programmes and how teachers and students use technology in their daily teaching and learning.

In this project I **am interested in what your department does and how you do it.**

Below are five questions that I seek responses to. If you agree to participate in this research, then simply reply and respond to the questions below. **It will take approximately 10 minutes of your time.** Please feel free to contact me if you have any questions prior to, during, or after your participation in the research.

Please note:

a) All the data collected will remain **secure** under lock or on a computer database accessible by password only.

b) Your identity and institution will remain **confidential** and **anonymous**, unless you specifically state otherwise.

c) You may decline to answer any particular question and have the **right to withdraw** from the research any time up to 3 weeks after you return your email, without explanation.

d) Information will be used for **journal articles, conferences, lectures and book chapters**. As stated earlier, individuals will **NOT** be identified by name in any publications or reports.
e) Please indicate if you would be willing to take part in an interview. If you are, type YES in the box.

Questions for participants
1: Does your department use computer-based technology in the music programmes on offer? If so, it would be helpful if you could provide details about what year groups and NCEA levels are involved.

2: Do you have access to computers in the department? If so, it would be helpful if you could provide details of the access and layout of the facilities i.e. if the computers are in a separate room, how many you have, Windows or Mac etc.

3: Are the computers linked to an internal network (intranet)? Please specify if you have access to the Internet and email facilities.

4: Are you using any commercial software programs in the department? If so, please provide a title.

5: If you are able to, please comment about your department's view on technology integration in music programmes.

Thank you very much! I look forward to your response.
Please let me know if you wish to receive a copy of the findings.

Amanda O'Connell
PhD candidate
University of Waikato

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, Charlotte Church, email fass-ethics@waikato.ac.nz, postal address, Faculty of Arts and Social Sciences, Te Kura Kete Aronui, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240, Aotearoa New Zealand

Appendix B: Letter of introduction

THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Department of Music
School of Arts & Social Sciences
The University of Waikato
Private Bag 3105
Hamilton, Aotearoa New Zealand

Kia ora

Background

My name is Amanda O'Connell and I am conducting research as part of a PhD at the University of Waikato on the use of ICT in secondary Music programmes. I am currently a senior teacher in the Music department at The Correspondence School in Wellington.

Invitation

This is an invitation to every secondary Music department outside the Wellington region who would be interested in taking part in the research. I have already contacted schools in my region but would like to make the research inclusive of the whole of New Zealand. If you are interested please respond to presto.man@xtra.co.nz and read on. You will then receive the initial survey via email. Following on to this will be an interview and possible consultation with student focus groups.

Aim

The aim of the study is to examine the use of computer-based technology in music programmes in New Zealand secondary schools in 2007-2009. It will investigate ways to improve the integration of technology in the Arts curriculum's Music strand. As a secondary music teacher I would approach the research from a professional as well as a research point of view.

What?

The research will investigate the successes and failures of technology used in daily teaching practice. It will also provide data about implementation and innovation as perceived in classrooms. It is not aimed at producing quantitative data about numbers of users and applications. It will seek to explain the reasons for using ICT, and then survey the opinions of the users by means of qualitative research methods.

Why?

The results will attempt to provide pragmatic information to music educators on the needs and the difficulties likely to be faced in providing technology-integrated music programmes in schools.

How?

By using qualitative research methods, the study will record the views and initiatives of teachers in order to establish how ICT integration helps secondary school music teachers to improve their music education programmes. The methodologies for this research are derived from ethnography and action research.

The research will make known specific classroom practices and strategies to the wider education community, make recommendations for future professional development for teachers, and also suggest areas for further research.

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This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences, University of Waikato. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, Charlotte Church, email fass-ethics@waikato.ac.nz, postal address, Faculty of Arts and Social Sciences, Te Kura Kete Aronui, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240, Aotearoa New Zealand

Appendix C: Consent form for interviews

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

The application of ICT in the music classroom:
Tools and Trends in New Zealand secondary schools (2007-2009)
Amanda O'Connell

CONSENT FORM

1. I am undertaking a research project on the use of technology in secondary music programmes. I am interested in the way technology is integrated in your programmes and how you and your students use technology in your daily teaching and learning. This project has been given ethical approval by the Human Research Ethics Committee of the University's Faculty of Arts and Social Sciences.

2. I would like to interview you about what your department does and how you do it. The interview will take about an hour.

3. I would like to tape record the interview so that I can obtain an accurate record of your views.

4. When I am not using them, the tape recording and any transcript of it will be stored in a locked filing cabinet in my office – no-one apart from me and my academic supervisor will have access to them. They will be stored there for five years from collection date after which they will be destroyed.

5. You may choose to be anonymous in this research project. This means that no-one else will know that you have been interviewed and you will not be able to be identified in any published report on the findings of the research.

6. The results of this research will be presented as part of a doctoral thesis and may be used at academic conferences or published in an academic journal.

7. If you agree to take part in this interview, you have the following rights:

a) To refuse to answer any particular question, and to terminate the interview at any time.

b) To ask any further questions about the interview or research project that occurs to you, either during the interview or at any other time.

c) To remain anonymous, should you so choose - anything that might identify you will not be included in conference papers, academic articles or any other report about the findings of the research.

d) To withdraw your consent at any time up until **three weeks** after your interview by contacting me at the email address on the letterhead or by telephone.

e) To take any complaints you have about the interview or the research project to the University's Faculty of Arts and Social Sciences' Human Research Ethics Committee (University of Waikato, Private Bag 3105, Hamilton 3240, or you can email its secretary, Charlotte Church, at charl@waikato.ac.nz).

f) "I wish to remain anonymous." (circle) YES NO – to be confirmed at end of interview.

g) "I wish to receive a copy of the findings." (circle) YES NO

h) "I wish to receive a copy of the transcription of the interview." (circle) YES NO

"I consent to be interviewed for this research on the above conditions"

Signed: Interviewee ____________________________ Date: ____________

"I agree to abide by the above conditions"

Signed: Interviewer _____________________________ Date: _____________

Appendix D: List of interview topics for teachers

Introduction
This interview will be recorded for research purposes. Please state your name, position and name of the school you're teaching at.

1. Background
1.1 What is your role in supporting /training the students in the use of technology in the music classroom?
1.2 What kinds of contact do you have with students helping them with technology issues specific to the music program?

2. Skill and use
2.1 What do you think of the current state of student technology skills?
2.2 What kinds of technology skills are you good at?
2.3 What types of technology do you use in the music classroom?
2.4 What types of technology skills are you bad at?
2.5 What are the best technology skills that students possess?
2.6 What is the most difficult hurdle to overcome regarding the use of technology in the music classroom?

3. Your use of technology in the music classroom
3.1 Do you think entertainment skills transfer over to the academic realm? If so, how do you utilize it in your programs?
3.2 Do you think students find the use of technology helpful in the music classroom? If so, why and if not, why not?
3.3 Do you have any specific examples of students using technology creatively or in an innovative way in the program?
3.4 Do you think students prefer to learn in an integrated environment? If so, why and if not, why not?

4. Future
4.1 If you had the time and resources to design a fully integrated music program making excellent use of technology, what would it look like?
4.2 What is your short term goal regarding the use/ integration of technology in the classroom?
4.3 If you could change three technology components in the classroom, what would they be?

Closing:
Is there anything you would like to add that was not covered during the interview?
Thank you for your participation.

(Adapted from the ECAR Research Study 6, 2005)

Appendix E: List of interview topics for industry experts

Introduction
This interview will be recorded for research purposes. Please state your name, position and name of your business.

1. Background
1.1 What is your role in supporting /training the teachers and students in the use of computer technology in the music classroom?
1.2 How would you provide the technology support specific to the secondary music programmes?

2. Skill and use
2.1 How would you rate the current state of student technology skills?
2.2 What kinds of computer technologies do students like?
2.3 What types of computer technology do you provide for use in the music classroom?
2.4 What types of technology skills are the teachers less confident with?
2.5 What are the best technology skills that teachers possess?
2.6 From the industry's point of view, what is the most difficult hurdle to overcome regarding the use of technology in the music classroom?

3. The use of computer technology in the music classroom
3.1 Do you think skills transfer from the entertainment to the academic realm? If so, how?
3.2 Do you think students find the use of technology helpful in the music classroom? If so, why and if not, why not?
3.3 Do you have any specific examples of students using technology creatively or in an innovative way in classrooms?
3.4 Do you think students prefer to learn in an integrated environment? If so, why and if not, why not?

4. Future
4.1 If you had the time and resources to design a fully integrated music program making excellent use of technology, what would it look like?
4.2 What is your short term goal regarding the use/ integration of technology in the classroom?
4.3 If you could change three technology components in the classroom, what would they be?

Closing:
Is there anything you would like to add that was not covered during the interview?
Thank you for your participation.

(Adapted from the ECAR Research Study 6, 2005)

Appendix F: Coding matrix for data set 1

Category	Parent Node	Child Node	Description
Infrastructure			Network, server, connectivity, access, devices and policies pertaining to ICTs
	1. Budget		School, department
	2. Devices		Any device with the capability to connect to the internet or to operate software as a program or application, including mobile and student-owned devices
	2a⇢	BYOD (bring your own device)	Student owned devices
	2b⇢	Mobile devices	Tablets, phones, MP3 players and laptops
	3. Equipment		Electric, fixed, projecting, photo, video
	4. Network		Wired, wireless
	5. Operating systems		School wide and specific to the music department – Apple Mac and Windows
	6. School policies		Policies regarding the use of devices and the conditions of access
Inside the music classroom			What happens inside the classroom in terms of ICT integration and utilisation
	1. Advantages		The advantages of using ICTs in the classroom
	2. Barriers		Anything preventing teachers and students from utilising ICTs in their daily teaching and learning programmes
	3. Class sizes		Student numbers and grouping
	4. Classroom setup		Organising of furniture, equipment and student rotations
	5. Composition		Composing with ICTs
	6. Creativity		Creating presentations, video, recordings
	7. Delivery format		How teaching is delivered
	8. Disadvantages		The perceived negatives of ICTs

	9. Frequency of use	Access to ICTs and consequent usage
	10. Integration	The level of ICT integration in classroom practice
	11. Internet	Accessibility and robustness of connections
	12. Notation	Notating with software programs
	13. Other hardware / Sound equipment	Amplifier, microphone, equaliser, mixer, USB controller, MIDI keyboard, MIDI interface
	14. Performance	Performing music with the support of ICTs
	15. Recording	Recording with ICTs
	16. Research	How ICTs support research in the classroom
	17. Software	Programs used for learning and teaching music skills
	18. Teaching programmes	Specific mention of ICT inclusion in teaching programmes
Skills and knowledge		Teacher and student skills, beliefs and knowledge around ICTs
	1.Technology skills of industry experts	Skills specific to industry experts
	2. Technology skills of students	Student skills and knowledge around ICTs
2a→	Competency levels	Natural ability of students with ICT
2b→	Innovative use	ICT application going above and beyond the expected
2c→	Student perceptions	The way students perceive technology from a teacher’s perspective
2d→	Transferrable skills	ICT skills used for leisure activities to be applied for learning (entertainment skills)
	3. Technology skills of teachers	Teacher skills and knowledge around ICTs
3a→	Competency levels	Natural ability of teachers with ICT
3b→	Beliefs	Professional and pedagogical beliefs regarding the use of ICT in education

3c→	Technology needs	Specific training needs of teachers
Support		ICT support provided for and needed by teachers and students
	1. Industry support for students	Examples of support from the industry for students
	2. Industry support for teachers	Examples of support from the industry for teachers
	3. Online help	Online support for teachers
	4. Support role of teachers	How teachers are expected to support students with ICTs
	5. Professional development	Availability of PD opportunities
	6. Technical support	Availability of third-party technical support
Ways forward		Plans, aspirations and wish lists
	1. Goals	Specific attainable targets and goals set by teachers regarding the use of ICTs
	2. Vision	Aspirational thinking and planning for the future
	3. Wishlist	Immediate needs for improvement of ICT capability and use

Appendix G: Coding matrix for data set 2

Category	Parent Node	Child Node	Description
Infrastructure			Network, server, connectivity, access, devices and policies pertaining to ICTs
	1. Budget		School, department
	2. Devices		Anything to do with connectivity and mobility
	2a⇢	BYOD (bring your own device)	Student owned devices
	2b⇢	Mobile devices	Tablets, phones, MP3 players and laptops
	3. Equipment		Electric, fixed, projecting, photo, video
	4. Operating system		School wide and specific to the music department
	5. School policies		Policies regarding the use of devices
Inside the music classroom			What happens inside the classroom in terms of ICT integration and utilisation
	1. Advantages		The pros of ICTs in the classroom
	2. Barriers		Anything preventing teachers and students from utilising ICTs in their daily teaching and learning programmes
	3. Class sizes		Student numbers and grouping
	4. Classroom setup		Organising of furniture, equipment and student rotations
	5. Composition		Composing with ICTs
	6. Creativity		Creating presentations, video, recordings
	7. Delivery format		How teaching is delivered
	8. Disadvantages		The negatives of ICTs
	9. Frequency of use		Access to ICTs and consequent usage

	10. Integration		How well ICTs are integrated in classroom practice
	11. Internet		Access or not
	12. Notation		Writing music notation with software programs
	13. Online platforms **(new node)**		Delivering learning programmes in an online environment
	14. Other hardware / Sound equipment		Amplifier, microphone, equaliser, mixer, USB controller, MIDI keyboard, MIDI interface
	15. Performance		Performing music with the support of ICTs
	16. Recording		Recording with ICTs
	17. Research		How ICTs support research in the classroom
	18. Software		Programs used for learning music skills
	19. Teaching programmes		Specific mention of ICT inclusion in teaching programmes
Skills and knowledge			Teacher and student skills, beliefs and knowledge around ICTs
	1.Technology skills of industry experts		Skills specific to industry experts
	2. Technology skills of students		
	2a⇢	Competency levels	Natural ability of students with ICT
	2b⇢	Innovative use	ICT application going above and beyond the expected
	2c⇢	Student perceptions	The way students perceive technology from a teacher’s perspective
	2d⇢	Transferrable skills	ICT skills used for leisure activities to be applied for learning
	3. Technology skills of teachers		
	3a⇢	Competency levels	Natural ability of teachers with ICT

	3b⇢	Beliefs	Professional and pedagogical beliefs regarding the use of ICT in education
	3c⇢	Technology needs	Specific training needs of teachers
Support			ICT support provided for and needed by teachers and students
	1. Industry support for students		Examples of support from the industry for students
	2. Industry support for teachers		Examples of support from the industry for teachers
	3. Online help		Online support for teachers
	4. Support role of teachers		How teachers are expected to support students with ICTs
	5. Professional development		Availability of PD opportunities
	6. Technical support		Availability of third- party technical support
Ways forward			
	1. Goals		Specific, attainable targets and goals set by teachers regarding the use of ICTs
	2. Vision		Aspirational thinking and planning for the future
	3. Wishlist		Immediate needs for improvement of ICT capability and use

Appendix H: Google form

The application of ICT in the music classroom: tools and trends in NZ secondary schools

This questionnaire is a follow-up from an interview I conducted in 2007/8 regarding the topic. Peruse the transcript if you are the successor of another colleague who took part in the research. It is important to note that no personal information or names of schools will be disclosed in the research.

I appreciate your time and effort to complete the questionnaire.

Amanda O'Connell, PhD candidate (Univeristy of Waikato)
* Required

Please state your name, position and name of the school you're teaching at. *

What is your role in supporting /training the students in the use of technology in the music classroom? *
Classroom may refer to a face to face situation or an online environment.

What kinds of contact do you have with students helping them with technology issues specific to the music programme? *

What do you think of the current state of student ICT skills? *

What kinds of ICT skills are you good at? *

Refer to skills you use in or for the music classroom.

What types of technology do you use in the music classroom? *

What types of ICT skills are you bad at? *

What are the best technology skills that students possess? *

What is the most difficult hurdle to overcome regarding the use of technology in the music classroom? *

What mobile technologies do you use in the classroom? *

Do you think entertainment skills transfer over to the academic realm? If so, how do you utilize it in your programs? *

Entertainment skills refer to informal skills students attain outside the classroom during leisure activities.

Do you think students find the use of technology helpful in the music classroom? If so, why and if not, why not? *

Do you have any specific examples of students using technology creatively or in an innovative way in the music programme? *

Do you think students prefer to learn in an environment where ICT is integrated? If so, why and if not, why not? *

Do you use a BYOD arrangement with students? Why or why not? *
BYOD = bring your own device

If you had the time and resources to design a fully integrated music programme making excellent use of technology, what would it look like? *

What is your short term goal regarding the use/ integration of technology in the classroom? How is this different from the short term goal in the first interview? *

If you could change three technology components in the classroom, what would they be? *
Explain what changes have taken place regarding the three technology components discussed in the first interview?

Is there anything you would like to add or comment on?

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Appendix I: ECAR qualitative interview questions

Appendix D

Qualitative Interview Questions

Questions for Student Focus Groups

1. Background

1.1 Student information: age, gender, senior/freshman, full/part-time, on/off campus, discipline, ethnic

1.2 How many computers do you own? What kinds? How long have you owned them?

2. Skill and use

2.1 How skilled are you at using computer technology to do work required for your classes?

2.2 There is a lot being said and written about the current generation of students being good at using technology and as being tech savvy. Do you think this statement is true of yourself? Of your friends?

2.3 What kinds of technology skills are you good at? (Last year's students reported being good at communications and Web surfing but less skilled at things like creating Web pages, graphics, video.)

2.4 What kinds of technology skills are you bad at?

2.5 What kinds of technology skills do they think students in general are bad at?

2.6 How good do you think students are at dealing with changes in technology (e.g., when you get a new course management system such as WebCT or Learn@UW) or a new set of programs or when what you are used to using isn't available?

2.7 Do you use computers and the Internet for entertainment? If so, what kinds of activities do you do for entertainment?

2.8 What impact do you think a student's major has on their use and skills with technology?

3. Your use of technology in courses

3.1 Do you think that the skills you may acquire in using the Internet for entertainment transfer to your school work? If so, what are the components of those skills? If not, why not?

3.2 What kinds of uses of technology have instructors made in the courses you have taken thus far?

3.3 What are the major advantages that you see in the use of technology in your courses?
3.4 What is the major disadvantage that you see in the use of technology in your courses?
3.5 Do you think that the use of technology in your courses helped you in your learning?
 3.5.1 If so, how?
 3.5.2 If not, why not?
3.6 Do you think that in general your instructors are skilled in the use of technology in teaching?
3.7 What are the major obstacles that you see to more effective use of computer and information technology in your courses?
3.8 One of the findings of last year's study was that students indicated that technology in their classes was about convenience and communication and control of the learning experience. While improved learning was also mentioned, it seemed to play a lesser role. Can you please comment on this?
3.9 If there was one thing your professors could do and not do with respect to technology in your course, what would it be?

4. Future

4.1 What advice would you give university administrators who are keen to encourage the effective use of technology in college courses? What sorts of things should they be doing?

5. Other

Questions for Administrator Interviews

1. Background

Names/e-mail addresses
1.1 What is your role in supporting/training students?
1.2 What kinds of contact do you have with students helping them with technology issues?

2. Student Technology Skills and Use

2.1 What do you think of the current state of student technology skills? Do you think students tend to be skilled in using technology or not?
2.2 What do you think is the breakdown from Highly Skilled, Average, and Poor to Very Poor skills among undergraduates?
2.3 What kinds of technology skills do you think students are good at?
2.4 What kinds of technology skills do you think students are bad at?
2.5 What impact do you think a student's major has on their use and skills?

3. Student Technology Use in Courses

3.1 Do you think their entertainment skills transfer over to the academic realm?
 3.1.1 If so how?
 3.1.2 If not, why not?
3.2 Do you think that most students find the use of technology helpful in their courses?

3.2.1 If so how?

a. Presenting complex information in visual/graphic format
b. Helping organize or manage information
c. Encouraging or requiring them to spend more time engaging with the course materials
d. Communicating with the instructor
e. Communicating or collaborating with their classmates
f. Because it makes learning more active (through use of simulations or animations)
g. Because it encourages prompt feedback from the instructor and provides a way for the instructor to provide them with more feedback
h. Because it allows the student to participate more fully in class activities
i. Because it enables them to take practice exams and quizzes and get feedback on their progress
j. Other (please describe)

(In last year's study, students indicated that they primarily used technology in classes for convenience, control of their activities, and communication. Increased learning was also reported at a lower level. What do you think of this finding? Does it fit with your experience?)

3.2.2 If not, why not?

3.3 Do you have any specific examples/experiences with student use of information technology that you thought were particularly useful or creative?
3.4 In last year's study, students indicated that they preferred a moderate amount of technology in the classroom. Does this surprise you? Why or why not?
3.5 Do you think most instructors make good use of instructional technology?

4. Future/Miscellaneous

4.1 Do you have an institutional overall strategy regarding student use and skills with information technology? How do the student's technology skills help or hinder achievement of this goal?
4.2 If you had to design a program to improve students' use of technology, what would it look like?
4.3 How do you measure the success of what you're doing in supporting/training?
4.4 What is different today than what you were doing 3 years ago?
4.5 What is changing in what you are doing in the next 12 months? 24 months?

5. Other