PREPARING STUDENT TEACHERS TO USE MOBILE TECHNOLOGIES IN TEACHING AND LEARNING: A SINGLE SITE CASE STUDY

A thesis

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Dedication

To my family especially to my dear mother, Esther Naliaka Obonyo.

She struggled to make the dream of education a reality.

Mama has always believed in me and she said

“put your trust in God, nothing is impossible.”

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Publications and Presentations arising from this Thesis

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Papers in Conference Proceedings

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Obonyo, C., Fickel, L. H., & Davis, N. (2018, July 3-6). Thriving through uncertainty: Teacher educators responding to 'future-focused' principles. [Paper presentation]. *In proceedings of the 2018 ATEA and TEFANZ Conference* (pp. 29-30). Melbourne, Australia. https://atea.edu.au/wp-content/uploads/atea-tefanz-2018-conference-handbook-final-jun25.pdf

Obonyo, C., Davis, N., & Fickel, L. H. (2018, March 26-30). Mobile learning practices in initial teacher education: Illustrations from three teacher educators. [Paper presentation]. In E. Langran & J. Borup (Eds.), *Proceedings of Society for Information Technology & Teacher Education (SITE) International Conference* (pp. 2424-2429). Washington, D.C., United States: Association for the Advancement of Computing in Education (AACE).

Obonyo, C., Davis N., & Fickel L. H. (2018, April 9-11). New forms of teaching and learning: Examples from one teacher educators' mobile pedagogical practices. [Paper presentation]. *Flexible Learning Association of New Zealand (FLANZ) 2018 Conference*. Palmerston North, New Zealand.

Obonyo, C., Davis N., & Fickel L. H. (2017, December 4-8). Mobile learning in initial teacher education. [Paper presentation]. In F. Y. Yu et al. (Eds.), *Proceedings of the 25th International Conference on Computers in Education (ICCE)* (pp. 9-12). Doctoral Student Consortia. Christchurch, New Zealand.

Podcast

Obonyo, C. (Presenter)., Davis, N. (Presenter)., & O'Shea, P. (Host). (2018, October, 9). Mobile learning practices in initial teacher education: Illustrations from three teacher educators. *Immersive Learning Research Network (ILRN)* [Versatilist Podcast]. North Carolina, USA. https://www.podomatic.com/podcasts/versatilist/episodes/2018-10-08T08_16_17-07_00

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ABSTRACT

The need to prepare student teachers for school classrooms that now require mobile technologies has stimulated teacher education providers to integrate technology into initial teacher education (ITE) programmes. However, with the increasing use of mobile technologies in schools, effective preparation of student teachers for their future school classrooms is unclear and under-researched. Research indicates that student teachers feel inadequately prepared for the realities of future teaching. Studies have identified several strategies that teacher educators may use and a common set of competencies for teacher educators to facilitate learning effectively with technology (Foulger et al., 2017). However, a few studies have explored mobile pedagogical approaches that teacher educators use to prepare student teachers for their future school classrooms but less is known about how teacher educators integrate mobile technologies into their practices to support student teachers' teaching and learning during their teaching practice.

The purpose of this case study was to explore how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers. In particular, the study sought to investigate the pedagogical strategies that teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning. This thesis presents a single instrumental case study of teacher educators' practices with mobile technologies in an ITE department set in an institution of higher learning in New Zealand. The study employed multiple data sources from both teacher educators and student teachers. Data were collected through semi-structured interviews with eight teacher educators who taught multiple courses across four 1-year ITE programmes. Furthermore, online and face-to-face teaching practices of three teacher educators were observed. Survey data of student teachers' perceptions of their learning with mobile technologies were obtained from 110 student teachers enrolled in ITE programmes and analysed using descriptive statistics. Four focus groups were held with 20 student teachers. Analysis of emerging themes using NVivo 12 Plus software identified four interrelated themes: collaboration, authentic learning, aligning coursework with school practices, and learning technology by design.

The findings confirmed earlier research showing that teacher educators used mobile technologies to enhance and support collaborative and authentic learning experiences of student teachers. Weaving mobile learning in all the courses enabled student teachers to

experience how mobile technologies can support teaching and learning, and also to develop pedagogical skills and practices that they could transfer to their future classroom practices. The findings of this case study indicated that teacher educators supported student teachers to learn how to use mobile technologies to design learning resources that were appropriate to the subjects they taught. Data from focus groups with student teachers revealed that learning with mobile technologies across their courses enabled them to build their confidence to use them in the classroom. Student teachers on teaching practice used some of the applications (apps) and digital learning resources they had designed in their coursework. The findings suggest that the coherence between ITE and school practices enabled student teachers to transfer mobile learning pedagogies from coursework to their teaching practice in schools.

This case study contributes to the discussions about preparing student teachers to understand the underlying practices of teaching in innovative learning environments (ILEs). Teacher educators emulated approaches of ILEs to create coherence between ITE programmes and practices in schools by emphasising collaborative learning. The study also contributes to the theoretical implications by identifying the relevance of the iPAC framework to study mobile learning practices in ITE with both teacher educators and student teachers across multiple programmes and courses. Furthermore, this study provides evidence of successful "far transfer" including the use of mobile technologies during their coursework by teacher educators and student teachers, in which the student teachers transferred that learning into their own pedagogy when on teaching practice.

CHAPTER 1: INTRODUCTION

There is an expectation that student teachers will be sufficiently prepared for the ever-changing reality of school classrooms; a change within the last decade is the integration of mobile technologies. This implies that at graduation from initial teacher education (ITE) programmes, student teachers need to be prepared to use mobile technologies for teaching and learning. However, the preparation of student teachers for their future school classrooms, where mobile devices abound, remains a challenge, especially in ways that are transferable to school classroom practices (Burden & Kearney, 2018; Maslin & Smith, 2017). Some researchers have noted a disparity with the way student teachers learn with mobile technologies in their ITE programmes and digital expectations in school classrooms (Maslin & Smith, 2017; Nelson & Johnson, 2017). To address this disparity, it is important that teacher education programmes identify leading pathways that prepare student teachers adequately to learn how to teach with mobile technologies (Schuck, 2016). For this reason, this case study explores how teacher educators prepare student teachers to teach with mobile technologies in their future school classrooms.

This chapter provides an overview of the research study. I begin by stating my position as a researcher, followed by a brief synopsis of key literature to illuminate the importance of the topic before explaining the need for the research. An overview of the methodology ends with the research questions that this study sought to address. The chapter then highlights the benefits of this case study on the use of mobile technologies in teacher preparation and provides the definitions of key terminologies used in this study. This chapter ends with an outline of each chapter in this thesis.

The Researcher

A passion for integrating technology into teaching to offer new approaches to learning led me to pursue a master's degree in instructional technology in the United States of America. During the study of my master's degree, I became a research assistant to a teacher educator who was introducing a flipped-classroom approach into her course (Obonyo & Leh, 2015). As the intermediary between technology experts and the teacher educator, I developed an interest in researching innovations in teacher education, particularly mobile learning. After my graduation, I joined University of Canterbury to pursue a PhD and I was employed as a research

assistant of an innovative teacher education programme. I did not work as a teacher educator. Hence, some distance from the participants, and potential limitation of bias.

Background

The growing presence of mobile technologies in teaching and learning is an increasingly important characteristic of the education landscape in the 21st century. Changes such as the rapid advancement of "bring your own device" (BYOD) in schools (Cavanaugh et al., 2018; Lindsay, 2016) and ITE programmes (Burns-Sardone, 2014; Cheng et al., 2016; Newhouse et al., 2015), has led to the effective use of mobile technologies being recognised as an important aspect of a teacher's knowledge for 21st century learning (Luik et al., 2018). Schools have embraced BYOD by encouraging students to bring their mobile devices to classrooms for learning purposes (Lindsay, 2016; Nelson & Johnson, 2017; Passey & Zozimo, 2016). Ally et al. (2014) noted that BYOD gives learners the freedom to decide what, how, where, with whom, and when to learn. Therefore, in response to these changes in schools, it is important that teacher preparation programmes adequately prepare student teachers to facilitate learning with mobile technologies.

There are challenges in preparing student teachers to integrate mobile technologies into their practices (Tondeur et al., 2017). Many studies have identified that student teachers continue to feel not fully prepared to integrate technology into their future classrooms (Admiraal et al., 2017; Cuhadar, 2018; Farjon et al., 2019; Maslin & Smith, 2017; Myers & Rivero, 2019). Over a decade ago, Darling-Hammond (2012) stressed that inadequate preparation of student teachers produces unqualified new teachers, who struggle to integrate technology into their teaching practices, but also fail to prepare students for the modern workplaces where 70% of jobs demand the ability to deploy information and communications technology (ICT). Since then, teacher education programmes have received criticism on how they prepare student teachers (e.g. Schuck, 2016), and there has been extensive debate in the literature about various ways to develop student teachers' knowledge and skills to successfully integrate ICT into their future classrooms, including mobile devices owned by teachers and learners (Newhouse et al., 2015). Many teacher education providers reviewed their curriculum specifically to integrate mobile technologies into their programmes (e.g. Foulger et al., 2013). In addition, the iPAC framework has been used to study mobile learning practices (Burden & Kearney, 2018). It is

not clear, however, how teacher educators introduce these technological innovations (Burke & Foulger, 2014) nor the digital literacy required.

Avidov-Ungar and Forkosh-Baruch (2018) argued that teacher educators lay foundations for the future of society. This means through preparing student teachers to become 21st century teachers by equipping them with the knowledge, skills, competencies, and dispositions they need to support school students. A central aspect of teacher preparation is helping student teachers understand how schooling is being shaped and practised. There is, however, a discrepancy between student teachers' digital expectations and the reality of their ITE programme experience, suggesting the need to improve the digital pedagogical confidence of student teachers (Maslin & Smith, 2017; Nelson & Johnson, 2017). Noteworthy concerns have been raised about the need for teacher educators to be competent at integrating technology into their teaching practices to support student teachers to become technology-using teachers (Darling-Hammond, 2012; Foulger et al., 2017; Taimalu & Luik, 2019). Although teacher educators "play a key role in enhancing preservice teachers' technology-enhanced educational practices," preparing student teachers to integrate technology into their practices is a challenge for teacher educators (Tondeur et al, 2019, p. 1190), and little is known of how mobile technologies affect the teaching and learning experiences of student teachers in ITE. Furthermore, in New Zealand, as in many other countries, there is limited research of teacher educators' mobile learning practices, or the views of student teachers about their preparation to use mobile technologies in teaching and learning.

Need for the Study

There has been a call for investigations of teacher educators' mobile pedagogical strategies (Burden & Kearney, 2018). Naylor and Gibbs (2018) stressed that if student teachers experience the use of mobile technologies during their coursework, they will be aware of the value of mobile technologies for education, and more likely integrate mobile technologies into their practices. There has, however, been minimal research investigating how teacher educators integrate mobile technologies across multiple ITE programmes in pedagogically innovative ways (Burden & Kearney, 2017) that could support student teachers to adapt and adopt these uses into school classrooms. This is particularly relevant in New Zealand where the majority of state schools have started to implement creative ways to integrate mobile learning into their practices along with the redesign of school classrooms as innovative learning environments

(ILEs), including many BYOD initiatives (Benade, 2017; Fletcher et al., 2017; Nelson & Johnson, 2017; Ministry of Education, 2016). Because of this, New Zealand is one of the countries that is a practical site to research how teacher educators can effectively prepare student teachers to use mobile technologies in their future school classrooms.

Research with a focus on mobile learning practices in teacher education has mainly examined the use of iPads and smartphones within specific discipline areas and/or ITE programmes (e.g. Burns-Sardone, 2014; Kearney & Maher, 2013; Mac Mahon et al., 2016; Naylor & Gibb, 2018; Pegrum et al., 2013). In addition, a few empirical studies have explored the use of mobile technologies in teacher preparation, with evidence from both student teachers and teacher educators (e.g. Pegrum et al., 2013; Vaughan & Lawrence, 2013). Much of the research into the experiences of student teachers has investigated how they use mobile devices to support learning during coursework, but not during teaching practice (e.g. Liu, 2016; Naylor & Gibbs, 2018; O'Bannon & Thomas, 2015; Tolosa, 2017). In contrast, there is limited attention in the literature about how teacher educators implement related innovations in their classrooms (Tondeur et al., 2019); teacher educators have been identified to be the least often studied participants in ITE (Burden & Kearney, 2017). As a consequence, Baran et al. (2019) recommended more research to examine "teacher educators' use of strategies, challenges, and exemplary practices that connect teacher education courses with field practices" (p. 368). Therefore, by exploring how student teachers use mobile technologies during their coursework and teaching practice, this study aims to respond to the recommendation of Baran et al. (2019) by taking an explicit focus on teacher educators' practices with mobile technologies.

It is important that teacher preparation programmes support student teachers to develop the required knowledge and skills to integrate mobile technologies into their future classrooms. Given the presence of mobile technologies in school classrooms, it would be valuable to discover how student teachers can be educated to use mobile technologies effectively as pedagogical tools. Research is needed into the pedagogical strategies that teacher educators use to prepare student teachers to integrate mobile technologies into their teaching and learning.

Research Methodology

A single instrumental case study design (Mills et al., 2010) was selected to explore how teacher educators used mobile technologies to influence the teaching and learning experiences

of student teachers. To achieve this purpose, this case study specifically employed an interpretive approach and multiple sources of data: semi-structured interviews, focus groups, observation of classroom practices, and student teachers' online questionnaires. I also maintained a researcher journal throughout the study. The case study was of teacher educators' practices with mobile technologies in four 1-year ITE programmes in an institution of higher learning in New Zealand. Unlike previous studies, this case study included perspectives from both teacher educators and their student teachers to gain nuanced insights into the pedagogical strategies that teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning. This research sought to contribute to a deeper understanding of how teacher educators integrated mobile technologies into their practices across four ITE programmes and how student teachers used mobile technologies during their coursework and teaching practice.

The research question and one subquestion that this case study addressed are:

How do teacher educators use mobile technologies to influence the teaching and learning experiences of student teachers?

1. What pedagogical strategies do teacher educators use to prepare student teachers to integrate mobile technologies into their teaching and learning?

I addressed these research questions by examining how teacher educators integrated mobile technologies into their practices, and how this was implemented to influence the teaching and learning experiences of student teachers. These aspects sought to identify specific pedagogical strategies that teacher educators used. I have theorised the findings based on related literature and broader theoretical understandings.

Benefits of this Study

This case study contributes valuable insight into the literature about the use of mobile technologies in teacher preparation (Burden & Hopkins, 2016; Maher, 2018; Naylor & Gibbs, 2018), particularly in relation to preparation with pedagogies that support student teachers who teach in schools with ILEs in New Zealand. Observations of classroom practices and the views of teacher educators and student teachers were sought to provide nuanced understanding of how student teachers were being prepared to teach with mobile technologies in their future classrooms, a research field that warrants more empirical study. The study sought to give

multiple examples of how teacher educators used mobile technologies and embedded them within their pedagogy across four ITE programmes.

Combining the views of teacher educators and their student teachers increases the understanding of the practical meaning and theoretical use of mobile technologies in teacher preparation. The theoretical orientation of this research was derived from the constructivist model. Employing both cognitive and social constructivist world views enabled me to explore evidence of multiple realities and to use an interpretive approach to better understand the subjective meanings that the participants had of the phenomenon being studied. The research was also informed by the iPAC framework (Burden & Kearney, 2017) which has three constructs: personalisation, authenticity, and collaboration, each made up of sub-constructs. This case study has described how the findings fit and extend the iPAC framework. According to Burden and Kearney (2018), the iPAC framework "provides a useful lens to explore how mobile technologies can leverage potentially transformational pedagogies in a range of formal and informal learning settings" (p. 91).

It may also be important to note that an unexpected finding related to far transfer is discussed in Chapter 5. This arose because the goal of teacher preparation is to provide student teachers with opportunities to develop knowledge and skills applicable to their future classrooms. Improving our understanding of how to achieve a successful far transfer of professional learning into school practices is particularly valuable to the field. A. J. Davis (2017) identified that far transfer is the ability to apply knowledge and skills to novel situations rather than what was originally learned. Since far transfer does not readily happen, A. J. Davis (2017) argued that the learner, the task, and the instructional contexts are crucial conditions for a successful far transfer of learning.

This case study has provided an opportunity to better understand the teaching approaches that teacher educators may use to design and facilitate their courses, and also support the development of student teachers to transfer their learning into professional practices. More so, how mobile technologies support and enhance teaching and learning. Investigating teacher educators' practices with a range of mobile technologies, using multiple sources of data, and in-depth perspectives of teacher educators and student teachers has previously received little research attention (Burden & Kearney, 2017).

Key Terminology

This section provides the definitions of key terminology used in this case study.

Mobile learning. In this case study, mobile learning is defined as the process of acquiring knowledge and skills by being taught, studying, and practicing across multiple contexts using mobile technologies. I share Pegrum's (2015) view of three levels of mobility which makes mobile learning different from other types of learning such as elearning. (1) Mobility of the devices, but the learners and the learning experiences are not mobile. (2) Mobility of the devices and the learners, but their learning experiences are not mobile, and (3) Mobility of the devices, the learners, and their learning experiences.

Mobile technologies. Lindsay (2016) identified mobile technologies to include "mobile devices, tablets and other portable devices such as iPods and netbooks that might provide insight into aspects of m-learning" (p. 885). In this case study, the term mobile technologies is used as a broad term to refer to the use of hardware mobile devices such as smartphones, iPads, laptops, notebooks, and tablets to facilitate teaching and learning. It also refers to software such as mobile applications (apps) and web-based platforms that can be accessed using a mobile device; however, some uses are limited by internet connectivity.

Mobile devices. Mobile devices are defined in this case study as handheld computing devices, which are easily portable, and can connect to Wi-Fi technologies. It is acknowledged, however, that the term mobile device cannot have a definitive definition because they are rapidly changing, so much so that the United Nations Educational, Scientific and Cultural Organization (UNESCO) embraced a broad definition by stating that "they are digital, easily portable, usually owned and controlled by an individual rather than an institution, can access the internet, have multimedia capabilities, and can facilitate a large number of tasks, particularly those related to communication" (West & Vosloo, 2013, p. 6).

Bring your own device (BYOD). A term used when learners are encouraged to bring their personal mobile devices to their classrooms for learning purposes.

Mobile applications (apps). Mobile applications or apps are pieces of software which are downloaded from distribution platforms, and they run on mobile operating systems. Some apps are free but others are not. In this case study, apps will be referred to those that are designed

explicitly for learning or could be used for learning purposes. Khaddage et al. (2016) identified three types of apps, namely, hybrid, native, and wed/or cloud apps, whereas Pegrum (2015) based their classification on two subject-specific apps such as mathematics, or general-purpose apps such as social networking apps.

Student teacher. A student teacher in this case study refers to a learner enrolled in an ITE programme at an institution of higher learning to undergo training to gain qualified teaching status in either schools (primary or secondary) or early childhood education (ECE) centres upon graduating from their ITE programme; also known as a preservice teacher.

Teacher educator. A teacher educator is defined in this case study as an instructor in a teacher preparation programme who educates student teachers and they often act as role models for student teachers.

Teaching practice. Teaching practice entails student teachers joining either schools (primary or secondary) or ECE centres to practise classroom teaching and undergo a series of supervised teaching duties during their ITE programme. This enables them to apply and practise what they learn in their coursework as they develop their identity as teachers.

Mentor teacher. An experienced classroom teacher who supports one or more student teachers by coaching, providing feedback, and supporting them to reflect on their practices during their teaching practice in schools and ECE centres.

Organisational Structure of the Thesis

This thesis consists of five chapters beginning with this chapter.

Chapter 2 reviews literature related to this case study and is presented in four sections. The first section details the literature related to preparing student teachers for future-focused classrooms, in general, then proceeds to a brief overview of some of the government policies from various countries. The second section reviews frameworks for technology integration, teacher educators' ICT competencies, and effective strategies for preparing student teachers to integrate technology that are evident in the literature. The section ends by highlighting challenges in achieving successful integration of technology into ITE. The third section reviews

studies that have explored mobile learning practices in ITE, while the conceptual framework for this case study is explored in the last section.

Chapter 3 presents a description of the methodology and specific methods I used to address the research questions of this study. This includes the underlying philosophical foundations and the rationale for the chosen research design. To help understand the context of the study, I have provided a general description about the setting of this instrumental case study. The chapter discusses the criteria that I used to select the participants of this study and how I developed and tested the instruments. The chapter also offers details about data collection techniques and data analyses used for this research. The chapter ends with ethical considerations followed.

Chapter 4 presents the case study findings for the reader to gain insight into the pedagogical strategies that teacher educators used across four ITE programmes to prepare student teachers to integrate mobile technologies into their practices. The findings are organised into two sections. The first section provides illustrative narratives of the practices of three teacher educators who were purposely chosen to give a more holistic view of their practices with mobile technologies, and how I experienced their use of mobile technologies through observations. The second section presents the four interrelated themes that emerged from the whole data set and includes all eight teacher educators: (1) collaboration, (2) authentic learning, (3) aligning coursework with school practices, and (4) learning technology by design.

Chapter 5 offers an in-depth discussion of the findings to address the research question. I have examined the findings relating them to both theoretical and practical considerations, conceptual perspectives, and the existing literature to show how this case study expands knowledge. The findings are discussed in three sections. In the first section, I have presented an overview of the integration of mobile technologies across the four ITE programmes. The second section discusses how the findings fit and extend the iPAC framework (Burden & Kearney, 2017). The third section begins with a brief review of literature related to transfer of learning into professional practice. This is followed by a discussion of the findings presented in three parts, the use of apps to support teaching and learning, emulating teaching approaches of ILEs and teaching practice. The fourth section concludes this thesis by presenting the contributions this thesis makes to the field of mobile learning in teacher education, a review of the limitations of the study and suggestions for future research.

CHAPTER 2: LITERATURE REVIEW

Introduction

This case study sought to explore how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers. This chapter reviews literature relevant to this case study, divided into four sections. The first section examines both international and New Zealand literature related to preparing student teachers for future-focused classrooms, in general, then proceeds to a brief overview of some of the government policies from various countries.

In the second section, the focus is on highlighting the progress that has been made concerning the integration of ICT into teacher education. Specifically, the section is structured on the concepts of frameworks for technology integration, teacher educators' ICT competencies, and strategies for preparing student teachers to integrate technology that are evident in the literature. I conclude the section with a closer examination of the barriers to technology adoption that are argued to hinder student teachers from transferring knowledge and skills acquired during their coursework into the school classrooms.

The third section provides an exploration of mobile learning practices in ITE. I begin the section with a focus on student teachers' contexts for mobile learning, followed by the use of apps to support teaching and learning. The section further presents how mobile technologies support and enhance student teachers' learning during coursework and teaching practice. The section ends by examining studies that focus on preparing student teachers for schools in New Zealand.

Finally, in the fourth section, I present the conceptual framework selected for this case study, one which is based on social constructivist perspectives, followed by a summary of this chapter.

Preparing Student Teachers for Future-Focused Classrooms

Student teachers are being prepared for a future with digital pedagogy and technology at its core, including the development of 21st century skills. This has resulted in pedagogically transformative changes to teaching and learning. Researchers (Bolstad et al., 2012; Redecker et al., 2011; Scott, 2015) have asserted that 21st century learning is characterised by

collaborative learning (within the classroom and the community), participatory learning, problem-based learning, authentic learning, and personalised learning; all of which are enhanced by technology. These are new pedagogies that teacher educators are recommended to model while preparing student teachers for their future-focused classrooms. This then entails a new approach to teaching and learning, within which teacher educators are encouraged to "rethink their reasoning about what they teach and why, and to rethink who they are as teachers" (Scott, 2015, p.15) to better suit their learning objectives.

Digital technologies have been identified as drivers of future teaching and learning (Newhouse et al., 2015). The use of digital technologies creates "opportunities for the rapid adoption of the new approach to learning and an increase in the quality of education... and will expand opportunities in lifelong learning" (Tallinn, 2014, p. 14). Many countries have recognised the impact of digital technologies and have invested in modern digital infrastructure to support teaching and learning. For example, Cavanaugh et al. (2018) noted that countries such as Japan, the United Arab Emirates, and Malaysia have adopted mobile learning as a strategy in their school systems to become high-performing. In New Zealand, a report on future-focused learning in connected communities (Ministry of Education, 2014) indicated that digital technologies are essential in supporting an efficient 21st century curriculum and that digital competencies are vital foundational skills for all students.

According to Scott (2015), both pedagogies and learning environments contribute to the development of 21st century skills and advance the quality of learning. This is echoed by a European report *The Future of Learning* that describes how learning will look in 2020 – 2030 (Redecker et al., 2011). It concluded that the future of learning entails active learning that takes place in new settings and contexts, where personalisation, collaboration, and informalisation are key teaching pedagogies. Benade and Jackson (2017) argued that the establishment of new learning settings in schools and higher education institutions signal government intent to control educational practices through the development of Modern Learning Environments, also known as, Flexible Learning Environments or ILEs. The use of ILEs is a flexible arrangement where pedagogies aim to support the needs of 21st century learners (Benade & Jackson, 2017).

For instance, in New Zealand, there is more investment in creating ILEs in schools than higher education institutions. It is estimated that more than 80% of teaching spaces in Christchurch schools will be ILEs by 2023 (Ministry of Education, 2015). The aim is to address the

shortcomings of conventional teaching and learning environments (Fletcher et al., 2017). During this study, I visited a school that had ILEs. Some of the classrooms that had previously been designed for one teacher with a class of students had been remodelled, while others were newly built using the ILE guidelines (Ministry of Education, 2016). I observed how teachers facilitated instruction in these open spaces and how students used their mobile devices.

In these redesigned teaching and learning spaces, a team of teachers work in a collaborative teaching relationship, with a high number of students in one large open space. The learning spaces also have breakout sections for individual teaching and group work. Pedagogical approaches that underpin learning in ILEs include personalised learning, collaborative inquiry, and co-teaching in student-centred flexible/open learning spaces facilitated by digital technologies (Fletcher et al., 2017; Nelson & Johnson, 2017). Nelson and Johnson (2017) noted that in ILEs, "pedagogies focus on developing twenty-first century skills and competencies … and classroom practice de-privatised in favour of collaborative engagement within and beyond schools" (p. 65). Other than collaborative teaching, the teachers also work on personal learning programmes with individual students to help them achieve their learning goals. These purpose-built environments are characterised by classes that have been combined into hubs of students, which require flexibility and adaptability and include a range of technologies that support new ways of teaching and learning.

Importantly, at the core of these ILEs is the use of digital technologies to facilitate formal and informal learning (Nelson & Johnson, 2017). This approach places a demand on teachers' competence and technology skills, and teacher educators have the challenge of preparing competent student teachers (e.g. Nelson & Johnson, 2017; Tolosa et al., 2017), especially in the pedagogical use of digital tools. Based on these current paradigm shifts taking place in New Zealand's school environments, teacher educators may have to advance their professional knowledge, and reorient their repertoire of pedagogical thinking to offer quality learning experiences to student teachers. Steel and Andrews (2012, p. 248) posited that "so little attention has been focused on academic development to assist teachers [teacher educators] to transform their practices for these spaces [ILEs]." Because of these changes with mobile technologies in schools, understanding how teacher educators prepare student teachers for their future classrooms, merits further investigation.

Given the need for simultaneous renewal of both schools and ITE (Adoniou, 2013; Goodlad, 1994), including innovations in technology (N. Davis, 2010), teacher education programmes are likely to require adaptation in their approaches to prepare student teachers effectively for these changing conditions. It appears the growing sentiment among researchers also stresses the need for more congruence between current practices in schools and ITE (Admiraal et al., 2017; N. Davis, 2010; Schuck, 2016; Tondeur et al., 2017). Admiraal et al. (2017) suggested that similarities between the practices in ITE programmes and schools are critical in facilitating the integration of technology into teaching and learning. For example, when Irish medium schools adopted the iPad as a tool for teachers and students, the use of iPad also became a course requirement for all the student teachers enrolled in one-year ITE programme (Mac Mahon et al., 2016). This was a major national education policy in Ireland that focused on developing the use of ICT in education. In the next section, I examine some of the government policies from various countries that seek to support integration of ICT into teaching and learning to successfully prepare student teachers for their future classrooms.

The Policy Landscape on ICT in Teacher Education

Facilitating teaching and learning in the 21st century and the desire to prepare student teachers who will be successful in using technology in their future classrooms continues to be a concern in various countries. This has resulted in government policies and initiatives that prioritise preparing the new generation of digital learners in the educational systems (Bolstad et al., 2012; Luik et al., 2018). For example, the Estonian Lifelong Learning Strategy 2020 outlined five strategic goals, one of the goals being the incorporation of digital culture into the learning process and the efficient application of modern digital technologies in teaching and learning (Tallinn, 2014).

In the United States of America, the National Educational Technology Plan (NETP) stressed the need for effective integration of technology into classroom pedagogies to ensure that student teachers "leave their teacher preparation programs with a solid understanding of how to use technology to support learning" (U.S. Department of Education, Office of Educational Technology, 2017, p. 35). The same is true in Ireland where ICT have become mandatory in all ITE programmes, and student teachers are expected to use them effectively to support their students' learning. An action plan from the National Digital Strategy for Schools 2015-2020 outlined how ICT should be integrated into teaching practices in schools, meaning that all

teacher education courses and programmes should embed ICT in their planning, design, and delivery (Mac Mahon et al., 2016).

In the New Zealand context, the New Zealand curriculum emphasises the focus on educating a confident, connected, actively involved, and lifelong learner and efforts have been directed towards achieving this vision. For example, as long ago as 2012, the Ministry of Education initiative about "what future learning—or "21st century learning"—should look like for New Zealand students" (Bolstad et al., 2012, p.7), signalled that education should prepare learners to engage with future-focused challenges. Bolstad et al. developed six school-based principles in response to this initiative as a guide for designing a future-focused education system. Although Bolstad et al. (2012) framed these principles to argue for what schools ought to do, they can also inform the tertiary context of preparing student teachers in ways that enable their transition into school classrooms.

Changes in national education policies have challenged teacher education providers around the world to address how they are preparing student teachers to integrate technology into their practices. The following section reviews the literature on how teacher education providers integrate ICT to support the teaching and learning of student teachers.

Integration of ICT into Teacher Education

Integration of ICT into teacher education has been studied for over 30 years (Kay, 2006); however, student teachers continue to feel inadequately prepared to integrate technology into their future classrooms in an effective manner (Farjon et al., 2019; Maslin & Smith, 2017; Myers & Rivero, 2019). In an attempt to facilitate successfully the development of knowledge and skills student teachers need to engage with technology, researchers have extensively studied how to integrate ICT into teacher education in an effective manner. A majority of researchers have focused attention on how ITE programmes integrate technology (e.g. Admiraal et al., 2017; Baran et al., 2019; Ottenbreit-Leftwich et al., 2018; Srisawasdi et al., 2018; Tondeur et al., 2017), others have examined teacher educators' pedagogical knowledge and ICT competencies (e.g. Foulger et al., 2017; Taimalu & Luik, 2019), while a few have identified effective strategies that support student teachers to integrate technology into their practices (e.g. Brenner & Brill, 2016; Kay, 2006; Tondeur et al., 2012). In this section, the discussion explores these approaches to the integration of ICT into teacher education.

Addressing the Integration of Technology into ITE Programmes

Preparing student teachers to integrate technology adequately into their practices is a complex and challenging process for teacher educators (Crompton, 2017; Foulger et al., 2017; Tondeur et al., 2019; Uerz et al., 2018). Kay (2006) argued that to effectively incorporate ICT into ITE, the following three conditions have to be met: (1) student teachers should have good access to software, hardware, and support, both during coursework and teaching practice; (2) teacher educators should make every effort to model and construct authentic teaching activities; and (3) student teachers, teacher educators and mentor teachers should collaborate. Other researchers have stressed positive attitudes and beliefs towards technology, training teacher educators and that developing a technology plan at the ITE programme level contributes to the successful integration of technology (Farjon et al., 2019; Tondeur et al., 2012).

N. Davis (2010) mentioned that since the 1980s, ICT had been integrated into ITE for three purposes: "(1) Preparing teachers to use ICT in educationally effective ways; (2) preparing K-12 teachers to teach ICT-related content; and (3) applying ICT to serve teacher education" (p. 217). N. Davis (2010) argued that teacher educators can achieve these purposes if they integrate technology, pedagogy, and content knowledge in effective ways. This argument affirms the idea that preparing student teachers for successful technology integration requires examining how technology intersects with pedagogical and content knowledge (Mishra & Koehler, 2006).

Frameworks for Technology Integration

Several existing frameworks guide teacher educators to integrate technology into their practices. Three well-known frameworks for technology integration in education are: (1) the Substitution, Augmentation, Modification, and Redefinition (SAMR) framework (Puentedura, 2009), (2) the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006), and (3) the characteristics of meaningful learning framework (Howland et al., 2012).

The SMAR framework guides teacher educators about how their use of technology can be categorised into four levels: substitution, augmentation, modification, and redefinition. The substitution and augmentation categories describe the use of technology as a direct tool substitute with and/or without functional improvement to enhance practice. The modification

and redefinition categories describe the use of technology as a creative tool to transform practice.

Mishra and Koehler (2006) noted that integration of ICT into teacher education is enhanced when teacher educators understand how knowledge of technology, pedagogical knowledge, and content knowledge are interrelated and how they align with one another. Mishra and Koehler (2006) developed the TPACK framework to assist in understanding the three areas of knowledge that a teacher educator requires for effective ICT integration into classrooms. These areas include: technology knowledge (e.g. understanding various technologies), pedagogy knowledge (e.g. methods of teaching), and content knowledge (e.g. subject matter). According to TPACK, successful technology integration is achieved when the use of technology works well with the pedagogy and content to facilitate new pedagogical ways of teaching. Farjon et al. (2019) noted, however, that the TPACK framework has been criticised for not being useful to determine effective technology integration. Similarly, Admiraal et al. (2017, p. 116) argued that although TPACK models knowledge that has to be acquired, it "does not say much about how this integrated knowledge should be acquired."

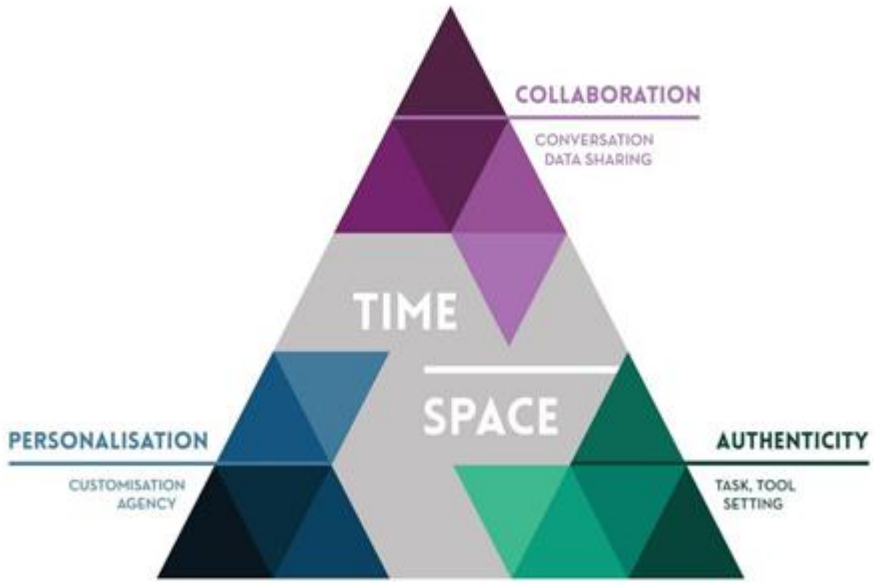
Learning tasks have to engage student teachers and produce valuable learning outcomes. Howland et al. (2012) developed the characteristics of meaningful learning framework, which encourages intentional use of technology for learning. Howland et al. (2012) noted that meaningful learning is achieved when the tasks that learners pursue represent a combination of the following five characteristics: active, constructive, collaborative, authentic, and goal-directed. In other words, the *active* characteristic of the framework encompasses discussion about learners actively engaged in using technology as a learning tool. The *constructive* characteristic highlights learners' use of technology tools to integrate their new experiences with their prior knowledge to make sense of what they observe. The *collaborative* characteristic focuses on how learners use technology tools to collaborate with peers. The *authentic* characteristic stresses learners' use of technology tools to link learning activities to the real-world context. Finally, the *goal-directed* characteristic emphasises learners' use of technology tools to engage in meaningful reflections as they plan their activities in different ways, monitor their progress, and evaluate their results.

Other researchers have developed frameworks for mobile learning to guide teacher educators to integrate mobile technologies into their practices. For example, Crompton (2017) designed

the mlearning integration framework which features four main constructs: beliefs, resources, methods, and purpose. These constructs are used to assess different ways of integrating mobile devices in teaching and learning. The iPAC framework (see Figure 2.1, Burden & Kearney, 2017), is based on the original framework of Kearney et al. (2012). It highlights the unique affordances of mobile technologies by mainly focusing on pedagogy as opposed to technology. This framework foregrounds the sociocultural perspective of learning.

Figure 2.1

The iPAC framework. Burden and Kearney (2017, p. 112), with permission.



The iPAC framework has three constructs: personalisation, authenticity, and collaboration, each made up of sub-constructs. It "provides a useful lens to explore how mobile technologies can leverage potentially transformational pedagogies in a range of formal and informal learning settings" (Burden & Kearney, 2018, p. 91). In mobile learning environments—time and space (which are at the centre of the framework)—strongly influence how learners experience these unique characteristics (Burden & Kearney, 2017).

Personalisation describes the characteristics of mobile technologies that make learning more individual. It consists of the subconstructs of agency and customisation. Learner agency is experienced when mobile learning activities allow learners to act independently, make meaningful choices, and have greater control over where (physical/virtual) they learn, when

they learn, and the pace of their learning (Ally et al., 2014). According to Kearney et al. (2012), customisation is experienced when mobile learning activities are individually customised (at tool and activity levels) to learners' needs. Learners can use their own mobile devices to work on their tasks, which increases their sense of device ownership, convenience, and gives them more ownership of their learning.

Authenticity is a pedagogical feature that describes how mobile technologies can be used to make learning more realistic and meaningful. Authenticity is enhanced by the affordances of mobile technologies, because they provide easier access to real-life tasks and multiple contexts for learning. Authenticity consists of the subconstructs of task, tool, and setting which "bring to bear the significance of learners' involvement in rich, contextualised tasks, making use of tools in a realistic way, and involving participation in relevant real-life practices and processes" (Burden & Kearney, 2017, p. 112). A well-designed mobile learning activity should situate learning in a highly realistic setting that reflects a real-life context, so that learners can learn effectively. In these settings, many educational apps and mobile devices enhance authentic practices either within a simulated learning environment or through actual participation (Kearney et al., 2012).

Finally, collaboration consists of the subconstructs of conversation and data sharing. Certain features of mobile technologies support and enhance social interaction, the discussion of ideas, instant feedback, the sharing of resources, and the negotiation of meaning. When learners negotiate meaning, they establish networked connections with people as they share information and resources across time and space. Social constructivists use collaborative learning as a pedagogical strategy to develop critical thinking, communication, and interpersonal skills (Gilbert, 2013). Farjon et al. (2019) noted that successful integration of ICT in teacher education largely depends on teacher educators. Some studies have examined teacher educators' ICT competencies, as discussed in the following subsection.

Teacher Educators' ICT Competencies

According to Foulger et al. (2017), technology competencies refer to "(knowledge, skills, and attitudes) *all* [emphasis added] teacher educators need to support teacher candidates as they prepare to become technology-using teachers" (p. 413). It is argued that to successfully teach and learn with technology, teacher educators should be innovative, collaborative, and

have a research-oriented attitude (Tondeur et al., 2019). In this respect, teacher educators are expected to model the use of technology as well as to give theoretical and pedagogical underpinnings of such uses to support student teachers to effectively learn and teach with technology (Foulger et al., 2017; Uerz et al., 2018). Some examples of the tasks include: providing student teachers with exemplars of the educational affordances of specific ICT (Tondeur et al., 2018), supporting student teachers to use ICT to search for information, learn independently, and acquire higher-order thinking skills (Tondeur et al., 2019). To be able to do these tasks, teacher educators are recommended to be proficient in the use of technology.

In 2000, the International Society for Technology in Education (ISTE) released standards for teachers that have been used to unpack teachers' ICT competencies (Foulger et al., 2017). These standards have influenced how ITE programmes implement technology to promote the preparation of student teachers for school classrooms (Brenner & Brill, 2016). Although for decades the ISTE has developed standards for students and teachers that have been adopted worldwide, Nelson et al. (2019) posited that, until recently, there were no standards that were developed specifically for teacher educators. This lack of attention in teacher education was also identified by Cuhadar (2018) who stressed that most national technology integration initiatives do not prioritise teacher education, even though "the starting point of the technology integration in education should be teacher education" (p. 70).

In recognition of this need, ICT competencies have been identified for teacher educators. Foulger et al. (2017) developed a set of 12 Teacher Educator Technology Competencies (TETCs) to shed light on technology experiences that student teachers should encounter. They suggested that TETCs could be useful to guide effective, transformational pedagogical practices. However, Foulger et al. (2017, p. 419) noted that "it is extremely difficult to determine exactly what teacher educators need to know related to technology." The literature review conducted by Uerz et al. (2018) examined teacher educators' ICT competencies that facilitate the preparation of student teachers for effective use of technology in school classrooms. Uerz et al. (2018) argued that to integrate technology into education, requires four domains of ICT competencies for teacher educators: (1) ability to use technology in general, (2) competencies for pedagogical and educational use of technology, (3) beliefs about teaching and learning, and (4) competencies in innovation and professional learning. Uerz et al. (2018) concluded that only a few studies investigated how teacher educators enhance their digital competencies.

Although the emphasis on teacher educators' ICT competencies does not guarantee that teacher educators will integrate technology into their practices, it implies that their ability to model how ICT can be used influences the quality and quantity of student teachers' experiences with ICT. In addition, the study of Tondeur et al. (2012) suggested that teacher educators' ICT competencies are associated with the strategies they adopt into their practices to prepare student teachers to integrate technology, as discussed in the next subsection.

Effective Strategies to Prepare Student Teachers to Integrate ICT

Research has identified several strategies used to prepare student teachers to integrate ICT into their practices. When systematic strategies are incorporated into the curriculum, they help to develop student teachers' attitudes, knowledge, and skills, which they need to integrate technology into their future classrooms adequately (Baran et al., 2019; Brenner & Brill, 2016; Steel & Andrews, 2012). One of these strategies is integrating technology in all courses. Nelson et al. (2019) stated that "teacher education programs are increasingly being required to demonstrate technology training across courses and field experiences" (p. 333). Kay (2006) noted that an integrated strategy allows student teachers to learn with technology and not about them, thus helping to improve their confidence and technology skills. The benefits associated with using this approach were also identified by Gill et al. (2014) who noted that if teacher educators teach ICT skills and pedagogical knowledge in an integrated way throughout the programme, student teachers will be able to examine, practise, and reflect on how they might integrate ICT into their professional context.

Tondeur et al. (2012) synthesised findings from 19 qualitative studies and identified six strategies to prepare student teachers to use technology in their teaching practices. These strategies include: (1) teacher educators acting as role models, (2) reflecting on the role of technology in education, (3) learning about technology integration, (4) collaborating with peers, (5) scaffolding authentic technology experiences, and (6) providing continuous feedback. Tondeur et al. (2012) suggested that these strategies should be considered when designing student teachers' technology training. Baran et al. (2019) found the use of these six strategies to be associated with student teachers' self-rated ability to apply TPACK in their instruction. Baran et al. (2019) relied on student teachers' perceptions but did not investigate how the strategies were used in ITE programme to engage student teachers and support their learning. In addition, studies (Baran et al., 2019; Cuhadar, 2018; Tondeur et al., 2017) found

that the least commonly used strategies in ITE programmes were learning about technology integration, scaffolding authentic technology experiences, and providing continuous feedback to technology use. The findings from all the three studies above were restricted to a list of strategies and failed to describe the related activities of student teachers. Because of this, studies that aim to show how these strategies contribute to student teachers' use of technology in school classrooms would be valuable to guide teacher educators.

The study of Admiraal et al. (2017) showed how multiple strategies can be used to educate student teachers to integrate technology to support students' learning. In one course, teacher educators taught various technology tools and used video clips to model a technology-integrated approach. Student teachers were encouraged to reflect on what they did in class and use technology in their own lessons during teaching practice. In another course, student teachers designed flipped lessons that they used during their teaching practice. They created instruction videos and enriched their teaching materials with audio or graphics. An evaluation of this class activity revealed a disparity between what student teachers were taught at the university and how they applied it in their classrooms. Feedback from school students and student teachers' experiences, however, enabled them to improve how they taught with technology. The findings indicated how teaching practice supported student teachers to develop knowledge and skills to integrate technology into teaching and learning, by applying what they learned and receiving feedback from school students. Admiraal et al. (2017) found that modelling the use of technology in the classroom motivated student teachers to integrate technology into their subject teaching. In addition, student teachers reported that they needed more role models to collaboratively reflect on technology and their experiences.

Modelling has been used to mitigate concerns that student teachers have about integrating technology into their future classrooms. Ottenbreit-Leftwich et al. (2018) investigated how four exemplary technology-using practising teachers used an asynchronous video mentoring session with student teachers to model appropriate technology use and offer suggestions about the effective use of technology to support teaching. The practising teachers responded to student teachers' concerns using examples from their own experiences. The findings revealed that the majority (68%) of student teachers felt less concerned after watching practising teachers' video-recorded presentations. Ottenbreit-Leftwich et al. (2018) suggested that another strategy could be the use of rich video cases that capture the teaching practices of exemplary

technology-using teachers. These video cases can be used to facilitate discussions with student teachers about the various ways that technology can be integrated into teaching.

Technology-rich field experiences provide opportunities for student teachers to learn to teach with technology. Field experience has been highlighted to help student teachers to develop positive technology attitudes and use technology more frequently (Ottenbreit-Leftwich et al., 2018). Tondeur et al. (2017) found that support from mentor teachers to experiment with different technologies motivated beginning teachers to start integrating technology into their practices. This finding was echoed by two case studies in New Zealand and Malaysia where student teachers indicated that preparation during their coursework, and the support they received while on teaching practice, helped them to develop knowledge and skills required to integrate ICT into teaching (Nordin, 2014).

Kay (2006) recommended that using multiple strategies to teach integration results in significant improvements in the technology integration practices of student teachers. However, Tondeur et al. (2018) argued that few research studies focused on the use of multiple strategies when preparing student teachers for ICT integration, since the majority of studies are generally limited to the impact of one single strategy. An examination of how using multiple strategies affect the preparation of student teachers to integrate technology into their practices will increase our understanding in this area. Furthermore, it is worth exploring the strategies teacher educators use to incorporate mobile technologies into their practices, given that mobile technologies are increasingly integrated in schools.

Barriers to Technology Integration in Teacher Education

As educational systems become more dependent on technology to support teaching and learning, there are challenges that affect successful integration in teacher preparation. A decade ago, N. Davis (2010) took an international perspective to identify the challenges of preparing student teachers to teach with technology and placing them in technology-rich classrooms. In 2020, this has expanded to include mobile technologies. Burden and Hopkins (2016) categorised these challenges as first-order barriers (external to the teacher) and second order-barriers (internal to the teacher) to the adoption of mobile technologies in teacher education (adapted from Ertmer, 1999). They identified issues such as lack of time and resources for training, lack of technical support, infrastructure problems, and hostile school culture as first-order barriers. Second-order barriers included confidence levels, skills, and pedagogical beliefs

and attitudes towards technology. Burden and Hopkins (2016) noted that student teachers reported first-order barriers more often than second-order barriers.

Evidence from the literature shows that teacher educators need support in the form of professional development or training, to integrate mobile technologies successfully into pedagogical practices. Burns-Sardone (2014) stressed the importance of including BYOD training in the ITE curriculum, to eliminate the "barrier of a lack of quality training programs to incorporate technology" (p.193). Jahnke and Liebscher (2020) noted that "the challenge for instructors is to understand how mobile technologies can be used to support teaching and learning with technologies." Some appear unwilling to integrate technology into their courses and encounter difficulties in using educational apps in the classroom (Gikas & Grant, 2013). This has been associated with a lack of quality training on specific technologies (Burns-Sardone, 2014), and limited or no pedagogical training to meet the educational needs of 21st century classrooms (West, 2012). These challenges negatively impact on the preparation of student teachers to use mobile technologies.

Furthermore, teacher educators have different positions on the incorporation of mobile technologies. While some are enthusiastic and embrace the opportunity to engage with new pedagogies enhanced by mobile technologies (Cochrane, 2014), others are frustrated by the increased demand for their practices (Tolosa, 2017). The main challenges teacher educators experience is the need to continually adapt and change their pedagogical practices due to rapid advances in mobile technologies (Kearney et al., 2015), and the time it takes to develop student teachers' technological pedagogical design capabilities for both primary and secondary education (Burden et al., 2016).

Although student teachers are expected to actively use digital pedagogy, their confidence and competence has been undermined due to what Maslin and Smith (2017) point to as "a mismatch between digital expectations and the reality of programme experience" (p. 48). For example, despite the rapid adoption of mobile devices to support learning in schools, Farley et al. (2015) noted that university classes lack these innovative technologies. Grudnoff et al. (2017) identified the need for collaborative university-school relationships that equally value scholarly and practical knowledge to prevent a disconnect between campus and practical components.

What seems to be highlighted in the findings by Mac Mahon et al. (2016) and Pegrum et al. (2013) were the challenges student teachers encountered when using iPads as learning tools. Pegrum et al. (2013) reported that student teachers experienced challenges when composing long texts or creating multimedia artefacts, due to the relatively small screen size. More experienced users were also concerned about software limitations, and they preferred using their laptops or desktop computers. A similar concern was echoed by Vaughan and Lawrence (2013), who found that student teachers preferred laptops or computers to create lesson plans rather than tablets or smartphones. Furthermore, the challenge of Wi-Fi not always being available or functional in classrooms was reported (Mac Mahon et al., 2016; Vaughan & Lawrence, 2013).

Student teachers have raised several challenges they face during their teaching practice that impact on their ability to integrate mobile technologies into their practice. Mac Mahon et al. (2016) revealed that the majority of schoolteachers were positive about the possibilities offered by the iPad, but that a few of them had less favourable responses to student teachers. While older teachers had negative attitudes about technology, student teachers mentioned that younger teachers were eager to learn from them about the affordances of the iPad and related apps, or that they had "actually bought mobile devices during the year to use in their classrooms" (p. 29). Other challenges include student teachers receiving conflicting pieces of advice from mentor teachers and university supervisors (Liu, 2016), and encountering teacher educators and mentor teachers who do not support their growth of digital pedagogical confidence (Maslin & Smith, 2017). These challenges can adversely impact the quality of student teachers' preparation. Addressing the challenges that student teachers encounter will help to realise the potential of mobile technologies in teacher preparation.

Mobile Learning Practices in ITE

There is no single definition of mobile learning in the literature. To date, definitions of mobile learning are still evolving. Keskin and Metcalf (2011) defined mobile learning in terms of ubiquity, access, immediacy of communication, individuality, convenience, as well as mobility in physical and social spaces (including virtual spaces). Pegrum (2015) also contributed but they had a techno-centric view and emphasised the portability features of the devices due to their smaller sizes and light weight. Most of the recent definitions focus on the learning experiences that can be encountered anytime and anywhere, while using mobile

devices as mediating tools for learning (Cavanaugh et al., 2018; Kukulska-Hulme, & Viberg, 2018). In essence, the flexibility and convenience afforded by mobile devices have enhanced learning because student teachers are not restricted to a physical location and/or time. As a consequence, other researchers view mobile learning as a type of learning that is untethered from formal classrooms and curricula since it occurs across boundaries and contexts (Khaddage et al., 2016; Schuck et al., 2017).

Student teachers can own a range of mobile devices (Farley et al., 2015; Maher, 2018). The affordances of mobile devices support and enhance their learning individually and collaboratively across multiple contexts. This also includes student teachers who are enrolled as distance learners where ITE programmes deliver electronic learning materials via mobile technologies (Vaughan & Lawrence, 2013). Various mobile learning studies have explored the affordances of mobile devices (Baran et al., 2017; MacCallum et al., 2017; Parsons et al., 2016).

Mobile affordances are the relationships between the physical features of the device being used and the activities of student teachers that enable particular kinds of their learning. The main affordances of mobile devices that are different from other tools include supporting learning regardless of location and time, situating learning in authentic contexts both inside and beyond the classroom context using real-time information and providing opportunities for communication, collaboration and data exchange. Parsons et al. (2016) outlined mobile affordances to be portability due to the size of the devices, communication affordances such as instant messaging, interaction with the interface, that is, using mobile apps and data gathering from indoor and outdoor authentic learning environment. Burden and Hopkins (2016) noted that data gathering affordances have the potential to expand the context of the classroom and offer greater opportunities for personalised and collaborative learning.

In this section, mobile learning practices in ITE are reviewed, by first examining the multiple learning contexts of student teachers that have been enhanced by mobile technologies. This is followed by a review of the literature that focused on the use of apps to support teaching and learning. Next is a review of studies that have examined how mobile technologies support and enhance the teaching and learning of student teachers during their coursework and teaching practice. This section ends by examining studies that focus on the preparation of student teachers for their future classrooms in New Zealand. It aims to highlight how mobile technologies enhance the learning outcomes and learning experiences of student teachers.

Student Teachers' Contexts for Mobile Learning

Researchers (Ally et al., 2014) agree that mobile learning takes place beyond physical spaces, such as lecture theatres, and virtual spaces, for instance the Learning Management System (LMS) mediated by teacher educators. Schuck et al. (2017) used the metaphor of a *Third Space* to describe how the use of mobile technologies has enhanced learning across a variety of settings and times. Based on how learning tasks are designed, mobile learning can occur in formal spaces (*First Space*), like a classroom to facilitate formal learning, and informal spaces (*Second Space*) for informal learning, like in a museum, library, or at home (Schuck et al., 2017). Focusing on innovative teaching and learning practices, Cheng et al. (2016) showed that institutions of higher learning have realised that both physical and virtual spaces have a major impact on student learning. Therefore, the variety of contexts in which mobile learning occurs helps to expand our understanding of the complexity of interactions that have become possible in teacher preparation.

After examining this in detail, Pegrum et al. (2013) concluded that mobile devices support student teachers by situating their learning across multiple contexts, meaning that learning is not limited by time or location. Furthermore, Kearney and Maher (2019) found that student teachers used their mobile devices during in-between times, in formal contexts but mainly in informal contexts like on public transport or at home. The increasing relevance of mobile technologies for teacher preparation is therefore not only due to the rapid advancement of mobile learning in schools, as indicated by Burden and Kearney (2017), but more so the mobility of student teachers who can learn in different contexts (see for example, Adoniou, 2013) and, at different times of the day, whenever and wherever they have access to the internet or have downloaded offline resources.

With that in mind, there is a need to consider the learning contexts in which student teachers find themselves when preparing to become the next generation of teachers; contexts which also extend beyond the physical environments. Mobile technologies have led to the blurring of boundaries between these contexts (Pegrum et al., 2013). The movement of student teachers between these spaces, add what Schuck et al. (2017) termed a Third Space that travels with them in their mobile devices. These learning contexts also include their professional support communities—both local and global—like teacher networks, and key organisations relevant to their careers, where they can self-regulate their learning (see Kearney & Maher, 2019).

Often, student teachers experience an overlap of formal and informal learning when interacting with their peers or experts, and experience this across time within a range of multi-layered contexts. These contexts, particularly in terms of physical and virtual spaces, include:

- The university campus in a classroom, online using the LMS, or other learning spaces such as a library, or laboratory. Furthermore, a field trip organised by a teacher educator is a university space.
- A partner school campus during their teaching practice, which could be within the classroom, in a library, in a school playground or local school community, or even in schools located in remote areas (Hartnett, 2019). More so, for student teachers who experience teaching practice in ILEs, "where digital technologies facilitate learning within formal and informal contexts, within and beyond schools and classrooms and across time" (Nelson & Johnson, 2017, p. 65).
- Student teachers' personal learning spaces like at home, a public library, or in cafes.

All of these contexts are interconnected, and student teachers continuously learn through the support afforded them by mobile technologies. For example, they may choose to learn independently in their own personal spaces during their placements in partner schools or on campus. They can also use digital spaces for professional learning by collaborating with their peers, teacher educators, and experts. Designing learning for these contexts can be challenging for teacher educators. However, mobile affordances mediate learning across these multiple contexts (Naylor & Gibbs, 2018; Pegrum et al., 2013). The following subsections provide a nuanced discussion of studies that have explored how mobile learning affordances support the development of student teachers. Some of the activities discussed include student teachers' taking photos, making videos, engaging in collaborative messaging, using QR codes, recording sound, and using augmented reality (Parsons et al., 2016).

Use of Apps to Support Teaching and learning

Studies have examined how teacher educators utilise mobile learning affordances by designing their courses to incorporate apps to support active learning in formal and informal settings. For example, Naylor and Gibbs (2018) reported on how student teachers implemented ideas from a pilot study; they developed ebooks based on their field trip to the seaside (see Naylor & Gibbs, 2015). Student teachers engaged with college students in outdoor learning

activity by using Book Creator apps on their iPads to construct ebooks. Naylor and Gibbs (2018) found that out of the six student teachers interviewed, three reported "that they had not thought of using technology at all in this way" (p. 73). Constructing ebooks has become a key task in schools. As reported by Cavanaugh et al. (2018), school students use ebooks to practice learning languages anywhere and anytime, while Kearney et al. (2015) found that schoolteachers frequently used ebook creation apps to create their own digital content. This suggests that to successfully support school students' learning, student teachers need to understand how to use apps to produce knowledge.

In Burns-Sardone's (2014) case study, 58 student teachers were guided to use AudioBoo (an app) to verbally record their book reviews of children's stories, and then convert the recordings to QR codes. Student teachers used QR Reader (an app) to scan the QR codes, which enabled them to listen and to learn from their peers' book reviews. It was found that the task enhanced student teachers' learning experiences and that they were willing to use their smartphones for learning purposes. Prior to this learning task, 99% of student teachers did not know how to use smartphones for learning purposes. Burns-Sardone (2014) concluded that apps can be used to engage student teachers and enhance their learning.

In a survey of 46 teacher educators based mainly in Australia and Europe, Burden and Kearney (2017) examined their mobile pedagogical practices and found that they used "generic, content-free, creative apps ... in a wide variety of ways across all disciplines" (p. 14). Among the apps that were analysed using Goodwin and Highfield's (2012) classification, 78% were classified in the "constructive category: leveraging students' communication and creation of their own digital content" (Burden & Kearney, 2017, p. 120). Apps classified in this category require a deeper conceptual understanding of within which users use their creativity to design their own digital artefacts. Student teachers can use these types of apps to support multimodal knowledge construction with their students; however, it is expected that they learn how to use them in conjunction with meaningful tasks that are relevant to teaching and learning. Although Burden and Kearney (2017) made a valuable contribution to the debate on the use of apps in teacher education, they did not address how the teacher educators integrated the apps into their own courses, nor clarify how student teachers could incorporate the apps into their own teaching. Burden and Kearney (2017) mainly focused on how teacher educators self-rated their pedagogical features of mobile learning.

The actual form of teaching associated with the use of apps was considered in studies by Newhouse et al. (2015) and Mac Mahon et al. (2016). For example, Mac Mahon et al. (2016) clearly demonstrated that during some workshops, student teachers learned "the possibilities offered by a range of apps to support teaching and learning" (p. 23). Before their final teaching practice, for example, they were trained on how to use iBooks Author (an ebook authoring app). Mac Mahon et al. (2016) also conducted nonparticipant classroom observations of student teachers during their teaching practice and reported how student teachers used apps in their school classrooms. Furthermore, student teachers responded to the questionnaire at entry-level, mid-level, and exit-level on the programme, which allowed them to easily remember and reflect on the apps which had supported their learning. The study drew on the TPACK framework to understand the knowledge required by student teachers to effectively use technology.

Although the findings from studies highlight the importance of using apps, there are few studies in ITE that have explored the integration of mobile technologies, using apps that are popular within schools, as recommended by Maher (2018). This suggests the need to give student teachers an opportunity to discuss and provide feedback about various apps that are being used in schools so that they can create meaningful learning experiences for their students. Maher (2018) argued that during teaching practice, student teachers do not have enough opportunities to analyse in a critical manner the apps they use and instead rely on what the schoolteachers provide. In addition, there is a need for further empirical study to examine the different ways in which teacher educators incorporate apps across their courses, and this includes modelling the use of the most appropriate apps that might be useful in their professional practice. According to Baran et al. (2017), integrating apps into teacher education challenges student teachers to develop skills and knowledge about the use of apps.

Learning with Mobile Technologies during Coursework

Although teacher educators are using mobile technologies to enhance their pedagogies (Burden & Kearney, 2017; Naylor & Gibbs, 2018; Newhouse et al., 2015), research shows that this use "does not automatically translate into effective teaching and learning practices" (Ng'ambi, 2013, p. 653) in ways that may link with schools. Most often this has resulted in a disparity between student teachers' digital expectations and current practices in ITE programmes across the world (Maslin & Smith, 2017; Myers & Rivero, 2019). The literature argues for pedagogical practices that are relevant to practices in schools so that student teachers can adapt to and engage with mobile technologies as pedagogical tools in their own classrooms.

Burden and Kearney (2018) pointed out "a need for greater exemplification of how teacher educators use mobile devices to model and practise approaches relevant to K-12 teaching and learning" (p. 88).

Teacher educators can design their courses to provide student teachers with structured tasks through which they are supported to engage in meaningful learning activities involving mobile technologies (Admiraal et al., 2017; Naylor & Gibbs, 2018; Rawlins & Kehrwald, 2014). In this way, the educator develops one or more courses that are authentic and more easily adapted to school contexts. Meaningful learning with mobile technologies prepares student teachers to link what they learn in their coursework with how they will use mobile technologies in practice (Luik et al., 2018; Naylor & Gibbs, 2018; Tolosa, 2017). Such activities, in turn, stimulate student teachers to support one another to develop their skills with relevant devices and software. However, mobile learning environments require new approaches in the design of instructional and pedagogical strategies (Burden & Kearney, 2017), to fully exploit the affordances of mobile technologies.

A number of studies have investigated how student teachers used iPads to enhance collaborative and authentic learning across multiple learning contexts (Mac Mahon et al., 2016; Naylor & Gibbs, 2015; Pegrum et al, 2013). Collaboration and communication skills are essential for the success of student teachers as they prepare to work with diverse groups of students. Fletcher et al. (2017) indicated that collaborative and co-teaching practices are key strategies teachers use in current school systems in New Zealand. Viberg and Gronlund (2013) found that 74% of students rated collaboration highly among the three themes of the iPAC framework. Student teachers expressed positive attitudes about using mobile devices for multimodal communication and exchanging information. Similarly, Gikas and Grant (2013) revealed that student teachers used the features of mobile devices to share information and learning resources with their peers and the instructor—across time and space using social media, text messaging, and their course website.

In the United Kingdom, Naylor and Gibbs (2018) examined how English and science student teachers collaborated with college students from Norway to engage in complex tasks. A key theme was how student teachers worked in various groups, the way the groups interacted with and around the iPads, and the resulting social construction of knowledge as they worked through the project. Student teachers explored topics related to the biology, physics, and

chemistry curriculum for college students. During their field trip, the portability of the iPads and in-built camera enabled them to record images, video clips and sounds relevant to their topics. In the classroom, they accessed the internet to translate scientific words instantly, research, and identify suitable maritime-related topics for the construction of their ebooks. This task changed student teachers' perception of how mobile technologies could be used. Student teachers mentioned that they would consider using mobile technologies on a school trip, and "that the use of mobile technologies provided learning strategies that they could use in their future teaching" (p. 71). College students also felt motivated to think about the Norwegian science curriculum. These findings revealed that situating tasks in a real-world context and using mobile technologies supported meaningful and authentic learning for student teachers. This is one of the pedagogical affordances of mobile learning that transcends traditional learning. The study used mixed methods, including an online questionnaire with 37 student teachers and semi-structured interviews with six student teachers. However, the article mainly reported the findings from the interviews.

The need to facilitate authentic learning to foster the development of self-learning, creativity, and higher-order thinking skills for the 21st century has been widely noted in the literature (Avidov-Ungar & Forkosh-Baruch, 2018; Myers & Rivero, 2019). Meaningful learning occurs when student teachers engage individually or collaboratively in authentic learning activities that are relevant in the real world. In case studies of eight student teachers enrolled in the Early Childhood or Primary programmes at the University of Western Australia, Pegrum et al. (2013) examined how student teachers used iPads as learning tools, and how they contributed to their teaching and learning. Although seven teacher educators were provided with iPads and individually trained in how to use them to support their classroom practices, only three out of seven teacher educators proactively supported student teachers to "make audio and video recordings, develop mind maps, create lesson plans and deliver class presentations" (p. 467). Pegrum et al. (2013) recommended that teacher educators should be supported to incorporate iPads into their teaching to encourage higher levels of students' reflection, model the use of iPads in a pedagogically appropriate manner, and encourage students to use their multiple devices for appropriate purposes, so that they can learn seamlessly across both formal and informal contexts.

Furthermore, the findings showed that the majority of student teachers perceived that iPads supported them to (a) develop a pedagogical understanding in regard to engaging their students,

group work, and selecting materials in the form of apps, (b) develop an understanding of content, specifically by recording and reviewing information that reinforced their learning, and (c) stay connected through their learning networks, and share resources through Facebook at different times from different Wi-Fi enabled locations. For example, one student teacher reported that she used her iPad to audio record her teaching, and then used the recording to reflect on her questioning skills. Another one mentioned that she used her iPad to search for online resources to extend her understanding of mathematical concepts. Student teachers also stated that they used iPads to create multimedia virtual records in real-world contexts, which could be accessed from different locations. This case study examined the pedagogical uses of the iPad based on student teachers' views on how iPads supported their teaching and learning, but omitted the views of the teacher educators.

Studies have examined how iPads support the professional learning and pedagogical knowledge development of student teachers. In one Australian case study that featured 16 student teachers, completing mathematics section of their course, Kearney and Maher (2013) analysed student teachers' mobile learning scenarios using the iPAC framework (Burden & Kearney, 2017). The study indicated that student teachers used iPads to take and annotate pictures of geometric shapes in the urban landscape, to support their professional learning. Mac Mahon et al. (2016) reported that student teachers created new learning spaces on social-networking pages, where they used iPads to support peer learning, resource sharing, and critical reflection. Like Pegrum et al. (2013), this study revealed that student teachers also used iPads as an organisational tool, a pedagogical tool, and a tool for reflection. Similarly, Vaughan and Lawrence (2013) found that both student teachers and teacher educators perceived that mobile devices were useful for supporting their future professional responsibilities, rather than for planning, assessment, or managing the classroom environment.

In summary, previous researchers (Kearney & Maher, 2013; Mac Mahon et al., 2016; Naylor & Gibbs, 2015; Pegrum et al., 2013) studied extensively how mobile technologies enhance and support the teaching and learning of student teachers. However, there has been limited research that explores the actual instructional practices of teacher educators with a wide range of mobile devices (i.e. smartphones, iPads, laptops, and tablets), apps, and web-based platforms. Given the fast-changing nature and the use of mobile technologies to improve the quality of education (Jahnke & Liebscher, 2020), investigating teacher educators' practices with mobile technologies (mobile devices, apps and web-based platforms) is imperative to bring further

understanding to the research of how student teachers are being prepared for their future classrooms.

The aim of my study was to explore how teacher educators use mobile technologies in ways that influence student teachers to adapt and adopt these uses into their own classrooms. The literature suggests that the preparation of student teachers should support them to acquire knowledge and skills so that they can meaningfully use mobile technologies in practice (Maher, 2018; Nelson & Johnson, 2017). Effective integration of mobile technologies has been demonstrated to provide student teachers with opportunities to develop their understanding of content and pedagogy (Pegrum et al., 2013), improve their learning achievements (Mac Mahon et al., 2016), connect and collaborate with others as they construct knowledge, and experience authentic learning based on real-world situations (Naylor & Gibbs, 2018). Because of these substantial learning advantages that research has found, teacher educators are recommended to integrate mobile technologies into their practices in ways that provide these benefits. It is evident that ITE programmes, which teach how to incorporate mobile technologies into teaching and learning, can help address the lack of innovative use of technology by student teachers (Ottenbreit-Leftwich et al., 2018).

Learning with Mobile Technologies during Teaching Practice

Teaching practice is a key aspect for transitioning student teachers to school classroom teaching. Teaching practice provides opportunities for student teachers to engage in teaching in real-world contexts in order to put into practice their pedagogical knowledge. Maslin and Smith (2017) noted that when student teachers practise knowledge and skills gained during their coursework into school classrooms, it helps to build their digital pedagogical confidence. Stressing the importance of a quality experience for student teachers, Darling-Hammond and Baratz-Snowden (2007) argued that to effectively prepare student teachers, a school-based practicum should exhibit the following features:

- clarity of goals, including the use of standards guiding the performances and practices to be developed;
- modeling of good practices by more-expert teachers in which teachers make their thinking visible;
- frequent opportunities for practice with continuous formative feedback and coaching;
- multiple opportunities to relate classroom work to university course work;

- graduated responsibility for all aspects of classroom teaching; and
- structured opportunities to reflect on practice with an eye toward improving it. (p. 124).

Researchers have established that social networking sites, such as Facebook, can support student teachers engage in collaborative reflections of their teaching practice experiences. For example, Liu (2016) found that through Facebook student teachers can engage in continuous learning conversations and reflect in real-time about their teaching experiences in schools. This enables them to strengthen their interactions, facilitate critical thinking and reflection as well as learn more about different educational practices in schools. Liu (2016) designed four tasks for 153 student teachers who were on their teaching practice to investigate their sense of community and perceptions of collaborative learning, via a Facebook group. The findings indicated that high browsing frequency on the Facebook group could positively facilitate a sense of community and perceptions of collaborative learning among student teachers. Liu (2016) concluded that student teachers "who often posted and responded to messages on Facebook group could experience the advantages of collaborative works" (p. 91). Facebook has become a part of student teachers' everyday life, and they should be encouraged to use it for educational purposes.

Similarly, Deng and Tavares (2013) showed that student teachers used their Facebook group to share information, exchange experiences and teaching ideas, discuss both academic and social issues and seek help during their teaching practice. Deng and Tavares (2013) indicated that student teachers were more actively involved in their Facebook group than in discussion forums on Moodle and learned more from their peers' responses. Student teachers associated Moodle with formal learning and felt their casual discussions would be monitored by their lecturers. This suggests that Moodle was not an ideal platform for their intended use during their teaching practice, since they viewed it as academic, formal, and instructor-controlled. A critique of why many virtual educational environments like discussion forums do not develop into a full learning community was raised by West and Williams (2017), who noted that social interactions occur in different spaces like Twitter and Facebook outside the potential community.

Other studies have focused on how the use of iPads facilitated practicum assessment. Mac Mahon et al. (2016) investigated how 38 student teachers from the National University of

Ireland incorporated iPads into teaching and learning during their teaching practice in secondary schools. The study used a mixed-method approach that included focus groups, questionnaires, reflective comments from student teachers, nonparticipant classroom observations of student teachers during their teaching practice, and written feedback provided by placement tutors. Student teachers used iPads to video record their own teaching and critically reflect on a short extract they had selected by adding a voice using iMovie. Student teachers also used Photo Stream (a cloud-based service) to share their files with placement tutors, which prompted immediate written feedback and on-going conversations. Similar to the results of Dann and Allen (2015), a key finding of Mac Mahon et al. (2016) was that over 80% of student teachers reported that analysing their practices using video was effective in promoting reflection. Further, 59% reported that they used FaceTime to maintain contact with one another while on teaching practice.

The use of video for teacher reflection has been found to help mentor teachers improve their teaching practices, especially their question-asking strategies. These studies (Dann & Allen, 2015; Mac Mahon et al., 2016) indicated that mentor teachers and student teachers can view video recordings at their appropriate time and place, and immediately engage in reflective conversation about the feedback. Effective feedback and feed-forward enables student teachers to monitor, evaluate, and reflect on their performance, which is an integral part of self-regulated learning during teaching practice (Mac Mahon et al., 2016). One effective method of providing feedback to student teachers while on teaching practice is to use video recordings of their teaching (Dann & Allen, 2015; Mac Mahon et al., 2016; Vaughan & Lawrence, 2013).

The importance of preparing student teachers to integrate mobile technologies into their instruction during teaching practice is reinforced in the literature. These studies (Deng & Tavares, 2013; Liu, 2016; Mac Mahon et al., 2016) found that student teachers used mobile technologies to exchange teaching ideas, share resources, and collectively learn beyond the confines of structured class time and location. Although there are increased demands for practices in ITE programmes and schools to evolve together (Darling-Hammond & Baratz-Snowden, 2007; Goodlad, 1994; Maher, 2018), none of these studies explored how student teachers used mobile technologies to support the learning of school students, thus relating their coursework with their teaching practice. Furthermore, few studies have addressed how teacher educators use mobile technologies to support the teaching and learning experiences of student teachers during their teaching practice.

Studies that focused on Preparing Student Teachers for Schools in New Zealand

New Zealand demonstrates recognition of the increasing challenges of the 21st century by funding ILEs (Ministry of Education, 2015) where learning often depends on mobile technologies. The majority of state schools in New Zealand are implementing creative ways to integrate ICT into their practices, by examining ILEs with an increasing number of BYOD initiatives (Benade, 2017; Fletcher et al., 2017). Effective ITE educates the teachers of these schools to meet the curriculum needs and students' learning preferences, including integrating mobile technologies more proficiently. An essential aspect of teacher education is to prepare student teachers to understand how schooling in New Zealand is being practised. There is a discrepancy between student teachers' digital expectations and the reality of their ITE programme experience, suggesting the need to improve the digital pedagogical confidence of student teachers (Maslin & Smith, 2017). Given the presence of mobile technologies in school classrooms, it is essential to determine how student teachers can be educated to use mobile technologies as effective pedagogical tools.

Maslin and Smith (2017) examined how student teachers' experiences during their ITE programmes supported them to be confident in using mobile technologies as pedagogical tools. The study was conducted with 31 student teachers during their 3rd year at two ITE providers. Findings indicated that student teachers were moderately positive about their digital confidence when they began training, but were less positive about their actual experiences during training. At the end of their training, however, they had strong positive attitudes and beliefs about their digital preparedness. Maslin and Smith (2017) stressed the importance of connecting coursework with teaching practice to develop student teachers' digital pedagogical confidence for their professional practice. This study focused on student teachers' in-course expectations by encouraging them to reflect on whether their digital experiences met their expectations at the outset of their studies.

Rawlins and Kehrwald (2014) conducted a case study with 28 student teachers to address their limited exposure to educational technology by supporting them to integrate technology into their own teaching. This study was underpinned by cognitive and sociocultural learning perspectives. Student teachers worked in groups to research how to incorporate into their daily teaching the five key competencies, outlined in the New Zealand Curriculum (Ministry of Education, 2007). They were then required to create a 10-minute video documentary drama to

present to their peers. Student teachers who were experienced in video editing were requested to teach their peers how to use video editing software. At the end of their course, more than 83% reported that the task provided a meaningful context for learning how to develop three key curriculum competencies in their own students: relating to others, participating and contributing, and managing themselves. In addition, student teachers reported that they would use a similar learning activity in their own classrooms. This task enabled student teachers to develop knowledge and skills to use various technologies and encouraged them to construct new knowledge in a collaborative environment.

Tolosa (2017) used an experiential approach to examine a one-year foreign language course that was redesigned to include the iPad as a tool for learning. Student teachers were encouraged to reflect on how best they could use iPads to teach school students. In particular, student teachers used iPads to take notes, access their LMS course site, create teaching resources for their lessons, and participate in collaborative tasks using Voice Thread to support their understanding of the challenges of intercultural language teaching. Student teachers posted an image that represented a cultural stereotype and explained how they would use it pedagogically. The findings indicated that student teachers felt most engaged when they used iPads to create resources they could use in their teaching, and when they used Google Docs to work on collaborative tasks. However, most of the student teachers who were not familiar with using mobile technologies for teaching, needed more time to learn about the use of iPads and were concerned about the number of new skills required to integrate mobile technologies into their future classrooms. Although Tolosa (2017) examined how student teachers would use iPads in their future classrooms, the study relied on feedback from three student teachers who had already adapted to using mobile technologies while learning to teach foreign languages. These findings are contrary to the study of Rawlins and Kehrwald (2014) where a learning community was created for student teachers to support one another to develop and reflect on key competencies but also to learn with technology.

At the time and place of this thesis case study, many student teachers go to schools with ILEs during their teaching practice. Yet, in New Zealand, there has been minimal "literature around ILEs and initial teacher education ... [and] on preparing student teachers for practicum in ILEs" (Nelson & Johnson, 2017, p. 65). This suggests little attention has been given to examining how teacher educators prepare student teachers for these new types of learning environments. Nelson and Johnson (2017) identified how nine student teachers learned to teach in ILEs during

their teaching practice. The findings indicated that student teachers' experiences of technology integration into their coursework, especially exploring the affordances of a range of digital tools, enabled them to incorporate technology-rich pedagogy into their practices. All the student teachers also perceived that multiscale collaborative relationships with more than one teacher—which were facilitated by Google Docs—enhanced their self-efficacy as teachers. Furthermore, student teachers felt more engaged when they used Google Docs to work on collaborative tasks and create resources they could use with their future students. While it is expected that teacher educators transform their teaching practices to prepare student teachers adequately for these new spaces, Nelson and Johnson (2017) noted that "these environments [ILEs] and the pedagogies they require pose significant challenges for practicum preparation" (p. 63).

Although these studies investigated preparation of student teachers for their future classrooms, they predominantly relied on student teachers' views. The actual practices of teacher educators, or their views about preparing student teachers for their future classrooms, were not presented. In addition, this review has identified that very few studies explored how mobile technologies support the teaching and learning experiences of student teachers in New Zealand. Although there is strong empirical evidence about how mobile technologies support and enhance 21st century teaching and learning (e.g. Burden & Kearney, 2017; Mac Mahon et al., 2016; Naylor & Gibbs, 2018), there is a lack of research on the preparation of student teachers to integrate mobile technologies in ways that align with practices in schools. With rapid advancements in mobile technologies, exploring the mobile pedagogical practices that teacher educators use to prepare student teachers is imperative, and should occur alongside other relevant changes to teacher education programmes in the 21st century (e.g. Fickel & Mackey, 2013).

Furthermore, studies exploring teacher educators' mobile learning practices have not considered how teacher educators model and scaffold the use of mobile technologies across multiple courses, and how it may influence the preparation of student teachers for their future classrooms; thus providing a rationale for this study. Exploring how teacher educators use mobile technologies to influence student teachers' teaching and learning is necessary. Consequently, student teachers' prior experiences, preconceptions, and motivation are more likely to affect their decisions about integrating mobile technologies into school classrooms. Because of this, it is important to understand student teachers' perceptions about their preparation, since they not only experience the use of mobile technologies to support their

teaching and learning but also as tools to improve the learning of school students. The findings of Burden and Hopkins (2016) showed that student teachers' experiences, attitudes, and beliefs affect their willingness to participate in mobile technologies-related activities (see also Gill et al., 2014). Similarly, as identified by Steel and Andrews (2012), student teachers' "prior experiences with technology along with their beliefs in relation to technology in teaching and learning are of critical importance and can have a significant impact on the ways in which teachers [they] use technologies in their classrooms" (p. 247).

For these reasons, my research study aimed to generate insights into how teacher educators integrate mobile technologies, not only across their courses and ITE programmes, but also into ways that student teachers engage and can adapt to their future classrooms. In my study, mobile learning is defined as the process of acquiring knowledge and skills by being taught, studying, and practising across multiple contexts using mobile technologies. Considering this definition in the context of this study, I argue that there is a need to study how the use of mobile technologies influence the teaching and learning experiences of student teachers, given their abilities to learn in different contexts (e.g. Adoniou, 2013) and, at different times of the day, whenever and wherever they have access to the internet or downloaded offline resources.

Conceptual Framework of This Study

The conceptual framework selected for this case study is based on social constructivist perspectives which theorise learning as an active, constructive and social activity. This framework helped to structure my examination of how teacher educators' practices with mobile technologies influenced the teaching and learning experiences of student teachers. Social constructivists emphasise that meaningful learning occurs when learners engaged in groups construct knowledge because cognitive development is a social process. The social constructivist orientation articulates that people make sense of their world through their individual and social experiences in relevant and real contexts (Vygotsky, 1978). Under this view, the learner explores the environment, interacts with others to construct knowledge, and apply its meaning to new situations, which is claimed by A. J. Davis (2017) as "far transfer" of learning.

The theory of social constructivism grounded in Vygotsky's sociocultural theory (1978), articulates that learning occurs through social interactions while using mediator tools and signs.

Vygotsky emphasised the importance of "mediated activity" by identifying both physical tools and psychological tools that have emerged within our cultural history. Through mediation, learners can advance within the Zone of Proximal Development (ZPD), which is defined as the distance between a learner's cognitive development influenced by independent learning and the level of potential cognitive development influenced through collaboration with the knowledgeable others. Vygotsky (1978) views the learner as an active participant who thinks independently, while the teacher is a facilitator and a coach who creates authentic tasks and negotiates meaning through multiple interactions among learners. Weiner and Lamb (2020) argued that the ability to learn within a situation of interactions in the social, cultural and professional environment challenges learners to examine their underlying espoused theories and theories-in-use which facilitates new ways of thinking and doing. Wenger (1998) views these new ways of thinking and doing as being able to build identity.

In the context of my case study, understanding this interaction is important because student teachers engage in a similar process when they learn with mobile technologies. Jahnke and Liebscher (2020) noted that learning with technologies extends cognitive functioning during learning and engages learners in cognitive operations while constructing knowledge that they otherwise would not have been capable of. In essence then, to support student teachers' ongoing development of their professional identity and teaching philosophy, implies that teacher educators must be knowledgeable and skilled, and have positive beliefs and attitudes about the use of mobile technologies. Ally et al. (2014) asserted that "if teachers [student teachers] are to transform new theories and leverage the potential of technology in the classroom, they must experience mobile learning in their initial training so they can effectively use what is available, including open educational resources" (p. 47). Naylor and Gibbs (2018) also stressed the importance of student teachers' experiencing pedagogical affordances of mobile technologies, since it facilitates the development of knowledge and skills needed for their future classrooms, such as cognitive development that other researchers (e.g. Hager & Hodkinson, 2009; Weiner & Lamb, 2020) have recognised as the transfer of learning.

Transfer of learning is a cognitive practice whereby a learner modifies and adapts "earlier learning to handle a related situation in a new context" (Hager & Hodkinson, 2009, p. 627). The comprehension of learners allows them to recognise how their knowledge and skills can be relevant and apply them effectively outside their original learning conditions. A. J. Davis

(2017) identified three distinctions of transfer of learning. One of these was "near and far transfer." According to A. J. Davis (2017), near transfer relates to implementing knowledge and skills to contexts that are similar to the original learning environment, while far transfer is the ability to apply knowledge and skills to novel situations than what was originally learned. To facilitate transfer to new contexts requires the most effective teaching methods that stimulate higher-order thinking such as student-centred approaches. A. J. Davis (2017) concluded that the focus of education must be on what the learner does with that knowledge.

There are different views on the transfer of learning that are founded on applicable learning theories. Weiner and Lamb (2020) talked about transfer from a more cognitive perspective. In the cognitive view, transfer depends on obtaining mental models (schema) to identify similarities between a past situation and a new situation to understand the new situation. A. J. Davis (2017) examined far transfer from cognitive and sociocultural perspectives, as discussed later in Chapter 5. Although these two theories have come from different theoretical perspectives in how learning and knowledge reconstruction are understood, A. J. Davis's (2017) perspective helps in understanding the nature of far transfer based on these two theories. I draw from A. J. Davis's (2017) view of far transfer because it helps to conceptualise and theorise my research. This case study explored how teacher educators used mobile technologies to prepare student teachers for school classrooms (far) that use mobile technologies to support learning. As presented in Chapter 3, this case study used multiple data sources to get views of teacher educators' practices and student teachers' perceptions of their learning with mobile technologies.

Chapter Summary

In this chapter, I have provided a review of literature relevant to this case study. This chapter began with a brief review of literature related to preparing student teachers for future-focused classrooms. This was followed by a review of government policies from various countries that have strongly endorsed preparation of student teachers to use technology.

The second section highlighted the progress that has been made concerning the integration of ICT into teacher education. I reviewed literature relevant to frameworks for technology integration and teacher educators' ICT competencies. The review also included effective strategies that teacher educators use which are central to successful preparation of student

teachers to integrate technology into their practices. To conclude this section, barriers to technology integration that challenge preparation of student teachers for their future classrooms were reviewed.

In the third section, I reviewed mobile learning practices in ITE by examining the multiple learning contexts of student teachers that have been enhanced by mobile technologies. Relevant literature that highlight how mobile technologies enhance the learning outcomes and learning experiences of student teachers were reviewed. I also focused on how apps support teaching and learning. Following this, the existing research provided guidance on how mobile technologies support and enhance the teaching and learning of student teachers during their coursework and teaching practice. The section ended with a review of studies that explored preparation of student teachers for their future classrooms in New Zealand.

The fourth section presented the conceptual framework selected for this case study which is based on social constructivist perspectives. Although not presented in this section, it is worth noting that I drew on the TPACK framework (Mishra & Koehler, 2006) and the iPAC framework (Burden & Kearney, 2017) to help design my study but then my study went beyond any one of those because I studied both teacher educators and student teachers. I was also informed by the iPAC framework in my analysis of data. The illustrations provided in this study extend the use of the iPAC framework in the field of teacher education, as discussed later in Chapter 5.

Based on the reviewed literature, it became clear that few studies have explored teacher educators' mobile learning practices that support student teachers to adopt and adapt such practices into their future classrooms. This in turn suggested the need to study how teacher educators prepare student teachers to use mobile technologies in their future classrooms. The next chapter describes the research methodology of this study.

CHAPTER 3: METHODOLOGY

Introduction

This chapter describes specific steps I took to address the research questions for this case study. According to J. W. Creswell and J. D. Creswell (2018, p. 18), a qualitative approach is used "if a concept or phenomenon needs to be understood because little research has been done." Studies have identified that preparation of student teachers during their coursework, and what is expected of them in their future classrooms about the use of technology, is under-researched (Maher, 2018; Ottenbreit-Leftwich et al., 2018; Uerz et al., 2018). As presented in Chapter 1, student teachers do not feel fully prepared to teach in their modern technology-rich classrooms (Admiraal et al., 2017; Myers & Rivero, 2019; Tondeur et al., 2017). To explore how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers, I employed an instrumental case study.

As the literature review in Chapter 2 shows, qualitative research (e.g. Baran, 2014; MacCallum et al., 2017; Mac Mahon et al., 2016; Naylor & Gibbs, 2018; Rawlins & Kehrwald, 2014) has been used to study the use of mobile devices during student teachers' coursework. Some studies that employed case study design specifically focused on student teachers (e.g. Burns-Sardone, 2014; Farley et al., 2015; Kearney & Maher, 2013; Pegrum et al., 2013; Tolosa, 2017). Few studies have utilised an instrumental case study approach with evidence from both teacher educators and student teachers to investigate teacher educators' practices with mobile technologies. To gain insights into the pedagogical strategies teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning, I collected rich and varied data, driven by an interpretive approach. In this chapter, I have provided detailed descriptions of the methodological choices that I made.

The chapter is organised into eight sections, presenting the overall research design used to address the research questions. The chapter presents the philosophical assumptions that underpinned this study, and a supporting rationale for the adopted instrumental case study design. I have described the wider context of this study, ITE in New Zealand, the ITE department and its approach to teacher preparation, highlighting the structure and salient components of the four ITE programmes. This is followed by information about how I selected the participants and how I developed and tested the instruments used to collect data. Next, I

have presented procedures used to collect data before describing the process I used to analyse data. Finally, the ethical considerations that I took into account are presented.

Philosophical Assumptions

Philosophical assumptions have been defined by Bogdan and Biklen (2007) as "a loose collection of logically related assumptions, concepts, or propositions that orient thinking and research" (p. 24), which J. W. Creswell and Poth (2018) identified as the first ideas and beliefs in developing a study. According to Guba and Lincoln (1989), philosophical assumptions are about the nature of reality and how it is viewed (ontology), how reality is made known (epistemology), and the entire process of research (methodology). These assumptions are often applied through the use of paradigms and theories when conducting a study.

The ontological position of this case study reflects my beliefs in social reality and the phenomena that influenced how I conducted this study. I believe the social world of teacher education is not an independent entity but it is a space created by the actions of people who derive meanings through interactions. In this study, I considered it important to examine both teacher educators' and student teachers' actions, thoughts, and experiences about the phenomenon under investigation to understand their personal meaning systems. Therefore, underpinning this research is a constructivist model.

Researchers who claim a constructivist stance aim to give evidence of multiple realities, to be interpreted based on the subjective meanings of the participants, since they argue there is no single reality (J. W. Creswell & Poth, 2018). This study focused on the use of mobile technologies in teacher preparation in the New Zealand context where the use of mobile technologies is high in schools (e.g. Lindsay 2016) and government initiatives are very supportive (e.g. Ministry of Education, 2015). In addition, these initiatives and institutional realities influence teacher educators' practices, as is argued later in this chapter. I argue in this study that teacher educators' practices with mobile technologies vary depending on different factors, such as their maturity with mobile technologies, the courses they teach, the context they design for mobile technologies to be used by student teachers, and the type of mobile technologies they integrate into their practices. As a consequence, I expected multiple realities.

Epistemology is about how people know what they know (Guba & Lincoln, 1989). J. W. Creswell and J. D. Creswell (2018) argued that an interpretive approach is rooted within the constructivist epistemology which assumes that human beings seek understanding of reality through subjective meanings of their experiences within a naturalistic context, in this case ITE. Since these meanings are varied and multiple, they influence the researcher "to look for complexity of views rather than narrowing meanings into a few categories or ideas" (J. W. Creswell & J. D. Creswell, 2018, p. 8). To gain an in-depth understanding of the phenomenon, researchers rely on the respondents' views which are socially and historically negotiated.

In this case study, I expected teacher educators and student teachers to have their own perspectives about the use of mobile technologies in teaching and learning, mainly defined by their lived experiences and the meanings they attributed to those experiences. I obtained participants' views, including those of myself as a nonparticipant observer, to present diverse perspectives about the research problem. Using multiple views enabled me to understand participants' subjective meaning of their experiences by looking for the complexity of their views and to interpret them in conjunction with my field notes. From this it follows that this case study was guided by the notion of multiple realities and complexity of views (J. W. Creswell, 2013) to understand the phenomenon being studied, which was the pedagogical strategies that teacher educators used. These multiple views are illustrated in the themes that emerged as case findings of this study, presented later in Chapter 4. For these reasons, the methodology of this research was designed to be consistent with the mainly interpretive stance.

Instrumental Case Study Design

An instrumental case study design (Mills et al., 2010) was chosen to explore how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers. According to Mills et al. (2010), an instrumental case study design uses a case to gain insights into a phenomenon by focusing more on the specifics related to the research question. As Merriam (2002) noted, a case can be an individual, a group, a programme or a scenario. In my study, the case was teacher educators' practices with mobile technologies. The case of my study was in a bounded system. Regarding the boundedness of a case, Merriam (2002) identified four key attributes: location, activity, time, and components comprising the case. The location of this thesis case study was an ITE department in one institution of higher learning in New Zealand, as described later in this chapter in the case study setting section. The

activity I investigated was teacher educators' practices with mobile technologies within the boundaries of four ITE programmes over a ten-month period. As Mills et al. (2010) suggested, the case of my study helped me to specifically examine the pedagogical strategies that teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning.

A common definition of a case study is based on Yin's (2018) definition: "an empirical method that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (p. 15). The use of instrumental case study research was considered suitable for several reasons. It can be argued that the pedagogical strategies that teacher educators use to prepare student teachers to integrate mobile technologies into their practices are a contemporary reality. This is due to the worldwide challenge of developing digital competencies of student teachers to integrate technology in meaningful ways into the school classrooms (Tondeur et al., 2017). For this reason, the use of a case study offered a way to gain insights into the phenomenon.

It is worth mentioning that other designs such as ethnography and phenomenology also give an in-depth understanding of the phenomenon (J. W. Creswell, 2013). However, I did not consider using them as methodological approaches because ethnography requires the researcher to be part of a community for a long time to understand the cultural underpinnings of a phenomenon. An alternative approach would also be to use phenomenology but it requires the researcher to describe the lived experiences and background of individuals about a phenomenon (usually an object of human experience). The focus of my study was on teacher educators' pedagogical practices and decision-making, rather than their wider views of mobile technologies, or how their background or experiences shaped those decisions/actions.

The benefits of utilising a case study have been articulated by various authors (e.g. Gray, 2014; Yin, 2018). In stating these benefits, J. W. Creswell (2013) noted that a case study provides a holistic means of presenting rich descriptions and interpreting a particular phenomenon using multiple sources of evidence. Sources of evidence that are commonly used in conducting a case study include the use of physical artefacts, direct observations, participant observations, documents, archival records, and interviews with participants (Yin, 2018). In this case study, I collected and interpreted data from multiple sources, to gain an understanding of participants'

perspectives, and to offer holistic details about the pedagogical strategies teacher educators' used to prepare student teachers to integrate mobile technologies. Collection of data from multiple sources also facilitated the triangulation of data to provide for multiple ways of interpretation and enhance the credibility of the findings (J. W. Creswell & Poth, 2018).

Finally, I considered a case study relevant in accordance with Gray (2014) who noted that a "case study method is ideal when a 'how' or 'why' question is being asked about a contemporary set of events over which the researcher has no control" (p. 267). The overarching research question for this study is a *how* question. To address the research question, I designed four instruments, as explained later in this chapter: (1) a semi-structured interview, (2) nonparticipant observations of classroom practices, (3) an online questionnaire, and (4) focus groups. Interviews were the primary data source used to assess the meaning participants had about the phenomenon being studied. Table 3.1 presents an outline of how I designed this study.

Table 3.1
List of Research Questions with Aligned Data Sources and the Participants

Research problem: Effective preparation of student teachers to teach in technology-rich classrooms where mobile devices abound is unclear and under-researched.		
Overarching research question: How do teacher educators use mobile technologies to influence the teaching and learning experiences of student teachers?		
Research subquestion	**Data sources**	**Participants**
What pedagogical strategies do teacher educators use to prepare student teachers to integrate mobile technologies into their teaching and learning?	Semi-structured interviews-(one interview per teacher educator)	8 teacher educators
	Nonparticipant observations (online and face-to-face classroom teaching)	3 teacher educators who teach in three different ITE programmes
	Researcher journal	Researcher
	Online questionnaire	110 student teachers

Identifying the Case

This is a holistic single-case study design (Yin, 2018) of an ITE department situated in one institution of higher learning in New Zealand, based on eight teacher educators and their student teachers, and within that case there are illustrative narratives of three teacher educators. The case in this study is teacher educators' practices with mobile technologies which I used "as specific illustration" (J. W. Creswell, 2013, p. 97). A single-case study design is used when examining a single unit of analysis (Yin, 2018), or one unit of a social phenomenon (Mills et al., 2010). Therefore, using the guidance of Yin (2018), in this case study, the pedagogical strategies that teacher educators used to integrate mobile technologies into their practices formed a single unit of analysis (one unit of a social phenomenon).

Student teachers' perceptions about the use of mobile technologies were obtained through an online questionnaire to illuminate the qualitative data from multiple sources, adding to the deeper understanding of teacher educators' practices. Furthermore, besides using the guidance of Yin (2018), I deliberately aimed to address a gap observed in the literature. As reviewed in Chapter 2, the majority of studies on the use of mobile technologies in teacher education contexts obtained the views of student teachers and not those of teacher educators (e.g. Kearney & Maher, 2013; Pegrum et al., 2013; Schuck et al., 2017). In this study, I argue that we should pay attention to teacher educators' practices with mobile technologies based on the perspectives of both teacher educators and their student teachers.

The Case Study Setting

This section begins by setting the scene in New Zealand ITE to clarify how contextual issues affected the phenomenon being studied. Based on Yin's (2018) argument, I was aware that the understanding of teacher educators' practices was likely to be affected by contextual conditions. I begin by describing the wider context of this instrumental case study, ITE in New Zealand, to contextualise the case presented in Chapter 4. Lincoln and Guba (1989, p. 302) argued that "it is not possible to understand *any* phenomenon without reference to the context in which it is embedded." To offer deeper insights into the pedagogical strategies teacher educators used to prepare student teachers to integrate mobile technologies, this description aims to enable the ITE department to be contextualised within some national initiatives in the education system that influenced practices in teacher preparation during the time of this research. I have then described the ITE department and its approach to teacher preparation,

highlighting the structure and some of the salient components of the four ITE programmes. This is necessary to inform an understanding of the context in which teacher educators were working and how they were responding to both their national and institutional contexts.

New Zealand the ITE Context

When this research was being carried out, 27 providers were offering teaching qualifications in New Zealand, ranging from a 1-year graduate diploma in teaching, undergraduate degrees that were three or four years of study, postgraduate diploma and master of teaching and learning between one and two years of study (Education Counts, 2019). These qualifications prepare student teachers to "acquire professional knowledge from multiple dimensions, including subject and context knowledge, general and pedagogical content knowledge and knowledge of learners and learning" (Buabeng, Conner, & Winter, 2015, p. 1). All providers of ITE are regulated by the Teaching Council of Aotearoa New Zealand (TCNZ) which oversees nationwide approval and monitoring of ITE, registration of teachers, and maintenance of professional standards. To gain approval, teacher education providers must prove how their programmes enable graduates to meet the New Zealand Standards for the Teaching Profession. The focus of these standards describes what a graduate should know, understand, be able to do, and the dispositions they will have that make them effective teachers (Education Council, 2017).

In New Zealand, transformations in ITE practices have been impacted by national priorities in the education system such as the integration of ICT into teaching and learning and preparing culturally responsive student teachers. As outlined by the New Zealand Education Council (2017), teacher educators are expected to teach student teachers "the details of current New Zealand education initiatives" (p. 23). Although teacher education providers in New Zealand do not have a national curriculum that guides how they design their programmes and courses, ITE programmes are obliged to "adequately model the skills and practices required for teaching in the learning context in which the graduates will be teaching" (Education Council, 2017, p. 23). In relation to this study, an important feature of these learning contexts is an increased interest in integrating ICT with teaching and learning because digital technologies have become a part of New Zealand school culture. For example, during the period of this study, schoolteachers were being guided by the curriculum which outlined technology as a key learning area to prepare all students to be technologically literate. The curriculum identified

the need for schools to explore how ICT can supplement traditional ways of teaching and open up new ways of learning (Ministry of Education, 2007).

Given such national priorities for schools, ITE is entrusted to enable student teachers to develop curriculum and learning experiences aligned to the digital technologies outcomes. There is the expectation from the New Zealand Ministry of Education that graduating teachers should show proficiency in ICT relevant to their professional role (Ministry of Education, 2010). Currently, ITE programmes are expected to enable graduating teachers "to effectively apply digital technology pedagogies," according to the TCNZ (2019, p. 16). This suggests that implementing innovative teaching approaches—as opposed to traditional approaches that place less emphasis on 21st century skills—is essential. However, "teacher educators assume a daunting responsibility when preparing students [student teachers] to become effective and pedagogically competent classroom practitioners" (Buabeng et al., 2015, p. 1).

Some of the changes focused on preparing culturally responsive student teachers to increase their effectiveness in supporting learners from diverse backgrounds, particularly Māori and Pasifika learners, students for whom English is an extra language, and those from low socioeconomic households. For example, in 2013, the Ministry of Education called for proposals for "exemplary teacher education programmes" which led to the development of new postgraduate programmes (e.g. Fickel & Abbiss, 2019). As outlined by the New Zealand Education Council, teacher educators have been responding to specific Graduating Standards such as ensuring that graduating teachers are knowledgeable about tikanga (the Māori way of doing things) and te reo Māori, and demonstrate respect for te reo Māori in their practice so that they can work effectively within the New Zealand bicultural contexts (Education Council, 2017). Furthermore, the school curriculum acknowledges that "all students have the opportunity to acquire knowledge of te reo Māori me ōna tikanga" (Ministry of Education 2007, p. 9). Currently, the standards require that "student teachers will be assessed throughout the programme on their competence in te reo Māori, culminating in their ability to pronounce Māori words correctly and to use te reo Māori accurately in teaching settings" (TCNZ, 2019, p. 6).

In common with practice globally (N. Davis, 2010), teaching practice in schools, or early childhood education (ECE) centres, has been required to be embedded within ITE programmes and this contributes to the professional development of student teachers as they reflect and

practise on their teaching pedagogies. In New Zealand, the required teaching practice period consisted of at least 80 days for 1-2 year programmes, and a minimum of 120 days for 3-year programmes or longer (Nordin, 2014). As outlined by the Education Council (2017), one of the requirements that must be fulfilled for approval as an ITE programme is the integration of theory and practice throughout the programme, and support student teachers to analyse and interpret what they observe in schools or ECE centres. One way this requirement is fulfilled is by teacher educators partnering with mentor teachers in schools and/or ECE centres to support student teachers. Studies show that student teachers benefit from this collegial triadic relationship through coaching of practices, modelling, engaging in feedback conversations that prompt their critical self-reflection (Fickel & Abbiss, 2019), and by developing their teaching competencies with ICT (Nordin, 2014).

I gathered data for this case study within one of the largest research-intensive universities in New Zealand, which is well-regarded internationally (A, 2016; obscured). The university was among eight universities across the country that offered degree programmes from bachelor to doctoral level. It also had a range of specialised ITE programmes, where student teachers enrol either for the first time or complete an additional ITE qualification if they were already qualified to teach or had a relevant bachelor's degree that is not in teaching, as identified by the Education Council (2017). Study options included full-time, part-time or by distance learning modes that increased the flexibility of learning. These programmes prepared student teachers to teach in New Zealand, either in ECE centres, schools—primary, intermediate or secondary, or kura (Māori medium or immersion).

Case Study ITE Programmes

This case study focused on four 1-year ITE programmes, which run from February to November. The year includes two semesters with four blocks of lectures (two per semester). The programmes will be referred to as Programme A, Programme B, Programme C, and Programme D to protect the identity of the ITE department and the participants. Student teachers enrolled in these programmes were being prepared to teach ECE centres, primary, middle and/or secondary schools. I selected these programmes to study teacher educators' practices in different contexts with a range of student teachers. The majority of teacher educators taught multiple courses across more than one ITE programme and some were team teaching. The course structures in all these programmes were set up to meet the requirements outlined by the Education Council (2017). Teacher educators designed weekly modules for

their courses and uploaded them on the LMS course site. The course readings which student teachers were expected to complete every week, links to websites, recorded lectures and assignments were all integrated into the weekly modules, as shown in the following instructions I obtained from one of the course sites:

> The weekly modules for this course can be found in the left-hand sidebar. We have labelled these modules by week and date to keep it simple for you. Each week a module will be made available to you as we do not want to overwhelm you with content. All past modules will be kept until the end of the course.

Delivery modes of instruction included on-campus, distance study, and a blend of both study options (A, 2016; obscured). The last-mentioned option was developed in selected programmes so that student teachers who preferred the distance learning option could have the opportunity to meet face-to-face with their teacher educators and peers, be introduced to the course content and form study groups (D, 2014; obscured). Contrary to common misconceptions, the programmes were designed so that student teachers, who were studying at an alternative campus and at a distance could have access to the same academic opportunities as student teachers attending classes on-campus. In this institution, the use of mobile technologies has supported the distance study options which have been offered for several years (A, 2016; obscured). For example, in 2012, a team of teacher educators used web-conferencing technologies Adobe Connect and Zoom to facilitate distance learning (D, 2014; obscured). They found that student teachers could engage in responsive interactions and connect in meaningful ways. This also improved the learning experiences of student teachers.

All the courses were taught face-to-face, using online resources, including web-based audio and video conferences which allow distance student teachers across the country to use their devices to connect with their peers and teacher educators. Furthermore, all the courses had only one course site hosted within the institution's LMS. Course readings, podcasts of lectures, tasks, discussion forums, and communications were accessed via the LMS. Also, student teachers uploaded their assignments to Dropbox within their course site and all assessment results are distributed to each one of them by the use of an online Gradebook tool in the LMS. The institution had developed an app for the LMS that permitted student teachers to use their mobile devices to access course resources and other support services. While on campus, student teachers and staff were provided with free Wi-Fi access to connect their mobile devices to the university network.

Participants and Selection Procedure

Two groups of participants were purposefully selected to participate in this study: (1) teacher educators who taught in one or more of the four 1-year ITE programmes; and (2) student teachers who were enrolled in one of the four ITE programmes. As J. W. Creswell and Poth (2018) stated, in purposeful sampling technique, participants are selected to be included in the sample because "they can purposefully inform an understanding of the research problem and central phenomenon in the study" (p. 158). This view has also been recognised by other authors such as Gray (2014), who asserted that purposeful sampling enables the researcher to decide who will provide the best perspectives about the phenomenon being studied. As Merriam (2002) suggested, the researcher begins by determining the selection criteria which "depends upon what you want to learn and the significance that knowledge might have for extending theory or improving practice" (p. 179).

When I was selecting the teacher educators, a set of criteria was applied: (a) I focused on the programmes they taught, that is, four 1-year ITE programmes, (b) whether they used mobile technologies in their practices, (c) their interest in the study, and (d) willingness to participate. With the student teachers, as well as volunteering to participate, they had to be enrolled in one of the four 1-year ITE programmes. This sample was accessible to me to examine their experiences with mobile technologies during their coursework and teaching practice. The study focused on obtaining student teachers' views at the beginning of their second semester, and immediately at the end of their first or second teaching practice. This decision was made for two reasons. They would have had enough time in their programmes to talk about their experiences during their coursework. Also, it was anticipated that they could clearly remember their experiences in schools or ECE centres to provide meaningful data. In addition, 20 student teachers volunteered to participate in focus groups as described later in this section. The decision to include teacher educators and student teachers in this research enabled me to collect data from multiple sources to study how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers.

Selecting Teacher Educators

At the time of this research, approximately 23 teacher educators taught in one or more of the four ITE programmes; all were invited to participate. The recruitment of teacher educators began when I contacted the Director of Teacher Education requesting her help in the

recruitment process. She invited the teacher educators to voluntarily participate in the study. Shortly after, I also sent an email invitation to some of the teacher educators I had interacted with during the recruitment process of the student teachers. Information sheets (Appendix A) which explained the purpose of the study and requirements for participation such as time commitments were attached to their emails. Part of the information also included asking the teacher educators to volunteer for my observation of their online and face-to-face classroom teaching. Eight teacher educators volunteered for me to study their practices (individually) with mobile technologies.

Selecting Student Teachers

At the time of this research, around 350 student teachers were enrolled in the four one-year ITE programmes; all were invited to participate. Securing entry to the field began when I sent an email, with an explanation of the goals of the study to four programme coordinators requesting permission to recruit student teachers in the programmes that they coordinated. The programme coordinators told some of the teacher educators in their programmes to notify student teachers, and allocate a convenient time that we could meet. After permission was granted, I invited all the student teachers to meet with me during one of their lessons. During these first meetings, I visited the classes to familiarise myself with the student teachers, explained the purpose of the study, and how the data were going to be used. I also gave them information sheets (Appendix B) which contained the description of the study, steps taken to ensure confidentiality, and requirements for participation. Student teachers who voluntarily accepted the invitation signed the consent forms (Appendix B). The procedure varied with the student teachers studying at a distance. I requested the teacher educators to tell them about the opportunity to participate. In addition, teacher educators also shared with the student teachers the information sheet which contained a link to the questionnaire, and that by completing the questionnaire it was understood that they had read the information and consented to participate in the study. One hundred and ten student teachers (n=110) who studied either on-campus or by distance mode of learning completed the online questionnaire (Appendix C), representing a response rate of approximately 32%.

Selecting Student Teachers for Focus Groups

According to Admiraal et al. (2017), when student teachers observe and appropriately use technology during their teaching practice, it develops their feelings of preparedness to integrate technology. To gain insight into student teachers' experiences about the use of mobile

technologies in their preparation, it was essential to also examine their experiences during teaching practice. During teaching practice, not all student teachers were in schools that had adopted digital classrooms and implemented the recent developments of ILEs (see Fletcher et al., 2017), a move away from traditional classroom practices. Because of this, I also used a purposeful sampling approach to select student teachers for focus groups.

I approached all student teachers enrolled in Programmes B, C, and D for follow-up focus groups. With the help of their teacher educators, I sent them an invitation email and 20 student teachers consisting of six males and fourteen females gave consent to voluntarily participate. The reason for selecting student teachers enrolled in these programmes was primarily to collect richer, more descriptive data and gain more insight into their preparation concerning their experiences in schools with ILEs, where the focus of pedagogies is on development of 21st century skills and competencies. Also, they had completed the majority of their required coursework, and their teaching practice. I, therefore, believed that they would provide vital data about how the use of mobile technologies had impacted their ITE studies, and in what ways it may have (not) prepared them for classroom teaching. This aimed to yield in-depth information of how their ITE programmes prepared them for their future classrooms. Before collecting data from the participants, I developed the instruments as discussed in the following section.

Developing and Testing the Instruments

Fraenkel, Wallen, and Hyun (2012) outlined the entire process of preparing to collect data to include selecting or designing the instruments and identifying procedures and conditions under which the instruments will be administered. Instruments are tools which are used by researchers to collect data. In this study, I developed four instruments:

a) Semi-structured open-ended interview
b) Nonparticipant observations of classroom practices
c) An online questionnaire, and
d) Focus group interview.

Multiple data collection methods offered a means to ensure valid and trustworthy interpretation of the data. Cohen et al. (2011) noted that the main advantage of using semi-structured interviews is that they allow the researcher to compare responses from the different informants

and the flexibility to probe for details. Through the semi-structured interviews, I understood teacher educators' views about how they used mobile technologies to prepare student teachers, different practices they saw in schools that informed them, and challenges as well, and further understood data that I collected from student teachers. Hence, the interviews with the teacher educators were considered a primary source of data. However, Yin (2018) cautioned that this method can be biased if questions are poorly articulated or if the respondents are not sincere.

I observed classroom practices of three teacher educators (see their illustrative narratives in Chapter 4). Observation is among the essential tools researchers use to collect data. As Cohen et al. (2011) noted, observation provides an opportunity for the researcher to gather live data from naturally occurring social situations by looking directly at what is happening rather than relying on secondary sources. This method has the potential of yielding more authentic data as compared to inferential methods because it provides the researcher with first-hand information about the behaviour of the participants.

According to Cohen et al. (2011), the use of a focus group interview allows a researcher to gain a collective view about the topic of discussion. Because by using a Likert scale I could not get "information about why participants respond as they do" (Leedy et al., 2019, p. 156), I conducted focus groups with student teachers to gain a better insight into their experiences about the use of mobile technologies during their coursework and teaching practice. Furthermore, with interviews, as suggested by Gray (2014), meanings of a question can be clarified immediately and produce a greater response rate. Drawing on student teachers' survey data and focus group results helped to triangulate the findings, which provided a nuanced description of the experiences and uses of mobile technologies by both teacher educators and student teachers.

The design of these instruments was guided by the research questions and informed by the conceptual framework and related literature with the assistance of my two supervisors. The following is a detailed description of how the instruments were developed and tested.

Semi-structured Interview Protocol

I designed the semi-structured interview protocol (Appendix D) for teacher educators by creating a list of specific topics to be covered. Interview questions were related to the research questions. Guided by the case study approach, I designed the protocol with "how" and

"why" questions of substance and form (Yin, 2018). I generated the questions and they were reviewed by my supervisors. The aim was to allow the teacher educators to build meaning about how they integrated mobile technologies into their practices, and how it influenced student teachers' learning experiences. The protocol consisted of two parts. Part 1 had four questions that enabled me to gather teacher educators' background information such as ITE programmes they taught, their years of teaching experience, type of mobile devices owned, and their maturity with mobile technologies using a self-assessment tool of a teacher's level of adoption of technology (Knezek et al., 2000).

Part 2 included five open-ended questions developed by referring to Kearney et al.'s (2015) survey of key pedagogical features of mobile learning. Kearney et al.'s (2015) survey was based on the iPAC framework developed by Burden and Kearney (2017), which identified three distinctive pedagogical features—personalisation, authenticity, and collaboration. These distinctive features also informed how the five questions were grouped. The questions in the interview protocol probed the teacher educators in how they used and embedded a range of mobile technologies into their instruction, strategies they used to facilitate instruction, and how student teachers used mobile technologies in their coursework. I reviewed the questions with experts before administering the interview protocol.

Content Validity

I validated the interview protocol by consulting with experts. These experts included, the Director of ITE research, one ITE programmes' coordinator, and two faculty in the field of mobile technology. I asked each of them to review the questions and annotate any information they felt was unclear or inappropriate. The intention was to find out if all the questions in the instrument would elicit relevant information for the study, that is, to collect data that would lead to addressing the research questions.

Their suggestions led to four revisions. (1) I redrafted some key questions to include follow-up questions which helped to probe for more information. (2) I revised the majority of the questions to improve the focus of the research problem. (3) My supervisors also reviewed the questions to ensure that they were appropriate for the New Zealand teacher education context. (4) The *Stages of Adoption of Technology Scale* (Knezek et al., 2000) was added so that teacher educators could self-evaluate their maturity stage with mobile technologies. The protocol was then ready to be piloted with one teacher educator.

Pilot Testing the Interview Protocol

Yin (2018) recommended a pilot test to refine data collection plans and to develop relevant questions. This pilot interview aimed to refine the content of the data by ensuring the questions were clear, and relevant, in line with the purposes of this study. The semi-structured interview questions were piloted with one of the eight teacher educators who created, coordinated, and taught in more than one ITE programme. The teacher educator was purposely selected because programme leaders recognised that she was innovative in her use of mobile technologies. Before the interview, I emailed her the information sheet detailing the purpose of the study, the consent form, together with the interview protocol so that she could get familiarised with the questions. In addition, the teacher educator was asked to indicate if she understood how the questions were worded, and give feedback on whether the questions addressed the research problem.

The interview session lasted for 30 minutes, was audio-recorded, and the transcribed verbatim. The interview transcript was sent to the teacher educator to ensure her ideas were represented accurately. The teacher educator provided her views about the quality and clarity of the interview questions and I made a few minor revisions to the interview protocol. For example, in the demographic section, I deleted a question that had asked the teacher educators to identify their age because that was too identifiable and so anonymity and confidentiality would have been comprised. Data collected from the interview with the teacher educator were analysed and presented at a conference as part of the preliminary findings of this case study (Obonyo, N. Davis, & Fickel, 2018). Insights obtained from this pilot study informed the research design and the procedures to be followed during the main study.

Observation Protocol

This study focused on examining in-depth information about teacher educators' practices with mobile technologies. I, therefore, set out guidelines about what to observe in their classrooms, as suggested by Cohen et al. (2011). I developed an observation protocol (Appendix E) based on the research purpose and research questions, and it was also informed by literature related to the preparation of student teachers to integrate technology into their teaching. The literature outlined various ways technology can be used to enhance teaching and learning, and a range of instructional activities that prepare the student teachers to integrate technology into their practices. My supervisors reviewed the observation protocol and provided feedback and recommended changes, which I implemented. The statements outlined in the

informal observation protocol guided in observing both online and face-to-face classroom activities.

Online Questionnaire

Gray (2014) noted that the use of a questionnaire allows for eliciting many people's opinions and they can respond in a place and time that are convenient to them. In August 2016, I developed an online questionnaire, which went through a number of iterations before I administered it during the main study. The questionnaire was used to collect data about student teachers' backgrounds, how they used mobile technologies during their coursework, functions of mobile technologies that they found useful during their teaching practice, and their pedagogical beliefs about the use of mobile technologies in teaching and learning. It was a customised questionnaire derived from two existing surveys (Nordin, 2014; O'Bannon & Thomas, 2015) that had been used with student teachers, and one survey that was used with school teachers (Kearney et al., 2015).

When preparing or selecting a research instrument, one of the most important ideas to consider is validity (Fraenkel et al., 2012). Leedy et al. (2019) defined the validity of a measurement instrument as "the extent to which the strategy yields accurate assessments of the characteristic or phenomenon in question" (p. 104). There was a need to validate the online questionnaire before it could be used in the main study. This is because, apart from Nordin's (2014) survey, the questionnaire had a combination of questions from surveys that were validated on student teachers and schoolteachers in other countries. Also, I used some of my own questions and combined them with questions from validated questionnaires. It was deemed appropriate to find if and how the items on the questionnaire were closely related, and whether they measured what the questionnaire sought to measure. In other words, I wanted to confirm that the questions posed to the student teachers were valid questions about their experiences with the use of mobile technologies within the New Zealand context and that they were likely to interpret each question the same way.

Content Validity

To increase the likelihood of content-related evidence of validity for this study, the questionnaire was subjected to scrutiny by my supervisors and a number of experts (reviewers) in the field of mobile technology and teacher education. I used their comments and suggestions

to revise the items and to redesign the questionnaire. This increased the chances of obtaining quality data to address the research questions, as noted by Leedy et al. (2019). For example, I made the following changes:

(1) The total number of items was reduced from 42 to 36 items that specifically addressed the research problem. Some items that did not give relevant information for the study were deleted and others re-grouped.
(2) One expert felt that the questions were relevant but suggested using the 5-point Likert scale throughout. This was done.
(3) It was suggested that *Stages of Adoption of Technology Scale* enacted by Knezek et al. (2000) be used to examine their maturity with mobile technologies. This was done.

Pretesting the Questionnaire

The amended questionnaire was pretested with 23 student teachers who volunteered to participate. The aim was to determine face validity, which is a check for clarity and relevance of the questions, as recommended by Leedy et al. (2019). A link to the online questionnaire was sent to them using the email addresses they had provided in the consent forms. I targeted student teachers who were doing their last coursework and had completed their second teaching practice. It was believed that they would give informative feedback based on their experiences throughout their preparation to teach. Although the student teachers were different from the participants of the main study, they had similar characteristics to the target group of student teachers. For example, they were in the same ITE department and were taught by the same teacher educators who participated in the main study. I gave the student teachers approximately three weeks to complete the questionnaire.

It was not easy to get permission from the teacher educator to visit her class and invite student teachers to participate. This was attributed to a lack of trust. For this reason, I started attending some of the faculty meetings to build rapport and talk about my research study. According to Leedy et al. (2019, p. 160), “the goal here is to motivate people to want to help you out by giving you a little bit of their time.” In addition, it was also challenging to get the targeted student teachers at an appropriate time for my time schedule. This informed plans to collect data at the beginning of the second semester and immediately at the end of their first or second teaching practice. This was a convenient time for the student teachers to participate in the study,

before getting busy with their coursework, so as to maximise the response rate. It also provided more time to follow-up with those who did not respond to my first invitation to participate.

When I closed the questionnaire, 20 student teachers out of 23 had completed the questionnaire representing 87% response rate. The responses of three student teachers who answered only a few of the questions were removed. These 20 responses were collated and used for pretest reliability analysis.

Pretest Reliability Analysis

Because the questionnaire was made up of three different scales, the internal consistency of the scales was established separately. The scales were experiences with mobile technologies, functions of mobile technologies, and pedagogical beliefs about the use of mobile technologies. Cronbach's alpha reliability coefficient was used as an estimate for scale reliability. The experience with mobile technologies scale contained 10 items (Cronbach's α=.81), 10 items related to the functions of mobile technologies scale (Cronbach's α=.88), and the pedagogical beliefs about the use of mobile technologies scale contained 10 items (Cronbach's α=.92). Cronbach's alpha coefficient (α) estimates of all the three scales were higher than 0.80, indicating *very good* according to DeVellis's (2017) guidelines. The scales generated for the questionnaire were considered to be reliable, and the questionnaire was ready to be sent out for the main study.

The Final Version of the Online Questionnaire

The online questionnaire (Appendix C) had two sections with a total of nine questions. Section A encompassed general questions (Questions 1, 2, 3, and 4) that were designed to capture student teachers' demographic information such as their gender, and age range, the type of mobile devices they owned, and their ITE programmes. This section also had Question 5 which asked student teachers to self-assess their maturity with mobile technologies using Knezek et al.'s (2000) *Stages of Adoption of Technology Scale* (Appendix F). I did not change this scale, apart from student teachers being required to respond with mobile technologies in mind. It is a self-assessment instrument of a teacher's level of adoption of technology based on Rogers's (1983) Diffusion of Innovations theory. The scale is openly available for scholarly research and it can be applied to different types of classroom technology use including mobile technologies. Knezek et al. (2000) stated that data gathered through this instrument could not

be used to calculate the internal consistency reliability measures since it is a single item survey. However, they reported high test-retest reliability estimates (.91) for this instrument when used on pre-post-tests with a large group of teachers.

Section B of the questionnaire consisted of three different scales (Questions 6, 7, and 8). Each scale was made up of 10 items. Responses to each item were assessed using a 5-point Likert scale ranging from 1 (*strongly disagree*), 2 (*disagree*), 3 (*neutral*), 4 (*agree*) to 5 (*strongly agree*). The majority of the surveys that served as a model for this study used a 5-point Likert scale, therefore I developed the items on a 5-point Likert scale. In addition, Leedy et al. (2019) posited that the use of Likert scale allows researchers to collect more data quickly, and efficiently especially when participants complete by themselves.

As indicated in Table 3.2, items 1-10 (Question 6) described student teachers' experiences with the use of mobile technologies during their course work. I developed all the items based on the survey by Kearney et al. (2015) (with permission) and relevant literature associated with mobile technologies and ITE. Kearney et al. (2015) developed and validated the instrument through intra-researcher validation based on how well the items aligned with the three constructs of the iPAC framework, sociocultural theory, and the consistency of the results. This was established by calculating the internal consistency of the questionnaire for the school teachers which was Cronbach's alpha of 0.832, suggesting very good internal consistency reliability (DeVellis, 2017). Their survey was used to collect data about mobile learning pedagogies in schools and university education.

Items 11-20 (Question 7) asked student teachers to identify useful functions of mobile technologies when they were in schools or ECE centres during their teaching practice. The goal was to identify how student teachers used mobile technologies as pedagogical tools. All the items were adapted from the survey developed by O'Bannon and Thomas (2015). The original instrument was developed for student teachers and focused on measuring their responses about how often they used mobile phone features and useful features of mobile phones for school-related work among other variables. O'Bannon and Thomas (2015) explained validation of their instrument and reported Cronbach's alpha coefficients for their themes ranging from 0.73 to 0.94. I was granted permission to incorporate some of their survey items into this questionnaire by Dr Blanche O'Bannon.

Table 3.2

Questionnaire Items Relating to their Sources

Items	Sources
Experiences with mobile technologies	Kearney et al. (2015) survey and related literature
1. Controlling the time, and pace at which I learn	
2. Having an opportunity to learn independent	
3. Controlling the context of my learning (e.g. where activities occur)	
4. Working on real-life tasks which I am likely to encounter beyond school	
5. Learning in a place outside the classroom that is a real-world context	
6. Using education apps to create digital content	
7. Using mobile device with a other(s) to create digital artefacts, e.g. video, or audio	
8. Communicating online with my lecturers, my peers or with other people outside the class, e.g. via email, discussion forums, or social media	
9. Sharing learning resources and digital content, e.g. videos, photos, and documents	
10. Sharing digital evidence of my learning, e.g. publishing my work on online platforms	
Useful functions of mobile technologies during teaching practice	O'Bannon and Thomas (2015) survey
11. Send/receive text message	
12. Send/receive email	
13. Take a photo	
14. Access the internet	
15. Record a video	
16. Watch a video	
17. Play music	
18. Play a game	
19. Use educational apps	
20. Use social networking site	

Items	Sources
Pedagogical beliefs about the use of mobile technologies	Nordin (2014) survey and related literature (i.e. Avidov-Ungar & Forkosh-Baruch, 2018)
21. I can learn to use new mobile technologies easily	
22. I know about a lot of different mobile technologies	
23. I have the technical skills I need to use mobile technologies	
24. I am thinking critically about how to use mobile technologies in my classroom/ECE centre	
25. I have had sufficient opportunities to work with a range of mobile technologies	
26. I can choose mobile technologies that enhance the teaching approaches for a lesson/activity	
27. I can choose mobile technologies that enhance students' learning of a lesson/activity	
28. I can apply mobile technologies that I am learning about to different teaching activities	
29. Mobile technologies have been used to support my teaching and learning experiences in the programme	
30. My ITE programme has stimulated me to think more deeply about how mobile technologies could influence the teaching approaches I use in my classroom	

Items 21-30 (Question 8) sought to describe student teachers' pedagogical beliefs about the use of mobile technologies. All the items were developed by referring to two constructs: Technological Knowledge (TK) and Technological Pedagogical Knowledge (TPK), and generating items from related literature (i.e. Avidov-Ungar & Forkosh-Baruch, 2018). These two constructs were related to the TPACK framework based on Nordin's (2014) TPACK survey in New Zealand. I considered only two constructs because TPACK is highly contextualised to specific activities and a subject-specific framework that is related to general technology integration (Crompton, 2017; Nelson et al., 2019), while this study specifically focused on teacher educators' practices in multiple subject-areas across four programmes with a range of mobile technologies. In addition, Abbitt (2011) found that the two constructs TK and TPK had a positive correlation to student teachers' self-efficacy beliefs about the integration of technology. Lastly, Question 9 offered an *other* option to obtain more information from the student teachers.

Instrument Reliability

I estimated the internal consistency of the questionnaire using Cronbach's alpha coefficient to check the reliability of the scale with my sample. DeVellis (2017) recommended that the Cronbach alpha coefficient of a scale should be above 0.70. In this study, Cronbach's alpha coefficient (α) estimates of the three scales ranged from (0.78) to (0.83) supporting "very good" reliability of the scale according to DeVellis's (2017) guidelines. Experiences with mobile technologies had Cronbach's alpha value of 0.78, and Cronbach's alpha value of 0.83 was obtained for functions of mobile technologies that student teachers found useful during their teaching practice and pedagogical beliefs about the use of mobile technologies. In general, I determined that the scale had reasonable internal consistency with the sample of this study.

Focus Group Interview Protocol

Taimalu and Luik (2019, p. 109) argued that "a self-reported questionnaire may also be considered a limitation" of the study. In this thesis case study, I addressed this limitation by developing a focus group interview protocol (Appendix G), so that student teachers could interact with one another and share their experiences with the use of mobile technologies, especially in ILEs. I developed the interview questions to address: (1) general perceptions of, and experiences about, the use of mobile technologies in ITE and schools, and (2) student teachers' views about being prepared to teach in ILEs where mobile devices abound. This technique enabled me to collect more detailed views from student teachers about how the use of mobile technologies affected their teaching and learning experiences. The protocol was reviewed by my supervisors who provided feedback and recommended changes, which were then implemented. In the following section, I present the procedure I used to collect data.

Data Collection Procedures

I collected multiple sources of data using the procedures described below in the following order: semi-structured interviews with teacher educators, nonparticipant observations of teacher educators' classroom teaching practices, an online questionnaire, and focus groups with student teachers.

Conducting Semi-structured Interviews

I conducted semi-structured interviews with eight teacher educators to share their views about how they used mobile technologies. Semi-structured interviews are nonstandardised and

allow the interviewer to probe for more views and opinions from the respondents (Gray, 2014). The interviewer may have a list of questions to ask, but he or she may not ask all of them in each interview and the order of questions may change. This is because of the open-ended format of the questions which gives the respondents an open forum to respond, as noted by Fraenkel et al. (2012). This was certainly the case for this study. The interview protocol (Appendix D) was an essential source of data because it allowed me to probe for further details and explanations to gather in-depth data required for this thesis case study.

I emailed each one of the eight teacher educators the interview protocol ahead of the scheduled time so that they could have enough time to get familiarised with the questions. At the start of each interview, the confidentiality of all the information gathered for the study was assured and their right to withdraw from the study at any time without penalty. The introduction listed in the interview protocol was read verbatim and any questions were answered before beginning the interview.

I asked all the teacher educators the same open-ended questions to make sure there was the consistency of content. Using open-ended questions also enabled me to gain their opinion without giving them information that could have influenced their responses. Follow-up questions, however, varied for each one of them depending on each response. Any interesting responses about the topic that were not included in the interview protocols were followed up. The interviews were audio-recorded to ensure correct transcription. All interviews were face-to-face, conducted at times and places at the university convenient for each of the participants. Each interview lasted between 30 and 40 minutes.

Member Checking

The interviews were fully transcribed verbatim which was essential to establishing the credibility and trustworthiness of the data. As suggested by J. W. Creswell and J. D. Creswell (2018), I sent transcript copies to the participants to ensure their ideas were represented accurately and to enhance the validity of the findings. I asked them to revise the transcripts before using the information in the study. None of them requested any changes.

Classroom Observations and Researcher Journal

According to J. W. Creswell and Poth (2018), when carrying out the observations, a researcher can assume different roles, such as engaging fully with the group under study (a

complete participant), taking field notes from a distance (a nonparticipant) or being not seen by the group under the study (a complete observer). For this case study, I obtained information through nonparticipant observation. I collected data without being involved in any of the class activities or with the participants because I was solely in those classes on campus and online to see teacher educators' practices with mobile technologies. The benefit of being a nonparticipant observer is the opportunity to perceive reality from an insider viewpoint which enhances the reliability of the evidence obtained. This also provided an opportunity to gather more information within a context that had not been captured before. However, my role did not change from a nonparticipant to a participant, as suggested by J. W. Creswell and Poth (2018).

The observation protocol described earlier (Appendix E) was used during all observations of online and onsite courses. The protocol had statements describing what was expected to be seen. Both descriptive information of what was seen or heard and reflective information were noted. When such behaviours took place, I checked its corresponding statement on the observation protocol. When the observed practices did not fall within the protocol, reflective notes were recorded verbatim in a journal throughout the observation period.

I gathered data by observing online activities on the LMS course sites and one campus session led by three of the teacher educators (Esther, Peter, and Rachael) (all pseudonyms). Out of the eight teacher educators, only three volunteered an opportunity for their online and face-to-face classroom teaching to be observed; they taught in Programmes A, C, and D. All of them used the LMS course site to support each of their courses, which enabled me to see details about how they integrated mobile technologies into their teaching to illustrate an incident, or strategies, in their practices where mobile learning was pertinent, and how it was being used. I observed relevant learning resources from these programmes that were posted on the LMS course site such as assignments, course materials, and student teachers' postings in discussion forums.

I observed online activities throughout the duration of all the three programmes (one academic year), while I reviewed them continuously since the teacher educators taught several courses. The procedure varied with face-to-face observations. Each teacher educator was observed once for the whole of one class session (three hours) when the class met on campus, midway through the course. Upon completion of the face-to-face observations, I reflected on the session while writing up specific details of the activities that took place with mobile technologies. These

reflections enabled me to expand my thinking and interpretation in relation to the key themes underlying the research questions. I maintained the journal throughout the data collection period, and reviewed it after each observation to re-examine any relevant insights that had emerged during observations.

Administering the Online Questionnaire

I sent a link to the questionnaire to student teachers via the email addresses which they had provided in the consent forms. The questionnaire was administered in August–September 2017 after completion of the first of their two semesters, and at the end of their first teaching practice. In order to reduce nonresponse, after administering the questionnaire I sent follow-up and reminder emails to complete the questionnaire. At the end of September 2017, I closed the questionnaire.

Conducting Focus Group Interviews

I arranged four focus group sessions as follows: (1) two focus groups were conducted with nine student teachers enrolled in Programme D and the student teachers were split into two groups. *Group 1* consisted of five student teachers and *Group 2* had four student teachers. (2) *Group 3* had six student teachers enrolled in Programme B, and (3) *Group 4* consisted of five student teachers in Programme C. All the focus groups were face-to-face. Student teachers sat around a large table which enabled consistent participation and data recording used to offer a full account of what was discussed. At the start, I read to them the introduction which outlined the purpose of the session. I guaranteed them anonymity and assured them that their opinions would be kept confidential.

The questions were broad and general to allow them to discuss with their peers (Appendix G). I facilitated the discussion and ensured that none of the student teachers' dominated. I used prompts to encourage them to talk about their experiences and, in addition to recording the interviews, I also took brief notes during each interview. Later, I added these notes to my journal, enabling further reflection on the findings. Each interview lasted about 60 minutes. In the end, I thanked them for participating in a constructive way. The digital audio files were transcribed verbatim, and the transcripts were emailed to them to be verified for accuracy before being used in the study. Feedback obtained suggested that the information transcribed was a true account of their discussion.

Data Analysis

In this section, I present the steps I took to analyse data gathered from the multiple sources. The process entailed synthesising all the information I had collected into a coherent description of how teacher educators' used mobile technologies to influence the teaching and learning experiences of student teachers. Data from student teachers' questionnaires were analysed using descriptive statistics, and the results were used to triangulate the findings from the qualitative data to provide a richer and more complete description of participants' experiences with mobile technologies.

I gathered qualitative data through interviews, classroom observations, and my researcher's journal. Analysis entailed an iterative and continuous comparative process to reduce the data from a variety of sources into meaningful parts and retrieve large amounts of written information to examine them. I used descriptive content analysis to analyse interview and observational data that were recorded as field notes, to get descriptive evidence about the purpose of this study. According to Sotirios (2013), the goal of descriptive content analysis is to identify and describe the main content of data either chronologically or thematically. This technique was used to study teacher educators' and student teachers' behaviour indirectly, by analysing the frequency and patterns of phrases they used, as suggested by Fraenkel et al. (2012). Participants' textual data, as well as themes derived from the literature informed this process. Qualitative evidence in this study established themes by converging several sources of data and perspectives from different participants, added to the validity of the study (J. W. Creswell & J. D. Creswell, 2018).

There are several ways used to analyse qualitative data. Bogdan and Biklen (2007) suggested that data analysis involves data analysis and data interpretation. In this study, the four steps for qualitative analysis as suggested by J. W. Creswell and J. D. Creswell (2018), were followed to analyse the data, namely: (1) organising the data, (2) writing memos, (3) coding the data, and (4) meaning-making.

(**1) Organising the data:** I organised the qualitative data into two categories (i.e. data from the student teachers and teacher educators). The grouping also included field notes from online and face-to-face classroom observations. I imported all of the transcripts into NVivo 12 Plus software, which is a qualitative data analysis software (Bazeley & Jackson, 2013) and that made it easier to organise the data into folders.

(2) Writing memos: Memos are "records of your reflective thinking about the project as a whole, particular sources or case, or about particular concepts" (Bazeley & Jackson, 2013, p. 61). J. W. Creswell and Poth (2018) noted that writing memos enables researchers to make sense of the data as they read through their interview transcripts and field notes, before getting caught up in the details of coding. I began by familiarising myself with the data by reading individual transcripts multiple times to formulate an overall sense of the data. I thought deeply about each transcript while highlighting key meanings (phrases or sentences) and noting keywords to the research questions, in addition to ideas that were consistently raised by each participant.

(3) Coding the data: Coding entails aggregating data into small categories of information and assigning labels to the codes, which represents the heart of qualitative data analysis (J. W. Creswell & Poth, 2018). During this step, researchers describe what they see, apply codes, and develop themes. According to Fraenkel et al. (2012), "codes and sub-codes are often refined iteratively by qualitative researchers as they strive to make sense of their data through categorization, thematic analysis, and in some cases advanced theory building" (p. 436). I used NVivo 12 Plus software for rapid coding of the data through iterative reviews of the transcripts. I was keen to keep as much detail as possible to reduce subjectivity and interpretive bias and so get more credible findings.

The first phase of coding entailed conducting an independent analysis of the interview transcripts. The transcripts were synthesised by labelling phrases that gave meaning to the pedagogical strategies teacher educators used in the preparation of student teachers. To inform the analysis, I began creating three a priori codes using the three constructs (pedagogical features of mobile learning) of the iPAC framework namely personalisation, authenticity, and collaboration (Burden & Kearney, 2017). These pre-existing codes captured the meaning of each phrase. Relevant phrases were derived from the transcripts, and they were sorted in a deductive way into the three categories. I carefully examined them while focusing on the research subquestion and referring back to the literature.

However, phrases within the three a priori constructs became unmanageable to analyse. In addition, analyses revealed more different pedagogical practices which were not captured under the three a priori codes. The three a priori codes limited the analysis to the pre-existing "codes rather than opening up the codes to reflect the views of participants in a traditional qualitative way" (J. W. Creswell & Poth, 2018, p. 193). Further, Yin (2018) recommended that

researchers should pay attention to discoveries that may emerge, to fully exploit opportunities for further evidence rather than being over-influenced by predefined procedures and hypotheses. Therefore, I allowed for an iterative process of data analysis, and I was open to other codes that emerged. During this process, I used open coding described as "coding the data for its major categories of information" (J. W. Creswell & Poth, 2018, p. 85). I achieved this by identifying and classifying all words, phrases or sentences that recurred and they were then labelled with codes. These codes were considered units of analysis. Both the theory and data themselves helped in coding the phrases or sentences. After many reviews of the open codes, I systematically identified repeated patterns which provided a clear picture of how to categorise the codes through inductive and deductive reasoning. This analysis led to the identification of common new themes that emerged as explained below.

The second phase of coding entailed analysis of the field notes from observation data to look at relevant insights that had emerged. I read through the reflective notes while referring to the themes emerging from the interviews. In this phase, every single message/posting within the LMS or discussion forums and what was noted down during face-to-face observations about teacher educators' pedagogical strategies was considered as a unit of data analysis. This is because the postings were clear enough to aid in identifying coding units and making appropriate coding decisions. The themes that emerged from the analysis of the field notes were consolidated into broader themes created during the analysis of the interviews. The credibility of the data analysis process was established by seeking the assistance of a colleague who reviewed the codes and the themes, and confirmed that they were identical to the information captured in the data.

(4) Meaning-making: As part of an analysis process, J. W. Creswell and Poth (2018) noted that this step involves making sense of the data by considering what is meaningful in the themes and categories that are generated through the analyses. I employed content analysis to formulate themes which helped to make sense of the data. As suggested by J. W. Creswell and J. D. Creswell (2018), through content analysis I condensed the codes into related themes using the coding scheme and grouped related themes into categories based on the key elements of the research question. I used a constant comparative method to compare and contrast key meanings obtained across the data to show a common set of themes. This process entailed moving back and forth until the phrases could not offer new insights for any new themes, or develop the themes that had already been identified. I interpreted content analysis using data

frequencies. The frequency of occurrence of the themes was achieved by counting the number of units of meaning for each theme, across all the sources of data as indicated in Table 3.3.

Table 3.3

Distribution of Main Themes Emergent from all Sources of Data, and the Number of Units of Meaning for Each Theme in Descending Order from the Most Common Theme

Main themes	Subthemes	No. of teacher educators	No. of sources	No. of units of meaning
1. Collaboration	a) Work in groups b) Communicate	8	13	62
2. Authentic learning	a) Perform real-world tasks b) Authentic contexts for learning	7	8	51
3. Aligning coursework with school practices	a) Use of apps b) Emulate teaching approaches of ILEs in schools	7	11	35
4. Learning technology by design	a) Design learning resources	5	9	23

Note: Sources were interview transcripts relating to all 8 teacher educators, observation field notes, and focus group interviews.

The final analysis yielded 171 units of meaning which were condensed into four overall interrelated themes: (1) collaboration, (2) authentic learning, (3) aligning coursework with school practices, and (4) learning technology by design. Throughout the data analysis, I was prompted to revisit the raw data for better understanding and re-examine my interpretations to provide an in-depth analysis of the data.

Ethical Considerations

This section outlines the ethical considerations that I took into account throughout the research process. J. W. Creswell and J. D. Creswell (2018) pointed out that "attention needs to be directed toward ethical issues before conducting the study; beginning a study; during data collection and data analysis; and in reporting, sharing, and storing the data" (p. 90). Before conducting this study, I requested permission from the Director of Teacher Education and four programme coordinators. I also sought institutional ethics approval because the study involved human participants, both teacher educators and student teachers. I carefully followed the guidelines set by the University of Canterbury Educational Research Human Ethics

Committee. Therefore, I submitted an ethical review application and it was approved (Appendix H).

Some of the ethical issues that I considered at the beginning of the study included obtaining voluntary participation, informed consent, anonymity, protection of privacy, and confidentiality. Participation in this study was voluntary. The teacher educators and student teachers were supplied with information sheets inviting them to participate (see Appendices 2 & 3), and explaining the nature of the study, outlining the various requirements of participation, and describing how the data collected would be managed to protect confidentiality. All the teacher educators and student teachers who volunteered to participate in either the interviews or focus groups were requested to sign the consent forms which outlined in detail what they were agreeing to (see Appendices 2 & 3). For the online questionnaire, I informed student teachers that by submitting a response they were indicating they had read and understood the information sheet and that they were consenting to have their answers used for the purposes of this study. The online questionnaire was anonymous so that student teachers could provide information about their learning with mobile technologies without feeling pressured to participate.

In relation to observation of student teachers' contributions in the online forums, I had to take a different approach to informed consent. Those contributions were viewed as being similar to the observations of an on-site classroom within which student teachers were also involved. Only the student teachers in the courses of the participating teacher educators were invited to participate in this aspect of the research. A copy of the information sheet (Appendix B) was posted on the LMS course site, and the teacher educators informed student teachers about their participation in the research study. The teacher educators explained that the researcher would use their postings on the LMS course site for research, and assured the student teachers that their decision to participate or not participate in this case study would have no effect on their learning or assessment outcomes. Student teachers were offered the option to opt-out at any time if they wished and their online data be excluded. However, none of them refused their postings on the LMS course site to be used for research purposes.

According to Yin (2018), privacy and confidentiality are important ethical issues to consider in any research involving human participants. Efforts have been made throughout this thesis research to protect the privacy and confidentiality of all the participants, the four ITE

programmes, the ITE department, and the university. The interview recordings and transcripts were stored in my computer with secured passwords and encoded. I informed the participants that all the information they provided would be treated as confidential. Pseudonyms have been used to protect the identity of teacher educators when coding and reporting their findings. Their names were changed into pseudonyms at an early stage of data collection, analysis, writing, and in the reporting of the findings. I did not show any personal identity of the participants in any data that has been published or presented in conferences or in this thesis case study. Individual quotes and specific data were presented in nonidentifiable ways, and participants were aware that they would be provided with a summary of results if they wished. Where evidence might have identified the ITE department and the university, this identification has been deliberately avoided. For example, citations related to publications about the ITE department and the university have been obscured.

Chapter Summary

This research was underpinned by a constructivist model. Employing this world view enabled me to give evidence of multiple realities, and use an interpretive approach to understand the subjective meanings of the participants towards the phenomenon being studied. In this chapter, I have explained how a single instrumental case study design was used to explore how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers. I have provided a brief description of the wider context of this instrumental case study, the ITE department and some of the components of the four 1-year ITE programmes. Eight teacher educators and their student teachers (n=110) in an ITE department, at an institution of higher learning in New Zealand volunteered to participate in this study.

I developed four instruments to collect data from multiple sources which enabled triangulation of data to address the research problem. I conducted semi-structured face-to-face interviews using open-ended questions with eight teacher educators, and focus groups with 20 student teachers. In addition, I also observed online and face-to-face classroom teaching of three teacher educators in three of the four ITE programmes. I analysed qualitative data using descriptive content analysis, by following the four steps suggested by J. W. Creswell and J. D. Creswell (2018): organising the data, writing memos, coding the data, and meaning-making. Analysis of data from interviews and observations of practices revealed four interrelated

themes: (1) collaboration, (2) authentic learning, (3) aligning coursework with school practices, and (4) learning technology by design.

An online questionnaire was used to obtain student teachers' perceptions of their learning with mobile technologies. Reliability of the instrument was confirmed through Cronbach's alpha, and it was found to be very good. I analysed the data of student teachers' perceptions using descriptive statistics and the findings were used to support and clarify the findings from the qualitative data. The following chapter presents the findings of the case of teacher educators' practices with mobile technologies, beginning with a section which describes the participants, followed by illustrative narratives of three teacher educators then the themes that emerged from the analyses of data.

CHAPTER 4: FINDINGS

Introduction

This chapter presents a rich description of the findings of a case of teacher educators' practices with mobile technologies across four ITE programmes in an ITE department in New Zealand, late in the first decade of the 21st century. As expressed through the semi-structured interviews, all eight teacher educators shared their views on how they used mobile technologies to support student teachers to develop professional knowledge, skills, and dispositions, as well as pedagogical skills and practices to transfer to the teaching-learning context. This also unfolded during observations of teacher educators' teaching practices. In addition, I have triangulated evidence that emerged following analysis of student teachers' perspectives taken from an online questionnaire, observation of LMS course sites, and focus groups to offer an in-depth understanding about their preparation to use mobile technologies in their own practices.

The findings are presented to illustrate how teacher educators integrated affordances of mobile technologies with pedagogical approaches to facilitate student teachers' learning. The illustrations depict mobile learning in all of the three ways: (1) the mobility of the devices where student teachers used their mobile devices, such as laptops and smartphones to support their learning, (2) the mobility of student teachers, and (3) the mobility of the learning experiences.

In this chapter, the findings are presented in three sections. The first section describes the participants. The background of participants' understanding and use of mobile technologies is also illustrated by describing how they self-assessed levels of their maturity with mobile technologies. In the second section, I give illustrative narratives of three teachers who volunteered for me to observe their practices to give a more holistic view of a finely nuanced complexity of the use of mobile technologies that is largely linked to a teacher educator in a naturalistic setting. The third section begins with a visual presentation of the themes and subthemes that emerged from the analyses of data of all the eight teacher educators. The visual presentation is my way of presenting an overview of how the student teachers experienced the pedagogical uses of mobile technologies. The remaining section includes an interpretation of the findings in a series of four interrelated themes, to address the research subquestion posed: what pedagogical strategies do teacher educators use to prepare student teachers to integrate

mobile technologies into their teaching and learning? Where relevant, some of the holistic findings presented in the illustrative narratives with the themes are linked. Teacher educators' and student teachers' quoted responses are included to exemplify key points. Finally, this chapter ends with a summary of the findings. To ensure confidentiality, I have used pseudonyms when referring to teacher educators and the four ITE programmes, and also blurred any identifying information within the screenshots.

Participants' Descriptions

The participants of this study were teacher educators and student teachers. Due to the nature of this case study, I have provided a broad description of the participants for ethical reasons; beginning with teacher educators.

Teacher educators. Eight (*n*=8) teacher educators volunteered to be interviewed. The descriptions of all the teacher educators are displayed in Table 4.1.

Table 4.1

Description of the Eight Teacher Educators in Alphabetical Order of Their Pseudonyms

Pseudonyms	Programme(s)	Teaching experience in ITE	Type of mobile devices owned	Course observed (F-2-F and online)
Eric	C & D	10 years	Laptop, Smartphone	None
Esther	A	15 years	Laptop, Smartphone, iPad	Blending of on-campus and distance including flipped classroom
Grace	B	28 years	Laptop, Smartphone, iPad, iPod	None
Jim	C	15 years	Laptop, Smartphone	Online
Kate	A & B	11 years	Laptop, Smartphone	Online
Peter	C	8 years	Laptop, Smartphone	Flipped class on-campus with project based learning
Rachael	C & D	3 years	Laptop, Smartphone, iPad	Student collaboration on project & library field trip
Sam	C	25 years	Laptop, Smartphone, iPad	Online

Note: F-2-F –face-to-face

In Table 4.1, I have also included a brief description of the courses that I observed as described later in this chapter in the section on illustrative narratives of three teacher educators. All the teacher educators provided the number of years they had taught in ITE ranging from three to 28 years. At the time of this study, out of the eight teacher educators, five had taught for more than 10 years. In response to the types of mobile devices owned, all eight teacher educators said that they owned at least two mobile devices. Four of the eight teacher educators said that they owned laptop, smartphone, and iPad. All the teacher educators had access to the laptop provided by the university. Smartphones and laptops were the most commonly owned mobile devices. The teacher educators were responsible for the development and delivery of multiple courses. They facilitated teaching in nine different subject areas (English, biology, physics, chemistry, music, social studies, visual arts, Māori language, and professional inquiry). All eight teacher educators also taught in other ITE programmes within the ITE department. Their subject expertise and gender are not included for ethical reasons in that it could lead to the identification of an individual.

All the teacher educators self-identified their maturity with mobile technologies, based on Knezek et al.'s (2000) *Stages of Adoption of Technology Scale* (Appendix F). I used this scale to examine how they understood their use of mobile technologies to support teaching and learning. They considered a stage from one to six: Stage 1 -*Awareness*. Stage 2 -*Learning the process*. Stage 3 -*Understanding and application of the process*. Stage 4 -*Familiarity and confidence*. Stage 5 -*Adaptation to other contexts*, and Stage 6 -*Creative application to new contexts.*

Four teacher educators (Esther, Grace, Peter and Sam) indicated that they were at the top-level, Stage 6 (*Creative application to new contexts*), which represented that they were integrating mobile technologies into the curriculum, and in the classroom as instructional tools. One teacher educator (Jim) rated himself at Stage 5: (*Adaption to other contexts*), suggesting that he was focusing on using mobile technologies as instructional tools including using many apps within the teaching contexts to facilitate teaching and learning. Three (Eric, Kate and Rachael) rated themselves at Stage 4 (*Familiarity and Confidence),* indicating that they were still gaining the confidence to use mobile technologies for specific tasks, and being comfortable to use mobile technologies for teaching and learning.

This finding indicated that six of the eight teacher educators identified themselves as at the top two levels—Stage 5 or Stage 6, suggesting that they were knowledgeable about using mobile technologies to support teaching and learning. In addition, it was found that teacher educators who taught more than one subject and had more years of teaching experience in ITE rated themselves at the highest level.

Student teachers. As presented in Chapter 3 in the selection of participants section, 110 student teachers responded to the online questionnaire. Table 4.2 shows the total number of student teachers enrolled in the four ITE programmes according to their gender and age groups.

Table 4.2

Frequency of Student Teachers' Gender and Age Groups within the Four ITE Programmes (n=110)

Student teachers	**Programme A** ***n***	**Programme B** ***n***	**Programme C** ***n***	**Programme D** ***n***
Gender				
Male	1	3	19	2
Female	21	15	35	14
Total	**22**	**18**	**54**	**16**
Age groups				
18-22	12	6	16	1
23-27	5	7	24	7
28-32+	5	5	14	8
Total	**22**	**18**	**54**	**16**

There were more female student teachers (85, 77%) than male student teachers (25, 23%). The higher percentage of females in this case study is due to a higher concentration of female student teachers in ITE. For example, the national statistics of student teachers enrolled in ITE in New Zealand (Education Counts, 2019), reported that in 2017, 85% were female and 15% were male which related to the year 2018 (84% were female and 16% were male). This sample may be seen as a true representation by gender of student teachers in New Zealand.

The majority of student teachers 43, (39%), reported being in the age bracket of 23 years and 27 years. Those between 18 years and 22 years were 35, (32%), while 32 (29%) indicated that they were between over 28 years and over 32 years. In relation to the national population of student teachers enrolled in ITE, the national statistics report (Education Counts, 2019)

indicated that in 2017, the majority (47%) of student teachers enrolled in ITE programmes in New Zealand were under 25 years. Those in the age group of 25 years and 34 years were 32% while 14% were reported to be in the age group of 35 years and 44 years. Only 7% of student teachers were above 45 years of age. This was similar in 2018. These figures included student teachers who were enrolling for the very first time in ITE programmes and those who had enrolled in earlier years. This indicated that most student teachers in New Zealand were generally less than 25 years of age at the time of this study. The sample of this case study may be seen as a true representation by age of student teachers in New Zealand.

As presented in Table 4.3, the majority of the student teachers (94%) indicated that they owned more than one mobile device. Smartphones and laptops were the most commonly owned mobile devices.

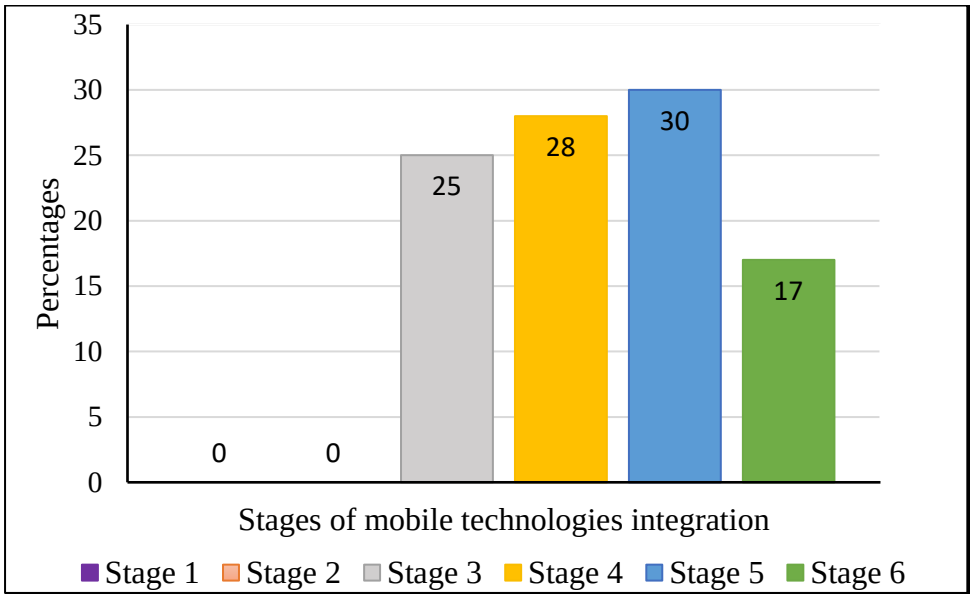
Table 4.3
Types of Mobile Devices Owned by the Student Teachers (n=110)

Mobile device type	Count	% of student teachers
Smartphone	105	95%
Laptop	103	94%
iPad	31	28%
Tablet	7	6%
Others (PDA, ereader, kindle)	6	5%

In terms of their maturity with mobile technologies, out of the 110 student teachers, over half of them reported that they were at Stage 4 or Stage 5. As shown in Figure 4.1, a majority of the student teachers (33, 30%) reported that they were at Stage 5 (*Adaptation to other contexts*), which highlighted that they believed they were using mobile technologies as instructional tools and apps to facilitate teaching and learning.

Figure 4.1

Student teachers' responses to self-assessed maturity with mobile technologies (n=110)



Twenty-eight percent (31) aligned themselves with Stage 4 (*Familiarity and confidence*), suggesting that they believed they were gaining the confidence to use mobile technologies for specific tasks, and beginning to feel comfortable to use mobile technologies for teaching and learning. The mean stage for the student teachers was 4.4 (*SD* = 1.04) out of a maximum of 6. Their responses suggest a positive indication that the majority of the student teachers (75%) believed they were confident, and knew how to use mobile technologies as instructional tools to support their teaching and learning. However, as findings reveal, some of the student teachers who indicated they were not proficient in the use of mobile technologies may need basic instruction in mobile technologies for teaching and learning.

Illustrative Narratives of Three Teacher Educators' Practices with Mobile Technologies

In this section, I present the illustrative narratives of three teacher educators. I have purposefully chosen to tell the stories of Esther, Peter, and Rachael (all pseudonyms) because, in addition to recounting how they used mobile technologies in their classrooms during their interviews, they also volunteered to allow me the opportunity to observe their online and face-to-face classroom teaching practices. The illustrative narratives aim to unravel and provide nuanced insights into the complexity of teacher educators' practices with mobile technologies,

how I experienced their use of mobile technologies through observations and the depth of participants' views that came through the themes that emerged (see Table 3.3 in Chapter 3). Therefore, these narratives are a blend of my interpretations from my experiences of their teaching, teacher educators' views on how they integrated mobile technologies into their practices, and reflections from their student teachers. I end this section with a summary of the three narratives highlighting the main similarities and differences illustrated across their teaching practices.

Each of the teacher educators' stories illustrates their mobile learning practices in three ITE programmes, focussing on (1) teaching approaches that each used to design and facilitate their courses, and (2) how each teacher educator prepared student teachers for the changing and challenging demands of school classrooms. I have further incorporated student teachers' tales—obtained from focus groups and their discussion forum postings—to illustrate how the use of mobile technologies supported their learning in teaching activities. From these data, I was also able to weave into the illustrations what student teachers had learned in their teaching practice contexts.

The Illustrative Narrative of Esther

Esther was a leader of a team of teacher educators that blended distance and on-campus offerings, creating a supportive learning environment that was so integrated that it was hard to differentiate between practices designed for teaching distance and on-campus student teachers. She facilitated courses in Programme A with approximately 50 student teachers. Programme A had two modes of study, on-campus and a blend of distance and on-campus study options. These study options increased flexibility of learning: student teachers could choose an option that suited them and that was enhanced by mobile technologies. The same LMS course site was designed to be employed for all of these offerings. Furthermore, Esther worked closely with other teacher educators to check and transform the curriculum for another ITE programme into blended courses and to coordinate the improvement of the blended courses especially the Māori language course across all the ITE programmes. Esther's narrative is about how she used different innovative pedagogical practices and integrated cloud-based technologies into her teaching.

Esther had 15 years of teaching experience at ITE when she participated in this study. Esther had created, coordinated and taught several courses in the ITE department. In her daily

classroom practices, technology resources that Esther said she used included: Quizlet, Education Perfect, Zoom VC, Adobe Connect VC, Dropbox, Padlet, laptop, smartphone, the internet, videos, and podcasts. Esther explained that she was motivated to integrate these mobile technologies creatively into her courses to support and enhance: (1) a flipped learning model, (2) distance learning, and (3) facilitate te reo Māori language course.

Esther integrated mobile technologies into her teaching in creative ways. Indeed, she played a key role in responding to the increasing demands of transformational changes centred on teaching in the 21st century, which can disrupt teacher educators' beliefs about teaching and learning. While using mobile technologies to support her teaching, Esther recognised the value of mobile devices for learning purposes and inspired student teachers to bring their own devices into their classes. This was positively received by student teachers since they were eager to embrace the use of mobile devices and preferred to use their smartphones when working on quizzes. Esther commented: "we design in-class quizzes using Quizlet and students choose to bring their own devices to do that [the quizzes]. In fact, many students used their phones rather than computers."

Esther's comments during the interview and what I observed about her practices indicated that a flipped learning model was obvious in her pedagogies to support both on-campus and distance study options. She uploaded the required readings and short video clips on the institution's LMS early enough for student teachers to think forward and then attempt some questions individually before their class sessions (either virtual or face-to-face), as shown in the following instruction that was posted on their course site:

> Please complete the . . . quiz. This will be based on the readings. There is a 15- minute timeframe for the quiz and you can complete it as many times as you wish. Watch: . . . . Note 2 things that you find interesting. Bring your answers to the workshop . . . The reading and links can be found in the workshop section of this week's [course site]. Please complete the workshop tasks before class. (*A more related instruction was posted for distance student teachers who had a separate course site.*)

It appears Esther gave student teachers more control of the learning process by asking them to be in charge of their learning. During their class sessions, it was expected that student teachers would contribute to the discussions about those readings and/or the videos. As evidence suggests, the use of the LMS enabled student teachers to explore learning resources

independently but also collaboratively with their peers. Furthermore, student teachers were not limited by time and place to access their learning. In her interview, she said, "I often feed on our LMS the readings, little video recordings of resources that are related to the course or the topic so that students can watch, review, and comment online, then they can debate during class time." Flipping the classroom seemed to support the learning of student teachers at their own choice of time and place. Esther organised for them to have "quite a long time to read and do the tasks any time . . . about six days really—to do all the tasks and the readings—before the session."

I observed Esther's face-to-face way of teaching in the classroom, where a BYOD approach was introduced to better support in-class group interactions. When I arrived in the classroom, I found the student teachers ready for their lesson. I sat at the back of the room, a place which made it possible to see student teachers' laptop screens. I looked at the surroundings, the number of student teachers, and the mood of the classroom environment.

Esther started the class by introducing me briefly, then reviewed the previous lesson by asking questions. Next, the student teachers took an online quiz in pairs, which was about a class reading activity they had been given. Esther reviewed the questions that were challenging. The next activity involved a Microsoft (MS) PowerPoint presentation about supporting students to be confident and competent learners, according to the five principles of the curriculum. I noticed that Esther expected student teachers to prepare for the lesson before class time. She had uploaded on the LMS course site (one week before class time), the MS PowerPoint, the class activities, reading material, and a document that outlined how to create an account and use the Padlet. Esther focused on educating student teachers to understand the relevant curriculum, as required by the Education Council. Next, there was a brainstorming session to gather student teachers' views on the principles listed in the curriculum.

Esther designed an activity that entailed using Padlet to support student teachers in their learning. She had requested student teachers to bring their devices. All of them had access to a mobile device. Nineteen had laptops, three used their iPads, while two student teachers used their smartphones. Esther asked the student teachers to work on a group task, and post their findings on the Padlet wall that was embedded in the current section of their course site. The following is a description (from the course site) of what student teachers were expected to do:

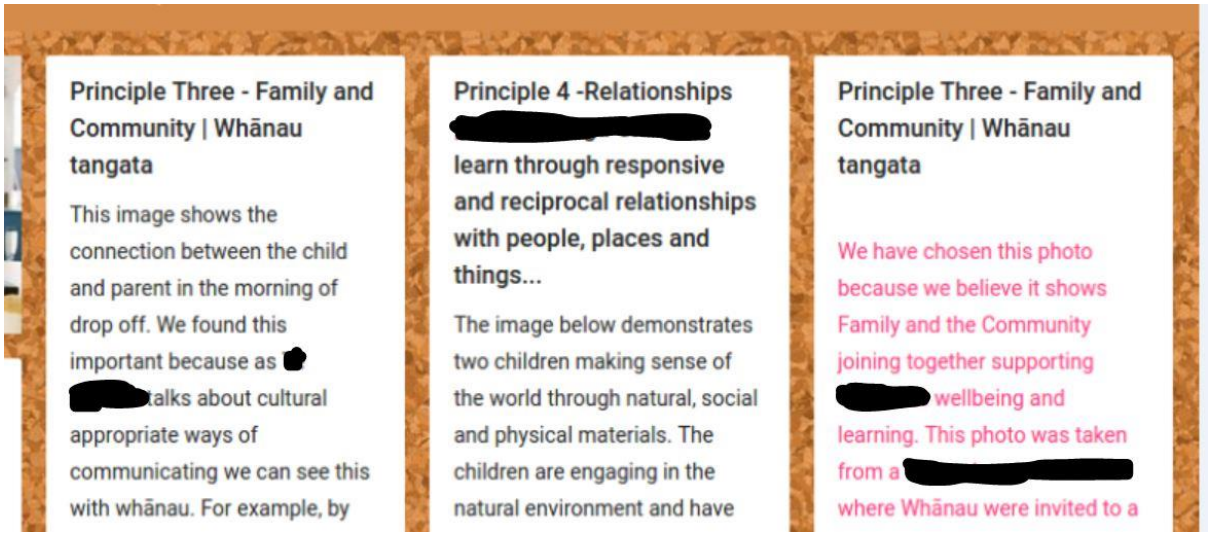
> Find images online that you think represent the intent of the principle of each column on the Padlet wall and upload them. You are also required to write a summary describing how the images reflect the principle. Each group will present this to the rest of the class during the workshops on Thursday. I have posted an image to get you started. Happy posting! [Esther].

Esther used her laptop to show them how they could collate their information and post on the Padlet wall to get the student teachers started. After only a few minutes, student teachers met into five groups of four or five, and each group chose one principle in the curriculum. They used their smartphones and laptops to gain access to the internet so that they could capture facts and import images. Student teachers worked together around their laptops by adding their concepts and organised them into categories on the Padlet wall. Posting on Padlet wall allowed every group's contribution to be seen by the entire class. I observed that this activity provided practical experience on how student teachers could use their mobile devices for learning purposes. After a while, a student teacher sitting directly in front of me was looking at something irrelevant on her smartphone, an off-task behaviour which Esther managed very well by reminding her to contribute to the group task.

Each group uploaded the images to the Padlet wall that Esther had created for this activity. Esther projected the Padlet wall on the whiteboard for all the student teachers to see and contribute their thoughts. An hour later, after reflecting on the activity, a member of each group orally presented their findings. During the presentations, the rest of the class asked critical questions and provided alternative interpretations of the images which extended the social construction of knowledge to the entire class context. An example of one group's findings was about holistic development, where they posted, "our image is a jigsaw puzzle because you need all the pieces to complete the puzzle. If one part of the child's holistic development is not developed then all parts of the child will be affected" (Padlet posting, 10 August 2017). Figure 4.2 is a screenshot of some of the groups' postings on the Padlet wall that illustrated their findings.

Figure 4.2

Student teachers' group work postings on Padlet wall



This task accorded an opportunity for all the student teachers to brainstorm ideas during the lesson and use their devices for ongoing access to their postings on the Padlet wall. They contributed actively to the task and learned each other's viewpoints based on what they had presented. This learning activity appeared to enrich the learning process of student teachers because Esther said: "what was great is that the student teachers got better from their first presentations to the last ones." These illustrations revealed the mobility of the student teachers and their devices but not their learning experiences. Feedback from an online post on a discussion forum from a student teacher indicated that the use of Padlet enhanced their interactions, interpersonal communication, and they did not lack the human touch:

> Having used Padlet in class to work on our assignments, I found it to be a good interactive tool and a way for the whole class to get their different ideas across clearly. Also, for those students who enjoy participating and contributing by writing and not speaking, Padlet is great for them (Online discussion forum, November, 2017).

The LMS provided a framework for Esther to organise the activity, and served as a vehicle for her to deliver learning resources to student teachers. Esther posted or linked learning materials for student teachers to access at any time, whether inside or outside the classroom. It seems Esther valued using Padlet and the learning support that student teachers offered one another:

> It was good to use Padlet because some students were struggling to know how to use Padlets to complete their assignments, and other students helped them. So that was

> great. It wasn't about gaining knowledge but actually giving them skills as well. I love that our students can help each other.

As Esther innovated with mobile technologies, I was curious to know how she learned to integrate mobile technologies into her teaching and enhance her digital competency. As presented in more detail in Chapter 3, Esther was among the four teacher educators who identified their maturity with mobile technologies at the highest level: Stage 6 (*Creative application to new contexts*). Esther spoke unhesitatingly about how she was self-taught and kept herself up-to-date with the rapidly changing mobile technologies. It seems Esther did not receive formal mobile learning training, for she said, "I think that's a really great question, because—I have to be honest—everything I've done is just because I've given it a go, not because I've actually sat down with someone who's helped me through it." I found Esther to be passionate about what she does. For example, when she could not figure out how to use technology, Esther would network with her colleagues to share their skills and knowledge. For example, she would converse with Kate, whom she was co-teaching, and they would help one another, which seemed to boost Esther's confidence in using mobile technologies. She elaborated on this: "I network with [Kate] . . . We just sit down and we say we're going to do this . . . and we just do that, and we hope it works really." Her explanation gives the idea that she also learned to integrate mobile technologies into her teaching from online sources, and seemed ready to overcome any setback.

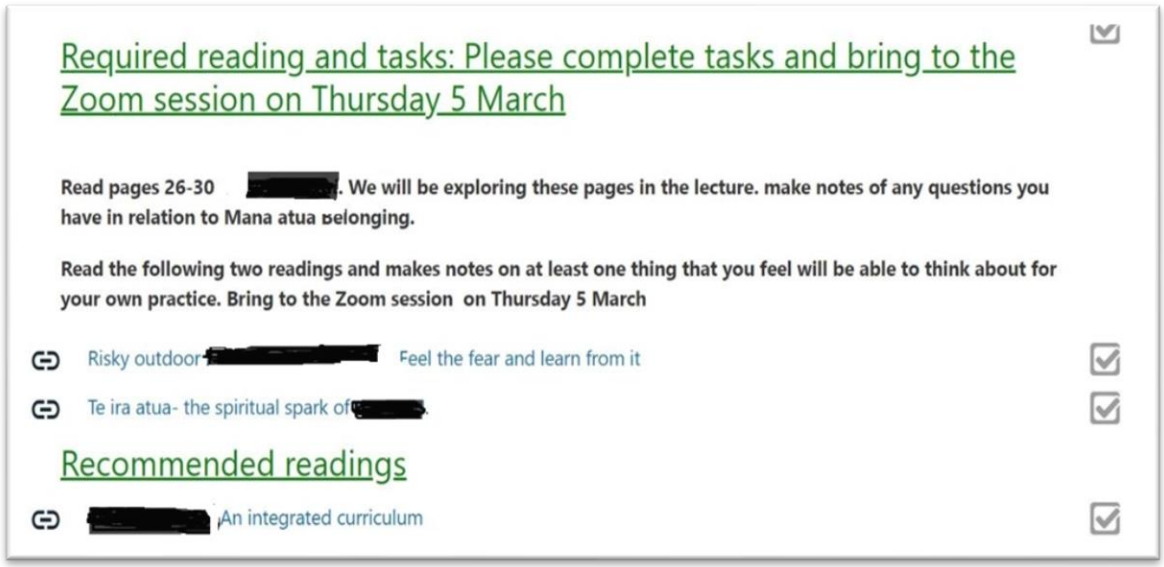
When I was observing Esther's online practice, I realised some of the learning tasks she designed were complex in ways that permitted student teachers to engage in critical thinking and active inquiry, thereby supporting a heuristic approach to learning. The tasks enabled the student teachers to build a deeper understanding of how they could integrate mobile technologies into their teaching. For example, Esther shared short video clips for student teachers to watch at their own time and place before class time. The video illustrated a storytelling technique that they could use with their future students. Whilst they were watching the video, student teachers were expected to reflect on four questions related to the video, which they would discuss during their class session. One of the questions was about how student teachers were going to offer opportunities for students to tell their stories. The affordances of mobile technologies, such as different ways to experience learning, were made available to student teachers and enabled Esther to reduce the time and effort that she could have used to do that same task if she had not shared the video with the student teachers. This learning task

involved student teachers in critical reflection since they integrated their understanding using multiple perspectives, which enhanced their creativity and innovativeness.

What distinguished Esther from other teacher educators is that she was skilful with a variety of mobile apps, web-based platforms, and aware of how they could be deployed for a variety of pedagogic strategies (see Table 4.4). With distance learning, Esther facilitated the courses using video conferences, audio-visual resources, and web-based materials. (Details about the context of the distance offering are presented in Chapter 3, in the case study setting section). For instance, she was at the forefront of using Zoom VC, Padlet, and Adobe Connect VC to link her with the distance student teachers (D, 2014; obscured), which also seemed to support a flipped learning model and transcend the walls of the classroom. Esther acknowledged that the use of the flipped learning model gave distance student teachers "enough time to choose how they want to do their assignments, and [also] . . . choose something interesting for them." Also, "it gives them more time to learn independently and for them to plan how they might want to study as well." As shown in Figure 4.3, Esther posted the following instructions on the course site for distance student teachers to individually work on their tasks ahead of their Zoom session.

Figure 4.3

Distance student teachers' assignment instructions



These tools (Padlet, Adobe Connect, and Zoom) further made it possible for distance student teachers to create and share digital artefacts with their peers from different locations, and to

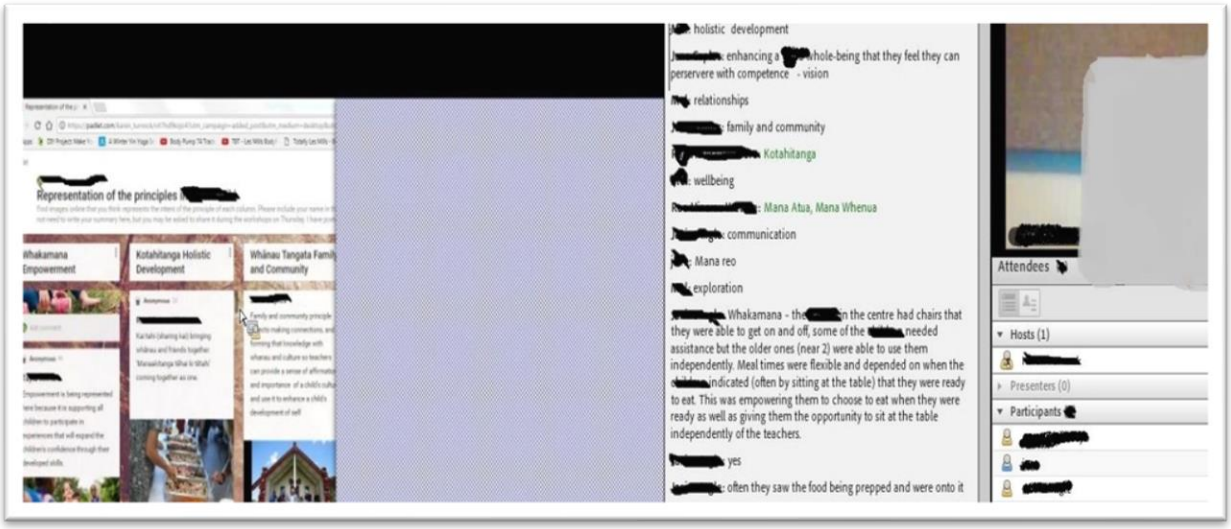
engage in virtual learning conversations with one another and with Esther. She elaborated that when distance student teachers post their work on Padlet, "It's there all the time and they can go back and see the comments. … We can highlight bits that people have done. So, I think that it [Padlet] has a real strength that we can think about, particularly for assessments." Esther posted the following instructions on the course site:

> There is a Padlet on . . . In the Padlet there are four columns. Each column will represent one principle from the . . . [curriculum]. Post an image that you think reflects the intent of the principle of the column. Write a summary of why you believe the image reflects the principle. You may be asked to share this during Adobe Connect session.

Esther also employed flipped learning with distance student teachers, much like she would during a face-to-face session. She used Padlet for them to "visualise their ideas and display them clearly." According to Esther, Padlet allowed student teachers to not just talk or use words but also upload images. She expected distance student teachers to post their tasks on Padlet walls for their peers to view, and also for later feedback and discussion, suggesting that Padlet enabled her to facilitate diversified contributions from the student teachers to solve problems. Esther said, "the quality of feedback/feedforward was very high . . . Students demonstrated the ability to offer constructive comments focused on the work they viewed." This enabled her to sample some of their work as exemplars when facilitating Adobe Connect sessions, as shown in Figure 4.4 below.

Figure 4.4

A screenshot of Esther (obscured) facilitating Adobe Connect session with a shared Padlet presentation of sampled student teachers' postings



While observing her online practices, I realised Esther had recorded Adobe Connect sessions and uploaded the links to the course site so that the student teachers could reach them at different times and learning spaces, especially those who had missed the sessions. Figure 4.4 presents a screenshot of one of Esther's recordings while facilitating an Adobe Connect session with a shared Padlet presentation. Esther explained how she facilitated the session:

> I take little snapshots of all the Padlets and I use them in Adobe Connect to reinforce my teaching . . . I give students the right to talk on Adobe Connect so that they can present at any time during the [small group] sessions. Some students also upload images and it gets them thinking a bit differently and exploring how other people see things.

Through our interview session, I learned that resource sharing, which was enhanced by Padlet, permitted student teachers to look at subject content in new ways to support reflective practice and connect their learning to real-life. The way Esther used Adobe Connect VC in her teaching appeared to suggest that she allowed distance student teachers to develop a deeper understanding of the content, and encouraged them to take a robust stance towards their learning process, as stated in the following excerpt from her interview transcript:

> We had another student who interpreted an image in a bicultural way where she had a Māori lens on it and she had taught with it. So I used her example in Adobe Connect. Other students appreciated that because they could see the image, and actually another student had posted a quite similar image but had a very Western way of looking at the image and how it met what we were looking for. So the students could see different perspectives and ways of thinking about things.

In addition to using Padlet as a tool for reflection, Esther used Padlet as an organisational tool to plan for her online classes and use student teachers' input to inform her teaching during the Adobe Connect session. While preparing for Adobe Connect sessions, based on what student teachers had posted on the Padlet wall, Esther would begin by "looking at the Padlet wall and making decisions about what I'm teaching and what that will look like and what bits I'll be pulling off from their postings on Padlets to talk about with them [student teachers]." She further used Padlet as a platform to prepare student teachers for what she was going to cover, seek student teachers' feedback, as well as respond to their comments:

> Sometimes I need them [student teachers] to prepare some work so that I know what to cover in the Adobe Connect sessions. So a week before, I will let them know this is what we will do, I want you to put your thoughts on this Padlet . . . and that way I can use that. It helps me know what they need to know.

The use of flipped learning model seemed to allow distance student teachers to have enough time to research their tasks, watch the recorded lectures, and be ready for their discussions during their Adobe Connect session. I observed on their LMS course site that Esther expected them to "share at least one key point you took from watching the lecture. Share your questions, comments, and/or thoughts with your group. Anything that needs clarifying?" Esther noted that if she "had not given them [distance student teachers] that briefing, the learning wouldn't have been as rich." She continued to say, "we would have run out of time probably. But because they could do the work before the class and set it up [on Padlet] meant that we did not have to spend so much time trying to unpack as a group." Besides the flipped learning model giving Esther an insight into what she needed to cover, she pointed out that, "it also helped me know that I needed to work a bit more with the students."

Using a live video conferencing (VC) approach supported distance student teachers to participate from different locations. As revealed from the interview, using VC to facilitate distance learning was relevant, for "the ability for me to connect with the students is huge. You know . . . with our distance students, what they all want is to connect to someone. That is very strong. Just the fact that they can see you." Esther explained how she prepared distance student teachers for Adobe Connect sessions as an alternative to an on-campus workshop. "In the first week [of the course], I get the students to bring their mobile devices, their headphones, particularly whatever device they are going to use during Adobe Connect, and we go into public classrooms [on campus] to have a mock Adobe Connect."

Ever mindful that the student teachers would be by themselves in different locations during the Adobe Connect sessions, Esther ensured that they had access to Adobe Connect. She supported student teachers to use their mobile devices to practice the mock Adobe Connect session. Although the ITE department had several computer laboratories that Esther could have used, it seems Esther considered that the student teachers needed to understand how to use their own devices to join the sessions and participate in the learning. She said, "It is really easy to use the

computer lab, but when they get home, they've got different computers or devices. So, they need to know where the microphone or camera is and all that." It seems it was vital that Adobe Connect was explicitly taught to ensure that distance student teachers had access to Adobe Connect and not left adrift so that they could not participate in the focus of their learning. Also, Esther conveyed the idea that learning with mobile technologies is not restricted to a specific place. At the same time, Esther also successfully negotiated with the student teachers on the best time to invite them for Adobe Connect sessions, either in the morning or evening. She pointed out that, "we also agree on a suitable time to have Adobe Connect with them." This is something she always endeavoured to do, because she found, "in previous years, we put a time up and students were not able to come. That's quite discouraging, you know, that's not good for us."

Most notably, I observed that Esther encouraged distance student teachers to use Zoom VC each week as a collaborative and communication tool to support their group discussions in real-time. She expected distance student teachers to connect and collaboratively work on their group assignments and then record their presentations using Zoom, as shown below:

> You can use this forum to contact each other about Assignment 2. Each person needs to introduce themselves in the [Zoom] recording. Briefly introduce your concept (do not read your assignment!) and tell us about your learning experience and how it will support students in learning about the concept. Only your group members will be able to get access to this forum. Only 1 person needs to upload the recording.

Student teachers were required to send their presentations to Esther to check them and give feedback to the groups. Her instructions on the LMS course site illustrate this point:

> We have set up forums on the assessment page for you to upload your Zoom recordings for assignment 2 . . . for lecturers to see. Please look at the instructions and give it a go! Also when you upload you may find that the file is quite large. . . . IT has advised us: If you set this to a maximum and the files are still too large to share via LMS, then students should be able to use their OneDrive to upload the video file there, generate a sharable link and add the link to the LMS course site. The instructions on how to do this are here: https:// . . . . We are looking forward to viewing your recordings.

All of the student teachers were expected to participate, which supported them to work closely and contribute to a shared understanding of the tasks. Esther said "that is the time where they can all work and present together when they can. And they get more involved with their Zoom sessions than Adobe Connect sessions, which are facilitated by both of us [with Kate]." Esther ensured that student teachers' learning was interactive by getting them into groups of five each week, using the internet for research, and working on a given topic. She continued: "one student takes responsibility for that group's learning and leading for that week . . . They present whatever it is that they are doing, and they support each other." This was echoed by a student teacher:

> We had Zoom evenings every week last semester. So there were five of us in our group, and everyone had their groups and each week one person would just take ownership and be the leader of that group, and you could share your screen, and you'd just share the slide show. And just go through the slide show. (ST11, Group B, July, 2018).

It seems student teachers understood the challenges of collaborating with their peers in distant contexts. For example, they used their discussion forum to negotiate on the appropriate day and time in the evening to work on their group tasks, as indicated below:

> Hi, just wondering how we are feeling about the presentation of our resources. Can we do a Zoom tomorrow night? I'm going to be out on Wednesday night so Tuesday is my only available time. Please let me know, thanks. [Name]
>
> Sure thing! what time? How is 7:30/8 pm for everyone? All good from me. I'm ok with Tuesday night. [Name]
>
> Sounds like Tuesday evening is a good night for most of us - what time? Let me know and I'll set up a meeting and email you the link. Cheers. [Name]

In addition to using Zoom as a collaborative tool to work on their assignments, Esther said that she designed the activity by incorporating Zoom, so that student teachers could practise their conversational skills in te reo Māori. As presented before, Esther was one of the leaders who developed this course across different ITE programmes. The student teachers met every week to listen to, and talk about how each other spoke in te reo Māori. When planning for the lesson, Esther used the recording facility on Zoom to record native speakers of the Māori language, in order for student teachers to see and hear how they spoke and pronounced te reo Māori words. She then used the LMS to share the Zoom recordings with the student teachers, which could

still be accessed at a later time and/or day. Esther said, “the main purpose was for student teachers to hear how other people speak in te reo Māori.”

Student teachers further recorded themselves speaking te reo Māori words. Indeed, they shared their audio clips and listened to one another for fluency checks and gave each other social support and explicit feedback in real-time. In addition, they used their mobile devices to listen to their recordings anytime, anywhere, and at their own pace for continuous learning. Esther facilitated this social-constructivist activity, which was enhanced by student teachers using Zoom. She explained why and how she facilitated this course:

> For us, it is about students making connections. They say they don’t have enough time for Māori to hear other people using it or to get support. So at least each week they [in a small group] must meet in a Zoom, they hear each other talk Māori and then at the lecture we will watch [some of it] it and are given formative feedback about what we were hearing, what some of the sounds were, . . . is more about the hearing of the language, because we give them a lot of feedback about pronunciation, about what they’re saying as well as the other grammar stuff, we actually used Zoom mainly for students to work together to hear the language.

Similar to the on-campus student teachers, distance student teachers also discussed on their forums how they would design similar activities with their students, as shown in the following excerpt from a student teacher’s posting on their course site: “I have been working with years 1 and 2, and I believe that I could use these same strategies to help them learn new subject-related vocabulary . . . so I could use flashcards with images to help them identify the words” (Online discussion forum, August, 2017).

Although Esther explained that she designed quizzes using Quizlet and Education Perfect as part of formative assessment, the way she modelled the use of mobile technologies seemed to align with practices in schools and assisted student teachers to learn with mobile technologies. Besides completing the quizzes, Esther said she used Education Perfect to support student teachers to learn Māori language. She encouraged them to look at Māori concepts and design quizzes for each other on what they had learned. Student teachers used their smartphones to create quizzes for one another about Māori concepts. Esther said:

> In those classes [te reo Māori], we also use Language Perfect [now Education Perfect] to design quizzes for them and so they will look at quizzes or do their own searches about particular concepts in te reo Māori . . . we also get students to create quizzes for each other and they will often use Quizlet for that one, that's my preferred one, it's easier for students, particularly for te reo Māori when they are learning new concepts, they will make quizzes for each other about the concepts we are doing.

Similar to other programmes, student teachers in this programme attended their teaching practice. When Esther visited them, she found that student teachers "used their laptops to help students look at their learning journals online and the students enjoyed." Furthermore, as revealed through my online observation of the LMS course site, the tasks that Esther designed appeared to positively influence the practices of student teachers when they were designing their own classroom activities during their teaching practice. One student teacher posted, "I designed a MS PowerPoint by incorporating the bicultural elements of te reo Māori for the students, with the use of numerous audio clips, a video, and a Quizlet. The audio highlighted specific words that they could learn about" (Online discussion forum, August, 2017). Another one said, "I used Match the Memory. I created cards with te reo Māori words, and cards to match the video about constructing a rocket. The students matched the correct paired pictures by interacting in flipping the cards to get the correct pairs" (Online discussion forum, August, 2017).

During a focus group discussion with a student teacher in Programme D, he explained how he used Quizlet as part of his private study to practice Māori language; a course in which Esther was among the team that developed it. He said, "I used Quizlet, which makes flash cards. So, I'd put all the concepts that we've learned in Māori and English. … But, you can also play games with flashcards, so it teaches you more." Although the student teacher said he did not use Quizlet during his teaching practice, he pointed out that: "I used it to teach the bridging Chemistry course for the university, and I used it a lot for those students."

In another focus group discussion with student teachers registered in Programme D, it was clear that the use of Education Perfect was gaining momentum in schools. One student teacher expounded on this:

> When we were in practicum there was an Education Perfect global competition, so basically, every school could register and then their school or class would have to get a

> certain amount of points, so we actually dedicated a bit of class time for them to do that. And students just loved it, and their reaction was always, it's a great way for them to learn. It's really interactive. It kind of takes away that boring aspect of languages. (ST5, Group 1, July, 2018)

By analysing the data, which included Esther's interview, observations of her face-to-face and online classroom teaching, and student teachers' views, I found that she integrated mobile technologies into her teaching to design tasks that enhanced collaborative learning experience and aligned with practices in schools. The use of Padlet, Zoom, and Adobe Connect enabled Esther to facilitate a flipped learning model and help student teachers learn from a distance. Distance student teachers met virtually, where they primarily used Zoom VC to support working on their group assignments. They were then required to record themselves and share their presentations with Esther, who, in turn, provided feedback. This enabled student teachers to interact and build knowledge with their peers from different locations. As such, this indicates that the affordances of the increasing ubiquity of mobile technologies enhanced 'anytime and anywhere' learning.

Esther modelled the use of mobile technologies enabling student teachers to use their mobile devices to share their knowledge and access information. She designed tasks that appeared to positively influence the practices of student teachers when they were designing their own school classroom activities during their teaching practice. The story of Esther shows how the affordances of mobile technologies, such as, social interactivity, the immediacy of communication, and transcending time and/or space restrictions, enhanced and supported her teaching approaches as well as permitted her to conduct her classes with both on-campus and distance student teachers, as she prepared them for their future classrooms.

The Illustrative Narrative of Peter

The story of Peter illuminates how he used a variety of teaching approaches which were well supported by a range of mobile technologies to engage student teachers. During the interview, he said "when I am designing the courses, or when I am planning to deliver the lessons, I have to consider the use of these devices because it is an integral part of all the science courses." As presented in this narrative, Peter's intention to design the instructional strategies was enacted in a way that the focus was for student teachers to effectively use mobile technologies in their school classrooms, and for developing skills such as critical thinking and

problem-solving. This narrative describes evidence from Peter's interview and the observations I made of his teaching practices where experiential and collaborative learning appeared to be the main teaching methods.

Peter taught several courses in Programme C which had a student teachers' population of approximately 100. Unlike Programmes A and B which had two study options, on-campus and at a distance, Programme C did not have a distance study option. All the courses were facilitated through face-to-face interactions on campus and were one semester in length. In New Zealand, student teachers who enrol in Programme C obtain their first degree which provides content knowledge in their respective subject areas (B, 2015; obscured). In this programme, student teachers study their coursework for approximately 10 weeks and participate in two seven-week periods of teaching practice. During teaching practice, student teachers work in a classroom where they are supported to try and refine their planning, teaching, and classroom management skills they learned in their coursework (C, 2014; obscured).

The findings revealed that Peter prepared student teachers to know and understand the subject matter content in science courses, and different pedagogical approaches as well as the practical aspects, so that they could make it explicit in their teaching. Alongside his teaching responsibilities, Peter worked with science teachers in schools to keep himself well-informed with issues relevant to the courses, which made him more aware of the current practices in schools (B, 2015; obscured). For example, according to the findings, Peter creatively employed mobile technologies to fit the programme and its needs, including preparing student teachers to go and carry out in ILEs in schools. He stressed that "we probably couldn't run our science courses without incorporating digital technologies because that is what is happening in schools and we are preparing the students to work in that environment."

Peter had eight years of teaching experience in ITE when he participated in this study. Although not amongst the longest-serving teacher educators in the ITE department, he previously worked as a scientist for many years before joining the university. Moreover, Peter received an award as best teacher educator of the year in the institution. He guided and facilitated many learning projects into four different science courses in the ITE programme. An inquiry into the interview with Peter and observational data revealed that: (1) he changed his existing pedagogy by incorporating mobile technologies to engage student teachers through interactive contexts that

provided clear learning goals, and (2) he also inspired them to pursue innovative pedagogical practices (with mobile technologies) which they could use in their teaching. For example, during the interview, Peter said, "I think we should be producing people that are at the cutting edge who will go out into schools and become proponents of that technology. I think it's important that we use the tools [mobile devices] correctly."

It appears Peter was inspired to use a range of mobile technologies to engage student teachers due to the nature of science courses. I base this interpretation on Srisawasdi et al. (2018, p. 7), who noted that there are "a wide range of digital tools in science education (e.g. digital probeware and sensors, mobile devices and applications, modelling tools, simulation and animation, virtual and augmented reality, digital and serious game, web-based learning system)." Furthermore, Peter used interactive teaching methods to motivate student teachers to construct knowledge. According to Buabeng et al. (2015), these approaches to teaching—mainly enhanced by the use of technology, help student teachers to understand complex ideas. They also promote collaborative engagement of student teachers through learning by inquiry to yield immediate feedback from their peers and/or teacher educators.

Peter motivated student teachers to use their devices to support their learning, but in addition to this, he was of the view that they needed technical skills to be productive in their school classrooms, as well as develop life-long learning habits. Therefore, he planned for tasks using different tools for student teachers to interact through various media while designing digital learning resources. It strongly emerged that Peter designed lessons by integrating multimodal media including web-based software to support his teaching in all the courses:

> My teachings invariably have some sort of multimedia presentation so that might be a MS PowerPoint. . . . I include a lot of very short segments of video clips or YouTube clips for students to access on their devices. I use PhET interactive simulations, Quizlet for making quizzes and quiz cards. . . . So, obviously, students use their mobile phones when they're doing a Kahoot quiz, or for Slowmation experiments. Slowmation I often use it with students producing either 2D animation videos, handcraft animations or even plasticine animations.

These tools enabled him to provide meaningful learning experiences related to student teachers' lives. As such, student teachers acknowledged the importance of integrating mobile

technologies into teaching science. I observed one of Peter's course sites and a student teacher had posted the following on a discussion forum: ". . . the benefits of using technology for science teaching is that they offer a multimodal approach to teaching, where ākonga [learners] can choose a range of modes/activities to learn the same thing, i.e. videos/recordings, readings, games" (Online discussion forum, August 2017). Part of the subject line for the task that I found from the course site stated as follows: *"You are required to draw your own learning, within the coursework workshops and teaching experiences, to critically reflect and present a description of your beliefs about science teaching and learning . . . Science activities with students from the collaborating school."*

It was revealed during the interview that Peter had positive beliefs and attitude towards using mobile technologies for educational purposes which he modelled to student teachers. In his teaching methods, Peter said he used visual interactive computer software programs which are supported by mobile technologies so that student teachers could experience scientific experiments that they could not easily meet in the real world, thereby improving their learning.

> There are some experiments which are potentially hazardous to perform . . . I use PhET [Physics Education Technology] interactive simulations so that students can watch the demonstration. I've also tried using augmented reality with some students . . . I presented it [augmented reality] at a conference and it was quite well received, he said.

Besides relying on computer laboratories to perform experiments, like other teacher educators who used a BYOD approach to facilitate in-class group interactions, Peter said that he encouraged student teachers to "use their digital devices [BYOD] to collect and analyse information, and then they put that together in a little MS PowerPoint presentation that usually includes video of what they were doing. They're required usually to present to the rest of the class." This approach enabled student teachers to use their own devices to support their learning. Student teachers selected suitable tools and learning resources for their assignments. They also used their mobile devices to search the internet for relevant information. Feedback from a student teacher showed how her course prepared her to use diverse mobile technologies:

> I think that there have been things that the course has introduced to me, things like Kahoot and Padlet to use for learning, how to create an interactive MS PowerPoint, and even just the concept of like, I bring my laptop to every lecture because we're always using them. Whereas my undergrad I would usually just bring a pen and paper. (ST17, Group 4, July 2018)

The use of multimedia resources appeared to positively impact on student teachers' practices because they incorporated the strategies in their lessons during teaching practice. Student teachers provided detailed explanations of how they implemented, in a more meaningful way what they had learned from their coursework, as indicated in the following three examples. Three of them used an interactive gaming tool—Kahoot—which is accessible from mobile devices. "We used Kahoot at uni [university] and I had never heard of it before, so when I went to school during my placement I used it. It's quite an easy way to get on board with it and engage students" (ST17, Group 4, July, 2018). "Kahoot and Quizlet were competitive, engaging, and useful as a kind of formative assessment . . . however, I found that for a deeper level understanding of the concepts, discussion with the class was more helpful" (ST20, Group 4, July, 2018). "My junior classes loved Kahoot, and I would often do them at the start of the lesson. So I'd go *'everyone get your devices out'* and they'll bring their phones out of their pockets and do the Kahoot" (ST19, Group 4, July, 2018). Another student teacher explained how he used simulations to engage his students:

> In the science course, he's [Peter] shown us a website which has lots of PhET simulations, and there are lots of scientific simulations which show in detail what's happening in a way that you can't really see in real life. I tried that in my own teaching class. So the students worked in pairs and they had a laptop between them, and they got a gravity simulation. So they could set some parameters like the weight of the earth, and the weight of the sun and they could see the earth going around the sun, and they could change these, make the earth crash into the sun if they wanted to. They enjoyed it, and we spent the whole lesson just on this one simulation, and I had an enquiry sheet alongside it which they filled out as they investigated. (ST16, Group 4, July, 2018)

Similar to Esther, Peter also identified his maturity with mobile technologies at the highest level, Stage 6 (*Creative application to new contexts*), which is consistent with how he used mobile technologies in his courses. For example, he was creative with mobile technologies to fit the new context (ILEs) of teaching science courses to support innovative experiments in science laboratories and collaborative learning.

Peter incorporated innovative experiments to support student teachers to acquire science content knowledge on classroom practice but also laboratories skills. He designed lessons that involved fundamental concepts of physics and challenged student teachers to go deeper in their

learning by allowing them to perform the experiments themselves. For instance, Peter supported student teachers to lead the learning activities in science laboratories which required them to show their conceptual understanding of the tasks. His comments during the interview revealed that student teachers actively worked in small groups to "make a model car, go down the corridor . . . they collected the data of the motion from that using data logging software. One student drove the car, another one took responsibility for the data logging and another one did the analysis." Student teachers used motion sensors to measure the distance of the car away from it, while the laptops enabled them to do the analysis. It seems this activity exhibited two benefits for the student teachers: support from their peers and Peter where they could help one another learn while working with mobile technologies, and hands-on experiences with mobile technologies. For example, in another experiment, Peter explained how student teachers studied a moving object by setting up a mass that was dropped from the ceiling. Student teachers used "a digital camera and strobe photography to collect the data from that, and then analysed the motion of the falling object to calculate the acceleration due to gravity."

Besides using mobile technologies, the findings indicated that student teachers also used authentic laboratory equipment to develop their practical laboratory skills. For example, in a different experiment, student teachers worked in groups to investigate the pH of a solution during an acid-base titration. They used their laptops and a pH electrode which was connected to data logging equipment. Peter said, "I had a group of students, one took the responsibility for performing the titration while the others did the data collection." At the same time, Peter stated that "I also teach some junior biology content, and students measured oxygen levels in an aquarium. They used an oxygen sensor which is connected to data logging equipment that is interfaced to a laptop." These learning tasks appeared to suggest that student teachers played a more active role in their own learning. Using data logging equipment appeared to make it easier for student teachers to understand scientific experimentation and concepts, as well as produce accurate results. Furthermore, it seems they were able to put together bits and pieces of information from various sources to develop the concepts needed to complete the tasks. These illustrations from Peter's mobile learning practices depict the mobility of the devices, the mobility of student teachers, and the mobility of the learning experiences.

In all his courses, Peter guided student teachers to perform real-life tasks and create new knowledge that was relevant to their world. He said, "If the tasks are not connected with real-life then why are we doing it? So everything we do is connected with real-life. We might

explore things at the molecular level, a simulation, but they are still perfectly real." It appeared that Peter enabled student teachers to learn how the processes of scientific inquiry work and how they could use it in their school classrooms. He facilitated experiential learning in science education by engaging student teachers in thought-provoking activities and self-reflection. The way Peter used mobile technologies suggests student teachers were not separated from the real laboratory environment and equipment. As revealed during a focus group, a student teacher talked about how they designed Stop motion animation out of plasticine:

> The way we did it in a science course, we were given a topic to make a little Stop motion movie. And we used plasticine, and like make a little movie with lots of pictures and you put it together in a program [Slowmation] and it makes a little thing [movie] out of it. (ST9, Group 2, July, 2018)

It seems student teachers understood the process of designing an experiment using mobile technologies. This was corroborated by student teachers enrolled in Programme C during their focus groups. One of them said, "in our subject [science] our lecturer uses the technologies so that we might be able to use in our practice . . . he's introducing us to things that we can use them in future" (ST18, Group 4, July, 2018). Another one expressed a similar view, "we were shown how to use the technologies in a way that you could easily show someone else how to do it" (ST20, Group 4, July, 2018). Similarly, Peter narrated how he prepared student teachers to effectively use mobile technologies in their future classrooms by first allowing them to understand the basics, and guiding them using school classroom examples that were general:

> The best thing that I do is start getting them to become very conversant with some of the technologies that are used in general, so that when they go out to schools they can then understand how to use them. So, for example, the first assignment could be a theory assignment, which is written reflections, so we know we've got the theory measure, we understand the principles. Then I tell them this is now about the practical one, and they love doing it because it's open-ended. But it still has to be scaffolded . . . I just give them a list of things they can create, and a whole list of apps they can use. And they do.

The online observations showed that Peter used an interactive instructional approach to promote problem exploration, self-learning, and develop high order thinking skills. For example, he demonstrated the use of Slowmation as a pedagogical tool in all the disciplines of science to explain scientific concepts. Later, based on their experiences student teachers were

expected to reconstruct new knowledge by working in groups to create their Slowmation. He used this approach to actively involve student teachers in the tasks. Peter uploaded on the LMS course site three-to five-minute-long videos related to the experiments for student teachers to watch. He also provided links to course readings, web-based software, apps, MS PowerPoint with notes, and supplementary reading resources so that student teachers could access the information they needed. Besides using the LMS course site to get access to resources, Peter created a discussion forum for student teachers to co-construct knowledge. For example, he said, "I set up forum spaces on the LMS where they might share the materials that they have produced, or they communicate with each other through the forum space." During a focus group, a student teacher talked about how they used the LMS in their courses:

> A lot of forum postings and forum tasks and things that we were expected to do were on the LMS and I found those quite valuable. So you can go through and read what other people have written on the same topic as you, or on different topics. You can also have a bit of a conversation in replies to those, and start a discussion about those forum posts. (ST17, Group 4, July, 2018)

This was also recognised by Peter. "With Slowmation experiments, the students can look at the material on the LMS [course site] either before class or after class . . . and so they are learning to use the tools which they will then get their students to use." The evidence suggested that this activity was intended for student teachers to have the opportunity to create and critique knowledge, as well as strengthen their ability to perform complex cognitive tasks. He said "all the activities I'm talking about, they [student teachers] would do cooperatively in groups . . . the whole class would be in small groups . . . They have to complete small projects, mini-projects . . . I walk around and just guide, monitor and troubleshoot."

Peter explained how student teachers came up with different ways of designing Slowmation to produce animations of scientific concepts. He said student teachers used their smartphones and iPads to take photos of still images, added narrations and produced short animated videos. During the interview, Peter mentioned that, "and in going through that process, the students have to understand the science behind the process. So it's not just a matter of producing a quality digital resource, but it's the learning that goes into that process." This suggests that Peter deliberately allowed student teachers to take responsibility for their learning and collaboratively participate in the process, while he supported them to develop metacognitive awareness by taking control of their own learning. Some of the artefacts they designed included

the life cycle of a frog, the reaction of particular substances forming products, and the motion of the planets at the atomic level or the molecular level. They later used a Dropbox tool on their course site to share their resources with Peter. Eventually, this formed a basis for discussion that Peter used in the lesson that I observed which was indicative of using a flipped learning model and seemed to align with the social constructivism approach as follows.

Peter began the lesson by introducing the topic, then outlining the learning activities. He reviewed what they had covered on the topic and explained three main concepts outlined in the MS PowerPoint which was displayed on the whiteboard using a multimedia projector. After about 30 minutes, Peter asked each group to discuss their work, and at the same time, Peter would respond to questions, asked reflective questions to challenge their thinking and discussion, and summarise what each group had presented. In my observation notes, I reflected that Peter allocated more in-class time for student teachers to test their thinking and encouraged them to give their ideas. Student teachers actively participated in the discussions which increased student-student interactions and learning. My reflection was consistent with Peter's view as he explained how he used this activity to assess student teachers' understanding of the concepts as well as give constructive feedback. "All the students demonstrated their contribution to their group and to show new learning from this process." As an observer in the room, I noted that the curriculum resources which student teachers created could be used with their future students.

It appeared Peter encouraged student teachers to work in more flexible ways and discover knowledge for themselves. For example, he said that "so the Slowmation one [task] in particular, students can choose the context they are working in." The approach of using Slowmation as an embedded and authentic assessment looked as if it helped student teachers to reflect on their learning while they engaged with the content and to capture their interest in learning. I noticed student teachers received continuous feedback from their peers and Peter which enabled them to refine their artefacts. Peter's comments in the interview revealed that student teachers collaborated with their peers using their mobile devices while working on their tasks:

> Some students used their mobile phones for Slowmation experiments. Slowmation material is very collaborative. So I would never have just a single student doing that,

> they would always be working as a team. And if they are exploring their understanding of a concept as a team, then they are teaching each other while they're doing that.

When designing the activities to support different learning outcomes, as revealed through the online observations I made, it seems Peter was aware of learning theories that are relevant to a digital age. For example, he used mobile technologies to deliberately design the learning activities to encourage constructive and problem-based interactive learning in which student teachers learned from one another. Student teachers created knowledge by collaborating with their peers which according to social constructivist perspectives results in cognitive benefits much more than what they could have experienced if they were working individually. This was also reflected in Esther's practices when she used Padlet for student teachers to collaborate. Peter explained: "so they end up sharing their digital resources, and others would ask questions like, how did you do that? What did you use for that? … because they can see [what other student teachers have designed]."

These activities appear to provide opportunities for active learning within a collaborative environment. This was noted by a student teacher who explicitly articulated how she benefited from their group work by being a creative solver, a critical thinker, and had a role to play. "I enjoyed taking an aspect of responsibility in group projects which allowed me to be creative and provided important information in a manner that was outside of the box" (ST19, Group 4, July, 2018). Also, as revealed through an online observation of the LMS course site, the tasks offered an opportunity for student teachers to internalise the type of information they were gathering and generate alternative strategies for solving problems. "This group project taught me to focus on the most important issues … when we were developing our animation we tried to ensure that we got key messages of the resource across to the audience in the most concise manner" (Online discussion forum, July, 2017). This appears to suggest that Peter allowed student teachers' ideas to inform their learning experiences through the creative learning resources that they designed.

Like Esther, Peter enriched his teaching by using Padlet to stimulate meaningful reflectivity through sharing knowledge. He described how student teachers used their mobile devices to post questions and also instantly gather their opinions about the lesson. Answering the questions seemed to motivate student teachers to find relevant ideas about their subjects and extend their learning. This teaching approach was enhanced using Padlet since Peter could

illustrate different student teachers' perspectives, build on concepts, and create a knowledge-sharing experience. He said, "I ask the students to post their messages or thoughts anonymously [on Padlet] then we might probe some of those ideas . . . just to share ideas that the students have had, or to review a subject at the end."

Student teachers did not hesitate to post the questions, and they articulated the benefit of using Padlet both during their coursework and teaching practice. An online observation revealed that in another course, the same group of student teachers were asked to share their experiences about some new digital technologies and one of them posted: "I think Padlet would be a very helpful tool to use as a teacher. It is user friendly and could be used for collaborating ideas . . . I like how users can be anonymous in their comments" (Online discussion forum, July, 2017). During a focus group, a student teacher also said:

> We used Padlets to present ideas, so some of our lecturers asked us, like before or after the lesson, to post a question. It can be anonymous as well, so that like we don't feel stupid asking a question, or post something we'd learned about. Then we went through them as a whole class. . . . Also, it is a useful tool like in our teaching practice. (ST16, Group 4, July, 2018)

The story of Peter is illustrative of highly interactive learning experiences that were supported and enhanced by a range of mobile technologies. Results indicated that Peter employed different teaching strategies such as interactive demonstrations, experiential learning, aligning theory and practice, authentic learning, and collaboration. He guided student teachers to use mobile technologies for authentic, project-based learning. The teaching activities ranged from student teachers' thinking about concepts, solving real-life problems, learning new skills, and developing artefacts.

Peter transformed his pedagogy by integrating a range of mobile technologies to engage student teachers through interactive contexts, and inspired them to pursue innovative pedagogical practices (with mobile technologies) which they could use in their teaching. He modelled the use of mobile technologies to support teaching and learning, especially when performing the experiments. Besides watching the demonstrations, Peter encouraged student teachers to design their learning resources that incorporated technology and were granted the opportunity to choose suitable technology for their learning tasks. The findings indicated that student teachers engaged in discussing their assignments which required inquiry. They developed their own

concepts which enabled them to acquire a deeper understanding of the content and problem-solving skills, as evidenced by the learning resources they designed to use in their teaching.

Peter facilitated collaborative group tasks which seemed to motivate student teachers to construct knowledge with their peers through social interactions, and support learning conversations. The findings illustrate that Peter empowered student teachers to take control of their learning, and gain new perspectives from their peers. He provided student teachers with greater autonomy of where they wanted to learn, and how they wanted to learn while using mobile technologies. Apart from student teachers and their devices being mobile, the tasks that Peter designed seemed to enable student teachers encounter learning experiences in various locations.

The Illustrative Narrative of Rachael

The story of Rachael illustrates how there was a difference in mobile technologies related practices across the courses that the teacher educators taught. For example, Rachael facilitated a common subject with student teachers enrolled in Programmes C and D, making limited use of mobile technologies and she preferred more face-to-face interactions. In contrast to Peter, who used a range of mobile technologies extensively in all the courses, and Esther also because distance student teachers were enrolled in Programme A. Rachael said:

> I think that the main thing for me is that I don't see digital stuff as necessarily a good replacement for face-to-face. I cannot see how I could through technology prepare students well for being English teachers if I did not get that face-to-face time with them as well. So if I had distance students for example, and I mean I know technology is capable of doing lots of things, but I think that it would be a lot easier for them to be physically together.

Similarly, student teachers' comments during the interview revealed that they found it challenging to teach English using mobile technologies during their teaching practice. For example, one of them said "sometimes I feel like there's a bit of tension with using devices in English classes. . . . It can be tricky because there's obviously an expectation that the kids are writing [using pen and paper] because that's something you have to do in English" (ST2, Group 1, July, 2018). Another student teacher enrolled in Programme C expressed a similar view, arguing that students need to practice writing:

> You may want the kids to have the opportunities to use the devices but I think particularly in English, it is a bit of a struggle because you want them to be actually writing . . . as boring as it sounds, they need practice at the spelling which they just don't get when they're using a device because it spell checks everything for them. So that can be quite hard. You don't want to feel like you are stamping down on the technology, but you also want to give them a chance to do what they are actually meant to do in that subject. (ST18, Group 4, July, 2018)

However, another one said that: "but then teaching [world or foreign] languages, I've seen the programs that are there and the opportunity and I think they're incredible. Like the apps that are available for the students to learn" (ST19, Group 4, July, 2018).

Rachael was very experienced in recent school classroom practices which informed her work as a teacher educator. At the time she participated in this study, she had three years of teaching experience in ITE with over 13 years' experience as a schoolteacher. While Esther and Peter taught several courses in only one of the four ITE programmes, Rachael facilitated one course in Programme C and several courses in Programme D. The total number of student teachers registered in Programme D was approximately 30. Similar to Programme C, all the courses in Programme D were facilitated through face-to-face interactions on campus for about 12 weeks. Rachael encouraged student teachers to bring their own devices to class for learning purposes, just like the other seven teacher educators did. When asked if she was comfortable with student teachers using their devices in class, she replied: "I'd be annoyed if they did not. Some of them bring laptops, some of them just bring their phones, not always the same device each day." It seemed like the student teachers owned and/or had continuous access to more than one mobile device.

The way Rachael explained how she used mobile technologies, suggested that she was beginning to use it to support her teaching. During the interview, she said "so when you initially asked me to be involved [participate in the study], I was thinking maybe I don't really use them [mobile technologies] much. . . . I have only been doing it for such a short time." For example, as presented in Chapter 3, she was among three teacher educators who identified their maturity with mobile technologies at Stage 4 (*Familiarity and confidence*). This seems to imply that she believed she was gaining the confidence to use mobile technologies for specific tasks and was beginning to feel comfortable integrating mobile technologies into her teaching.

My observations of Rachael's online practices revealed that she used the LMS mainly for student teachers to access course materials. She uploaded course readings on LMS so that student teachers could get access to them 'anytime anywhere' using their mobile devices and submit their assignments, "because every day there is something [learning materials] where they need to go on the LMS to access or something they need to try to find on the internet. It's unusual for a student not to have a device," she said.

A creative and authentic task that Rachael described was how she designed an outdoor activity that took place in a local setting outside the classroom to influence in-class learning. The aim was for student teachers to use their mobile devices to design resources and extend their learning beyond the classroom environment. Rachael considered how the task would be implemented both inside and outside the classroom. She required student teachers to go to the library and work in groups to create found poems, meaning she supported student teachers' choices and autonomy over their learning content. Student teachers used their smartphones to take photos of book titles on the spines which formed part of their notes. This enabled them to edit and create found poems using the spines of books and their titles. This activity required reflection on knowledge, because student teachers were expected to use the information they had gathered to design visual presentations of their found poems which they then shared with their peers. The use of mobile devices enhanced student teachers' learning experiences in an authentic setting.

During the interview, Rachael noted that "they [student teachers] have their [selected] books all stacked up, take a photo of it, and then put the photos in the Google slide [set] and then we can have this whole slide presentation with lots of different poems that they've created." The student teachers used their mobile devices to access one another's presentation, brainstorm about their found poems, and then worked in pairs to plan a lesson that might be inspired by that. During their presentation, Rachael mentioned that the student teachers would:

> Talk about what they liked about their poems and what they disliked. What was easy about the activity and what was challenging? What sort of students would enjoy this activity in class, and how might they need to set it up to make it successful? What else could they [student teachers] do as a follow-up after they've done it?

Due to the portability features of the devices, it seems to have allowed student teachers to experience the activity for themselves in an authentic context but also reflect on it, and choose what to write. Rachael stressed "most students have some anxiety about whether they can actually write a poem, so this is a way of creating poems that is quite easy. I give them some choices of theme, and they get book titles that look interesting." The use of mobile technologies appears to have enabled Rachael to design this activity and facilitate personalised learning.

Rachael's experience with mobile technologies in class involved the use of a university loaned laptop, her iPad, video recordings which she uploaded on the course site, Google Docs, OneNote, and Padlet. She said:

> In terms of my real teaching, I mean I prepare everything on my laptop, so I use my laptop and I would be lost without it. . . . Sometimes I use videos and that will be posted on our LMS page, then students can use their devices to watch them . . . occasionally I might show a clip of some educationalist talking about an issue.

Esther and Rachael taught language courses. While Esther used Kahoot to facilitate te reo Māori language (see Esther's narrative), Rachael preferred to use Google Docs. A student teacher said, "we haven't used Kahoot in English but we used that [Kahoot] for Māori" (ST19, Group 4, July, 2018). Another one described how Rachael used Google Docs by saying "we have an ongoing Google Docs at the moment that everyone sort of puts young adult literature on, anything that we come across that could be useful in class. So it's an ongoing thing that people just keep adding to" (ST16, Group 4, July, 2018). Similar to Esther and Peter, Rachael expected student teachers to work collaboratively in the learning activities, which were enhanced using Google Docs. However, contrary to Esther's class where each group posted their work on the Padlet wall, Rachael created a discussion forum so that each student teacher could share their contribution to the group tasks. The following is an example from a student teacher:

> Title: Forum for collaborating with your presentation group
>
> . . . . I have added a series of PowerPoint slides onto Google Docs. I think that it is important to work collectively to develop a presentation that is an effective presentation [demonstration] of the issues surrounding behaviour management. I have learned that I can contribute to a project by providing support for others and developing a structure for presenting the information. The following is a link to the draft PowerPoint presentation I created. (Online discussion forum, August, 2017)

I observed that Rachael employed a more flexible style of learning using Google slides for student teachers to collaborate on their group tasks. She mentioned that "if we're doing short stories where different pairs or threes or fours are focusing on a different aspect, then I'll get them to produce a Google slide about it through their mobile devices and I'll put the presentation on the LMS." Since the student teachers could access the LMS using their mobile devices, this suggests that they could view all the presentations at their time hence increase the flexibility in their learning. A student teacher reflected on her experience. "I learned that I can work collaboratively with others. I found using Google slides an effective way to collaborate. A challenge I found was making the time to attend group meetings, but I overcame this by being organised in advance" (Online discussion forum, August, 2017).

Also, working on collaborative group tasks enabled student teachers to synchronously and asynchronously comment on a document by setting up a cloud-based collaborative site, chat, or negotiate how they could continue working at a later time. For example, through peer-to-peer interactions, student teachers in Programme D said they used their private Facebook group and Google Docs to work on their group tasks as indicated in the following excerpt. "We mostly used Google Docs to share resources. We also communicated a lot through Facebook chat, asking questions, or giving feedback. . . . We made the slides on a single shared document, so we saw what the others were doing" (ST3, Group 1, July, 2018). Another student teacher liked the collaborative work because it built their team: "There was a good team spirit . . . no one felt behind or 'out of it', everyone pulled their weight and actually put in extra effort to work together and help others" (ST1, Group 1, July, 2018). Their explanation of how they used Facebook indicated that it promoted interactions and a sense of community: "The Facebook group is our own, not part of the university. At the beginning it was really good, we were all trying to get to know each other and socialise. . . . I found the Facebook group a lot more helpful" (ST4, Group 1, July, 2018).

It seems like student teachers could relate and interpret how to integrate Google slides in their practices in schools to support learning. One of them explained how he used Google slides:

> I used Google slides for all my lessons. So I'd make a presentation and they'd [students] have access to that from Google Classroom. They'd also have to log in after each lesson to do a small reflection activity on the lesson. So, what it was about, what they learnt and any questions they had. So I could log in and see what every student has put in for

> each lesson. And I would use their questions, which they put up there in future lessons to find out what they wanted to know about. (ST16, Group 4, July, 2018)

In addition, Rachael mentioned that she emulated practices in schools by preparing student teachers to use Google Docs because they are commonly used in schools. “I always ask my students, what digital environments are teachers using in schools? . . . Most of the schools are using Google Docs. They [student teachers] need to learn how to use Google Docs.” A student teacher talked about how during his teaching practice he used Google Docs because the school was using Google Docs. He said “when I was on placement they pretty much operated under Google Docs so like the kids had Chromebooks, they used Google Slides, and everything was very Google Drive based. So when I was there I did everything on Google basically” (ST20, Group 4, July, 2018).

It appeared that Rachael was in a challenging situation because unlike Esther, who was actively involved in designing some of the programmes, Rachael joined the team when the programmes had already been designed, making her less familiar. For example, Programme D was unique from the other three programmes. Adoption of OneNote (www.onenote.com) in Programme D was designed as an innovative strategy to build student teachers’ knowledge and skills in a way that such practices could evolve with their growing competence and reflections throughout their preparation. Student teachers used OneNote as an eportfolio-based learning environment to show their professional competence by documenting their developmental growth.

I observed teacher educators who facilitated courses in Programme D used student teachers’ eportfolios for formative assessment (individually) to track their progress, show good practice and achievement of their learning. During teaching practice, student teachers were expected to link evidence of the activities they performed by writing reflections and uploading photos to their eportfolios. In addition, Rachael explained how student teachers used eportfolio by saying, it “involved focusing on how they’d [student teachers] used teaching as enquiry . . . so they would be linking to specific parts of their OneNote and say, I observed something in the class and then they might link to where they’ve written it.” The instructions in Figure 4.5 were posted on the course site.

Figure 4.5

Student teachers’ assignment about developing an eportfolio

Part 1: Evaluation of the Structured Teacher Portfolio (65%)

Through the Structured Teacher Portfolio you will respond to the guiding questions in each section, providing examples and evidence from professional practice. Teaching-as-inquiry cycle(s) will be a source of evidence for some of the guiding questions.

1. The portfolio will contain evidence and artefacts drawn from your digital repository and presented through OneNote.
    - Be selective when considering which items to draw from your repository to be represented in your Portfolio.
    - Ensure the Portfolio is clearly organised and has sufficient evidence, including documented teaching-as-inquiry approaches, to support your responses to the guiding questions and demonstrate the above learning outcomes.
2. Use the guiding questions to critically reflect on three key aspects of teaching practice
    - Learner centred
    - Assessment centred
    - Community centred

    A maximum word count, excluding hyperlinks, references and headings, is 2600.

*The Evaluation of the Structured Teacher Portfolio contributes **65%** of final mark allocation.*

Furthermore, other than OneNote playing a key role in fostering reflective processes, student teachers created multiple eportfolios independently to construct meaning from their personal experiences, by linking to digital images, videos, audio files or hyperlinked text. This appeared to enable each student teacher to both grow and showcase their digital literacy while they reflected and internalised the type of information they were gathering, and how it related to their graduating teacher standards. Every student teacher had "OneNote Class Notebook" that was organised into three parts. The first part was a private notebook which was to be shared between the teacher educator and the student teacher. Then the second part had a read-only notebook where teacher educators could share handouts with student teachers, while the third part was a collaboration space for all the student teachers to share, organise, and collaborate on their projects. The following is an example of how student teachers were expected to use their OneNote:

> Create a page for . . . in your OneNote Classroom [collaboration] space for this course . . . . This page will allow you to link easily to any useful online resources or readings. . . . You will find four collaborative spaces set up in the OneNote Classroom entitled Digital Technologies; Resources; Online Collaborative Tools; and Digital photos of work station setups. These enable you to share what you have found or created with others in the class and are related to tasks highlighted in red font in each section.

It appears ongoing documentation promoted reflective practice, as well as a personalised learning experience for student teachers, as discussed during the focus groups:

> Like with the technology assignment, we had to go away, research how we could use Padlet, make an example and then put it in the collaborative space on OneNote and say, this is how I plan to use Padlet in school during my teaching practice. (ST8, Group 2, July, 2018)

> We mostly use OneNote for assessment tasks. . . . For example, we are doing a literature review assignment that has a presentation bit and I think we are expected to do something in OneNote to show that we are collaborating on the presentation, so it's essentially a space where the lecturers can see what we are doing. (ST3, Group 1, July, 2018)

Moreover, the use of OneNote seemed to align with practices in some schools. Two student teachers explained how schools used OneNote, as indicated in the following excerpts:

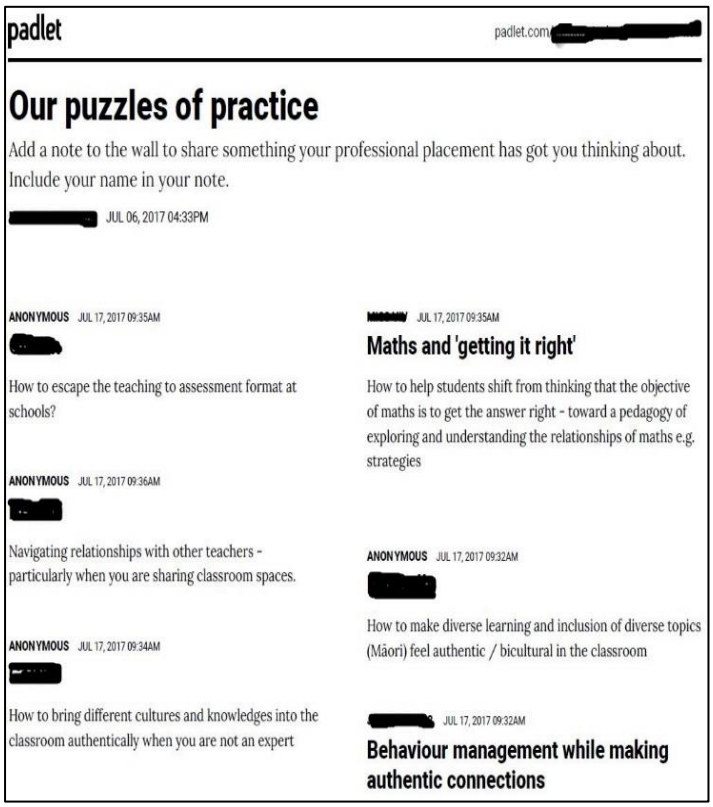
> I was teaching languages, and so for languages, they have a portfolio, so it's all their written work or recording speeches because you can record on OneNote, and so it was a portfolio of all the work that they would do themselves, rather than like taking notes, it was more for them to showcase what they had done and how they could do it and we could go in and check it. And then sometimes instead of photocopying twenty worksheets, I would put it on OneNote, and then we'd work on it together as a class. (ST5, Group 1, July, 2018)

> During my time at placement, they used OneNote workbooks. The school had BYOD policy [and] students in my Year Nine classes had paperless learning majority of the time. Their workbook was available on the online OneNote, or parts of a page were scrolled through on the projector screen. (ST6, Group 2, July, 2018)

In addition to student teachers using OneNote as an eportfolio-based learning environment to show their professional competence, Rachael also engaged them to recall their experiences during teaching practice. Like Peter, Rachael used Padlet as a reflection tool for student teachers to learn through individual inquiry and what their peers had posted. An example is indicated in Figure 4.6 showing a screenshot from the course site (with permission).

Figure 4.6

How Rachael used Padlet for student teachers' enrolled in Programme D to reflect on their experiences during teaching practice



In Programme C, because of the type of the course that Rachael taught, when assessing student teachers' work she said that "I prefer to mark off the screen because I feel restricted to this one window. . . . And I prefer a paper document where it's easier to flick, jump back, oh what was that bit, okay . . . so I find it easier to mark off the paper." Unlike Esther and Peter who used quizzes as a form of assessment in their courses, Rachael said: "I don't give them quizzes, no." She pointed out that:

> I tend to use more Google slides for informal assessment. . . . I use that [Google slides] a lot for different sorts of things. Like if we are looking at studying short stories, or I might give them different topics to do some research online around something we are studying and then they can produce theirs, summarise [it] on a Google slide and then the whole class has access to this Google slide presentation. . . . And sometimes I'll give them links to particular sites as a starting point.

Last but not least, student teachers enrolled in Programme D had practice-based experiences in two different local partnership schools during the first and second semesters, for a total of 14 weeks. They were expected to teach their major subject during the first teaching practice and major and minor subjects during the second teaching practice (B, 2015; obscured). In the second teaching practice, student teachers constructed a unit plan, incorporated language, showed specific behavioural management techniques and reflective practice (C, 2014; obscured). My observations of online practice showed that student teachers recounted their experiences with the use of mobile technologies in schools. One of them spoke about how the mentor teacher used technology in their English class. "My teacher was very conscious of finding helpful ways for the devices to be used. They used a brainstorming website called Popplet [also an app, https://popplet.com/] for creative writing." She continued to explain how the students created children's books using their mobile devices. "The Year Nine's were writing their own children's books and there's this website called Story Jumper where they can type in and add pictures and it can make a proper little book" (ST7, Group 2, July, 2018).

While observing student teachers in schools during their teaching practice, Rachael said: "I have an iPad so sometimes that is quite useful for taking notes and photos." When asked which types of photos she took, Rachael replied: "I would not photograph the students . . . so it's kind of limited. But I have taken photos of resources that they might be using in the class or displays on the wall, partly to kind of jog my memory." Taking photos enabled Rachael to capture what student teachers were doing in schools, which seems to have supported observing their practices and providing feedback. The schools that Rachael visited were using digital technologies to support learning. "I do see digital technologies as really well integrated into the classrooms that I go to and I think you'd be hard-pressed to find a teacher who would want to go backwards and use less technology." Similarly, online observations of the LMS course sites revealed student teachers' experiences in ILEs, suggesting the use of mobile devices supported learning due to the mobility of students in the open space classrooms:

> With the learning environments in schools, you need to do a lot of rotations between subjects. For reading, you would have three groups and for mathematics, you would have two groups. I found that it was really useful specifically for the mathematics unit to have devices because you would concentrate your time on that first group to teach

them something. And then the other group would be doing mathematics on their devices (Online discussion forum, November, 2017).

The story of Rachael indicates that she was limited in her use of mobile technologies. Although she might have been eager to integrate mobile technologies into her teaching, as seen from both the comments of the student teachers and herself, she seemed challenged by the type of subject she was teaching, but also probably lacked professional development. In addition, she indicated her maturity with mobile technologies at stage 4, as opposed to Esther and Peter who said they were at the top level. Although Rachael designed a creative activity for student teachers to use their mobile devices outside the classroom in an authentic context, they mainly used their devices for data gathering and sharing their found poems. The use of OneNote and Padlet in Programme D appears to have supported continuous self-reflection and being used as tools for assessment. What emerged as prevalent in Rachael's practices, is that she used mobile technologies to enhance collaborative learning experience and emulate practices in schools. These findings suggest that there may be a need to support Rachael to further integrate mobile technologies into her practices.

Summary of the Three Illustrative Narratives

This section has presented illustrative narratives of Esther, Peter, and Rachael. The narratives primarily related to the teaching approaches that each used to design and facilitate their courses, and how they prepared student teachers for their future classrooms. To exemplify the similarities and differences in their practices, Table 4.4 presents the summary of the narratives organised into three parts: (1) pedagogical strategies they used, (2) assessment of student teachers, and (3) technical resources that supported teaching and learning. The table also shows their self-assessed levels of maturity with mobile technologies and a brief description of the illustrative narratives.

Table 4.4

Summary of the Illustrative Narratives of the Three Teacher Educators in Alphabetical Order of Their Pseudonyms

Pseudonyms	Self-rating adoption of technology	Pedagogical strategies	Assessment of student teachers	Examples of mobile technologies/ apps	Brief description of the narrative
Esther	6	Collaboration Flipped learning Authentic learning Aligning coursework with school practices Modelling	Group work Online quizzes Group presentations Padlet postings Discussion forum postings Individual assignments	Laptop, video clips, Quizlet, Zoom VC, podcast, Adobe Connect VC, Dropbox, Padlet, smartphone, iPad, MS PowerPoint, Kahoot, LMS, Education Perfect.	Leader of team teaching blending distance and on-campus offerings. Alignment with practices in schools.
Peter	6	Interactive demonstrations Experiential learning Authentic learning Collaboration Flipped learning Project-based learning Aligning coursework with school practices Modelling	Online quizzes Group work Group presentations Discussion forum postings Padlet postings Slowmation artefacts Individual assignments	Augmented reality, PhET simulations, Kahoot, Padlet, smartphone, MS PowerPoint, LMS, Slowmation, laptop, video clips, Quizlet, digital camera.	Creatively employed a range of mobile technologies. Alignment with practices in school science. Facilitated student teachers' design experiments.
Rachael	4	Collaboration Emulating practices in schools Authentic learning Modelling	Group presentations Group work Discussion forum postings Individual assignments Padlet postings	iPad, LMS, laptop, MS PowerPoint, Google Docs, OneNote, Padlet, Google slides, smartphone, video clips.	Need support and professional development on mobile learning.

Pedagogical Strategies Used By Esther, Peter and Rachael

Evidence from interviews, observations of face-to-face and online classroom teaching revealed pedagogical strategies Esther, Peter and Rachael used to prepare student teachers to use mobile technologies for educational purposes. As indicated in Table 4.4, all of them emphasised collaborative learning by encouraging student teachers to use collaborative tools to share their learning experiences by working in groups, and constructing knowledge with their peers. Comparatively, findings from the student teachers showed that they acknowledged the importance of group activities. Other recurring approaches included authentic learning, aligning coursework with school practices, and modelling. However, modelling did not emerge strongly in Rachael's practices. I have examined these pedagogical strategies in greater detail in the following section.

In terms of their practices, the findings showed that there was a difference in mobile technologies related practices of the three teacher educators. There is strong empirical evidence that shows a difference in technology-related practices across subject areas, as identified by Crompton (2017). Based on the evidence, it emerged that Peter designed a variety of engaging learning activities. Observations of his courses and the interviews indicated that he used a range of mobile technologies to enhance interactive demonstrations, experiential learning and project-based learning by allowing student teachers to think about how to solve the problems. Interview data with student teachers indicated that they were able to incorporate some of these strategies into their own practices in schools. In addition, Esther and Rachael did not use simulations compared to Peter who taught science courses. This finding supports the finding that teacher educators in science, engineering and mathematics disciplines indicated a higher tendency to use simulations than those who taught literature, languages, and history (Barak, 2016).

As indicated in Table 4.4, there were differences in the mobile learning practices of these three teacher educators. For example, as seen from the narrative, the type of subject Rachael was teaching may explain why she made limited use of mobile technologies in her teaching. She also identified her maturity with mobile technologies at level 4 in contrast to Esther and Peter who were at level 6. Therefore, the minimal use of mobile technologies can also be attributed to the level of maturity with mobile technologies. This finding is consistent with Barak's (2016) finding which indicated that "teacher educators who are ICT experts use advanced technologies

in their teaching more often than their peers" (p. 291) since it is suitable for the discipline they teach and that it relates to their teaching philosophy. This can be seen to be reflected in Esther's practice who integrated cloud-based technologies into her teaching to support distance learning. She used VC tools and Padlet for distance student teachers to have virtual interactions, reflect upon their learning, and show their presence in the virtual classroom.

As shown in Table 4.4, Peter and Esther used a flipped learning model to create an individualised learning environment for the student teachers. For Peter, he shared course readings, video recordings of animations and simulations, and student teachers' designed simulations, then later engaged in discussions during their classroom sessions. During classroom observation, I noted that the student teachers were actively engaged in the learning process by discussing their Slowmation artefacts and receiving feedback which made their experience richer. Similarly, the findings revealed that Esther also used class time for active learning exercises such as group-based problem-solving activities. She expected that student teachers would come to class having read the assigned materials, completed the quiz, and took notes of anything they found interesting during their self-study.

Assessment of Student Teachers

The following approaches appeared commonly used to assess student teachers: group work, group presentations, and individual assignments. Although Peter and Esther used online quizzes, Rachael preferred to mostly use Google slides. Similar to Rachael, Esther expected student teachers to audio-record their pronunciation of te reo Māori language to get feedback. The results indicated that teacher educators integrated multiple assessment approaches throughout the learning process to evaluate student teachers and offer continuous feedback.

Technical Resources that Supported Teaching and learning

Finally, as presented in Chapter 1, the term mobile technologies in this thesis is used broadly to refer to the use of hardware mobile devices, software such as apps and web-based platforms. By integrating these tools into teaching, the findings indicated that Esther, Rachael and Peter enforced meaningful changes in their practices to provide a far-reaching understanding of the content. All the teacher educators repeatedly mentioned a range of media they used to facilitate instruction in their teaching subjects. Their usage varied from one educator to another depending on their areas and was also contextualised during face-to-face and online classroom observations. This allowed student teachers to experience meaningful use

of mobile technologies in teaching and learning. Evidence from student teachers' interviews showed that the use of mobile technologies during their coursework motivated their use in school classrooms.

As indicated in Table 4.4, student teachers' learning was mediated through a range of mobile technologies. Rachael and Peter used Padlet as a reflection tool for student teachers to learn from their experiences. On the other hand, the observations of online and on-campus classroom practices revealed that Esther made more use of Padlet as a learning tool to support both on-campus and distance student teachers. Esther, Rachael and Peter used the LMS as a platform to deliver courses but also a repository for learning resources in the form of text, audio, or video clips. This created an opportunity for student teachers to access the resources using their devices at any time and place. In addition, student teachers used discussion forums as shared conversational spaces to exchange points of view with their peers, which seemed to support seamless learning across time and place. This appears to suggest that student teachers had time for self-study at their own pace and location, before and after attending their classes, since they could always refer to what was posted online. Also, findings revealed that Esther and Peter meaningfully selected multiple modes of media to enhance their lessons.

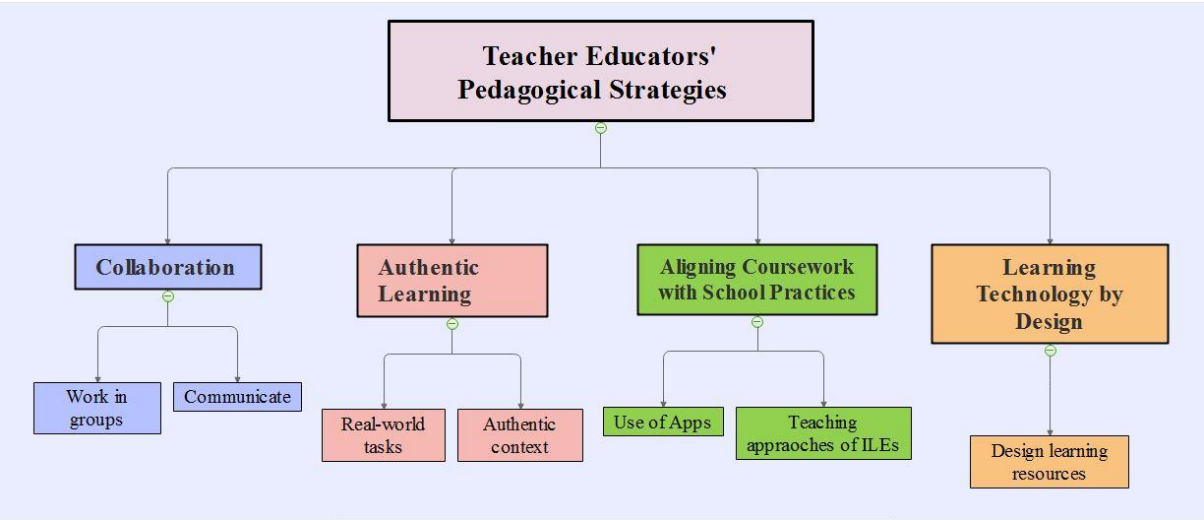
Generally, these findings show that Peter, Esther and Rachael mainly held a constructivist view of teaching and learning. This section presented the illustrative narratives of Esther, Peter and Rachael. In the following section, I will more closely examine the four themes and subthemes that emerged from the analyses of data for all the eight teacher educators.

Visual Presentation of the Four Themes and Subthemes

The teacher educators embraced strategies that benefited from meaningful and authentic use of mobile technologies. The findings show that the strategies were not intentionally designed within teacher educators' courses, rather each one of them desired to integrate mobile technologies to prepare student teachers for their future classrooms. As shown in Table 3.3 in Chapter 3, after coding repeated patterns in the data, four interrelated themes emerged: (1) collaboration, (2) authentic learning, (3) aligning coursework with school practices, and (4) learning technology by design. In this section, evidence illustrating these four themes is presented beginning with the theme that was the most evident in the majority of the themes. Figure 4.7 shows how each one of the themes is separately presented.

Figure 4.7

Presentation of the four themes and subthemes that emerged from the analysis of data in this research



I have used a visual presentation of the four themes as a lens to illuminate the pedagogical strategies that teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning. These four themes, as they manifested in the data, combine two aspects: (a) how teacher educators used mobile technologies to support collaborative and authentic learning, and (b) what teacher educators engaged student teachers to learn about. For example, use apps that are commonly used in schools to support learning, and use mobile technologies to design learning resources appropriate for the contexts student teachers were going to teach.

As presented in detail in this chapter, these were the learning experiences that the teacher educators wanted student teachers to engage with school students. The findings also illustrate how student teachers reflected upon their preparation experiences to use mobile technologies, and how they applied the acquired knowledge and skills during their teaching practice. Such reflection of their learning and practice is critical since it provided more in-depth information about how teacher educators prepared student teachers for school classrooms. Key aspects of teaching and learning include learning goals, learning activities, and integration of mobile technologies, assessment, learning outcomes, and social interactions. This is the framework which I will now use as an approach to unpack each theme. The goal is to develop deeper knowledge about the research question: how do teacher educators use mobile technologies to influence the teaching and learning experiences of student teachers?

These four themes were not distinct, they overlapped and mutually reinforced with each other. For example, *collaboration* emerged as the most evident theme, and it overlapped with the rest of the themes—*authentic learning, aligning coursework with school practices*, and *learning technology by design.* As presented later in this section, evidence about collaboration related to how teacher educators indicated that they used a range of mobile technologies to introduce a "space" for student teachers to work in groups, and communicate.

Findings categorised in the theme *authentic learning* include aspects linked to how teacher educators designed real-world tasks that student teachers would likely do with school students in different subject areas, guided student teachers to use mobile technologies in authentic contexts and facilitated learning that was seamlessly integrated with authentic assessments. This theme overlapped with the first theme (*collaboration*) because findings indicated that student teachers worked in groups to solve ill-defined problems, and interacted with one another, and with the learning environment to construct knowledge. *Authentic learning* also overlapped with the fourth theme (*learning technology by design*) since student teachers used mobile technologies in authentic contexts to design learning resources that they were likely to use in their school classrooms.

The theme *aligning coursework with school practices* focused on how teacher educators guided student teachers to use apps to support learning and emulated teaching approaches of ILEs in schools. This theme overlapped with the first theme (*collaboration*) because teacher educators prepared student teachers in ways they could collaborate and coordinate with other teachers in schools.

The last theme was *learning technology by design*. Teacher educators encouraged student teachers to use mobile technologies to design learning resources either in groups or individually, indicating this theme overlapped with *collaboration*. Although the themes were overlapping and their sum is more than the parts, I will now take you through each one of the themes.

Theme 1: Collaboration

Collaboration emerged as the most common pedagogical strategy teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and

learning. According to the findings, collaboration related to how teacher educators used a range of mobile technologies to introduce a "space" for student teachers to work in groups, and communicate. Examples of collaborative authoring tools used included Padlet, Google Docs, Facebook, and Zoom VC. These tools were used to support student teachers to share multimodal resources, co-construct knowledge in multiple ways, connect with their peers, and communicate. Analysis of survey data revealed that 83% of student teacher participants either agreed or strongly agreed that they used mobile technologies to share digital evidence of their learning, e.g. publishing their work on online platforms. The use of mobile technologies allowed for collaboration in both asynchronous and synchronous (in real-time) formats. As it emerged from the data, the two subthemes of collaboration are now considered and presented below beginning with work in groups then followed by communicate.

Work in Groups

Four teacher educators designed collaborative tasks so that student teachers could work using several mobile technologies to share multimodal resources and provide each other with social support and feedback. Working in groups seemed to reinforce social interactions and co-construction of knowledge as student teachers engaged in their learning while also learning from their peers. We saw this theme develop when Peter facilitated interactive groups where student teachers worked on innovative experiments in science courses, as presented in the illustrative narrative. According to the findings, teacher educators used mobile technologies to support educational activities through collaborative groups, where each group member was a potential source of information. For example, it was observed during one of Esther's courses with on-campus student teachers that student teachers used Padlet synchronously to share multimodal resources and collaborate on their assignment. They interacted with and around their laptops, then posted their work on the Padlet wall, extending their collaboration into the virtual space. Padlet is an interactive app that can be used for brainstorming by sharing texts, videos, and images.

Peter asked the student teachers to post their messages on Padlet so that he could create a knowledge-sharing experience. Since the reflections were publicly visible, student teachers likely accessed information posted by their peers while presenting their thoughts online which enabled them to compare their thinking. The way student teachers used Padlet during their coursework, seemed to have influenced how they used it during their teaching practice. For example, a student teacher said, "I had groups of four or five students and they had their mobile

devices. They used Padlet to brainstorm their ideas and contribute their ideas in the form of sticky notes on the screen" (ST17, Group 4, July, 2018).

Esther and Kate used Padlet as a cognitive and collaborative authoring tool to engage student teachers to co-construct knowledge with their peers, and advance their understanding of concepts. Kate said: "I've used Padlet to share ideas that the students have had and to build concepts. It's quite an interactive way for students and lecturer communicating together." It seems the use of Padlet enabled student teachers to experience multiple sources of evidence of learning, and benefit from communal knowledge to build a deeper understanding of their learning. For example, Esther said "interesting for the Padlets I think, some of the students have developed some learning from other people's thinking. . . I was really surprised by how much they enjoyed finding things and posting and being meaningful." Results revealed that 94% of student teacher participants either agreed or strongly agreed that they used mobile technologies during their coursework to share learning resources and digital content, e.g. videos, photos, and documents.

Further to being used as cognitive and collaborative tools, similar to Rachael, Kate also used Padlet as a tool for reflection to promote exploration and interactivity among student teachers. She encouraged student teachers to post and link their ideas with new information on the Padlet wall. This created a comprehensive wall full of ideas for every student teacher to see. As Kate explained, she used Padlet "mainly for critical reflection. So the students might complete a learning module, and then I might pop a Padlet up with reflective questions about the module, and then the students will come in and pop their responses."

Two student teachers' posts in discussion forums suggested how working in groups enabled them to develop interpersonal relations and collaboration skills they need for their future classrooms: "People in the group worked well and contributed to the discussion. I was impressed that we worked well together (Programme A) even though some of us had never talked to each other and I was proud of the result" (Online discussion forum, November, 2017). "We were a little bit chatty, but we ended up being productive and did a lot of work. We learnt more about how to work with each other" (Online discussion forum, November, 2017).

Mobile technologies supported distance student teachers to work in collaborative groups including meet virtually. Illustrations from two teacher educators showed how they used Zoom

VC as a collaborative tool for distance student teachers to meet each week and work synchronously from different geographical locations. The findings indicated that student teachers contributed their thoughts in real-time, experienced a sense of belonging, and benefited from the thoughts of their peers. It is noteworthy that student teachers made more use of mobile technologies to support their learning and connect with their peers from different locations. For example, Grace mentioned that they had, "distance students from everywhere around the country, and they access course content from digital devices depending on where they are . . . They posted on the LMS photos of themselves. That was even good for me. I could check when they're talking."

Esther and Kate organised distance student teachers into collaborative groups to work simultaneously on their projects using Zoom VC. As presented in Esther's narrative, student teachers used the discussion forum on their course site to agree on a suitable day and time to attend the sessions, indicating increased flexibility in their learning. Based on the interview with Esther, it seems that both asynchronous and synchronous strategies were used to cater for diverse learning needs and styles. Kate explained how distance student teachers used Zoom VC and Google Docs:

> Our distance students work collaboratively at a distance through technology to work on their assignments. So they will access Google Docs and will be working on it together. They used Zoom in one of their other courses in the first half of the year. So they're used to being in Zoom groups. When they want to meet face-to-face with one another, they will also use Zoom or Google Hangout, it breaks the ice.

Furthermore, interactivity and social interaction, provided by Zoom, seemed to support each distance student teacher to actively participate by leading their own group discussions and taking responsibility for their learning. This experience suggests that using collaborative tools enabled distance student teachers to plan and implement their ideas, but also build up their knowledge as a group from multiple interpretations, and become part of a community of learners. For example, Esther found that student teachers used Zoom as a platform for peer learning beyond their scheduled class time and maintained their learning communities even after completing their course, as explained:

> Students told me that they still meet in their Zoom groups, just to talk about any course that they have. So it's become a kind of meeting place, like a cafeteria for them, where they Zoom together if they have anything they want to talk about because they can

> upload things, and they feel familiar, comfortable and know how to use it. They are starting to use it to kind of work with each other and work through whatever it is they need to be working through, so Zoom has become a good tool, I think for our students that are more comfortable and know how to use it.

As revealed through online observations, student teachers' comments posted on their course site indicated collaborative learning enabled them to exercise self-regulation, self-determination, and willingness to participate as they listened to different perspectives from their peers. A student teacher in Programme A explained that "through group collaborations, I have learned the value of listening to other peoples' ideas and the value of those ideas for my learning" (Online discussion forum, July, 2017). Another one also acknowledged "how collaborative work brought out individual strengths and allowed us to create a shared vision. Working alongside others meant this remained relevant but also well presented" (Online discussion forum, November, 2017). As student teachers worked in groups, mobile technologies facilitated how they communicated with one another and their teacher educators as follows.

Communicate

It is a complex process for student teachers to engage in computer-mediated communication while collaborating on their group tasks. However, the transactional model of communication (Wood, 2009), has simplified this complexity by providing details about specific concepts and steps within such a form of communication. In general, the description I provide here is mainly focused on the purpose of communication where both student teachers and teacher educators simultaneously send and receive messages (Wood, 2009). Informed by insights drawn from the literature (e.g. Nykopp et al., 2019), the way student teachers communicated using mobile technologies stood out as being able to be identified as direct sharing of information and engaging in learning conversations to co-construct knowledge. Furthermore, student teachers' communication encounters were influenced by their interpersonal relationships with one another, and the rules that teacher educators stated. Student teachers used Facebook, Padlet, Google Docs, emails, Zoom VC and discussion forums to engage in both synchronous (in real-time) and asynchronous communication. Results from 95% of student teacher participants revealed that they either agreed or strongly agreed they used mobile technologies during their coursework to communicate with teacher educators, and their peers outside the class in a socially responsible manner, e.g. via email, discussion forums,

or social media platforms. I now present a closer examination of how mobile technologies supported direct sharing of information between teacher educators and student teachers, as student teachers engaged with their peers in learning conversations to co-construct knowledge.

Multiple channels were used for direct sharing of information to get tasks done by conveying messages, asking questions, and receiving feedback. All teacher educators conveyed messages where immediate feedback was not expected. They posted course announcements on discussion forums and sent emails to guide student teachers while working on their group tasks. For example, data from the interview with Eric indicated that he created and used a digital space—Facebook as a supplement to in-class teaching to share course information and learning resources. Eric said that "in some of my smaller classes, we'll set up a Facebook page and to be honest students look at Facebook more often than they use the LMS." It seems since student teachers were keen to participate in their own Facebook groups, Eric used Facebook to maximise the chances that student teachers would see and read the course information. Eric duplicated learning resources from the LMS course site into the Facebook page, used Facebook to communicate with student teachers, and as a forum to answer student teachers' questions. He went on to elaborate that, "whatever I put up on the LMS I'll also put it on Facebook, any discussion forum posts, any questions that they ask, and they feed into the Facebook page stuff that might be of interest to the group."

The findings revealed that student teachers preferred to have a private, closed Facebook group (excluding their teacher educators) to send online chats. For example, Kate said "students use their Facebook page which of course I don't have access to. And I know they use their mobile devices to text each other. Because sometimes they will let me know that someone's sick she's posted on Facebook or she's running late." In addition, data from the student teachers showed that they also used their Facebook groups as an online platform to participate in dynamic learning conversations and share ideas with their peers. It seems they exhibited a strong sense of ownership of their Facebook group. A student teacher in Programme C explained: "We had created a Facebook group in which we would ask questions and help each other . . . someone would take a screenshot from the lecturer that answers that question, or someone else would say I interpreted it this way . . ." (ST20, Group 4, July, 2018). These findings indicate that a rich part of communication came in when student teachers used Facebook to co-construct knowledge. It seems that even when the conversation began by asking a question, it gradually developed into knowledge construction where student teachers shared more information.

With Programme D, student teachers said that "our Facebook is a formal group and it's about the course." They expounded how they used their Facebook group to share their interpretations with their peers and develop new knowledge by, "having a discussion about an assessment, or someone forgetting how to reference something, and we share resources that we come across and think, ooh!! This might be helpful for everyone else." When asked about how many times they posted, one of them said, "We post multiple times a day and everyone in the course pretty much engages with it." The many postings were attributed to the number of student teachers in the course because they created a safe digital space to ask questions across time and place. "Our group is small, maybe if we were a larger group, we wouldn't know some people so well so we'd sort of be hesitant about posting." It is likely that student teachers felt connected to one another within their learning community since they had established trust. This also suggests student teachers were comfortable posting on their Facebook page because they had a common sense of purpose to achieve their goals. Besides creating a safe digital space, the postings increased when they were expecting an assignment since they could receive more critical and timely peer feedback. Another student teacher said: "I think there are a lot more posts than there would be if there were more people, but also sometimes when we are coming up to an assignment, and there's not a lot of like mean postings." The way student teachers discussed their use of Facebook seemed to show that it was a platform where they were actively involved in supporting each other and learning from their peers' experiences to enhance their learning. "So we are all very comfortable posting questions up there and everyone is happy to respond because we all want each other to do well."

On the other hand, student teachers in Programme B discussed how they used their Facebook group to share resources, and promote ongoing learning conversations to maintain their social and professional support: "our team was very supportive, we had a group chat on Facebook and a shared Google Docs that helped us to share resources, or it can be don't worry I'm confused as well . . . we also used Facebook Messenger all the time" (ST10, Group 3, July, 2018). It seems the notification updates on Facebook enabled student teachers to monitor the task process and provide instant interaction and feedback. Another one said:

> Only one person didn't have Facebook. We posted comments, or someone saying I looked at this research and it was fantastic . . . When you have a certain question about an assignment, usually there are three or four people who will get back to you very

> quickly. Because everyone is on Facebook all the time . . . Occasionally we use it to organise social events. It was a pretty good group. (ST15, Group 3, July, 2018)

The ability to communicate, connect and interact via Facebook provided a valuable environment for student teachers to learn and engage with their peers at a time and place that suited them.

Esther used Padlet to create a social space to enhance virtual learning conversations and establish relationships among distance student teachers. A Padlet link on the course site was created, and the student teachers were expected to introduce themselves by uploading their selfies, saying their names, where they came from, what they were passionate about, and what they were looking forward to getting out of their course. Although the student teachers were in different locations, they used Padlet to share information and stay connected. Two student teachers' postings about their aspirations related to how they expected their preparation would impact their future practices with their students, as indicated in the following excerpts. "One thing I know is really important for young people is a sense of belonging, so I look forward to seeing how the practices I learn in this course will impact my work with students and other young people" (Padlet posting, 20 February, 2017). "I am hoping to gain a better understanding of how to create an inclusive teaching environment that allows for the best learning for all students" (Padlet posting, 20 February, 2017).

The findings showed that student teachers used Google Docs to engage in both synchronous and asynchronous learning conversations to co-construct knowledge. Esther mentioned that "students have to do weekly group tasks, and they use Google Docs for that, and OneDrive as well to put documents on." It is likely Google Docs promoted flexibility in information sharing and commenting on group tasks. Student teachers across three programmes also talked about how they shared information and learning resources using Google Docs to support each other. "We used Google Docs a lot to share files or, if we're all contributing to one file, the lecturer will say, tell me what have you learnt about this subject?" (ST9, Group 2, July, 2018). Another student teacher said, "at the moment we're doing a group project using Google Docs . . . When someone updates something in Google Docs we all get an email, then we can instantly go and check. So like peer sharing it's really helpful" (ST7, Group 2, July, 2018). It appears that email updates enhanced group communication since student teachers could keep on track with their tasks. Student teachers in Programme D used OneNote when they wanted to share their work

with teacher educators and Google Docs to enhance peer-to-peer conversations, as stated by one of them:

> Between our peers, like if we have a group task as we do at the moment, we share everything through Google Docs, but if we have to like share stuff with the lecturers, it has to be through OneNote then they can access that. Well, that's just the way they do it. I'd say OneNote has the upper hand on Google Docs because it has collaboration tabs, it's a good organizational tool. (ST2, Group 1, July, 2018)

More importantly, Grace and Eric played a fundamental role between on-campus and distance learning student teachers. They used Zoom VC to facilitate interactions for both groups, not only bridging their geographical and social isolation but also a psychological and emotional sense of detachment. Although the learning experiences were not mobile, it appeared using Zoom enabled student teachers to connect through synchronous interactions. Grace mentioned that "within that course, we were able to mix up our distance and our on-campus students. So when they are in discussion groups, they are talking to different people from different geographical locations. Which is good for them." This made student teachers' interactions similar to a face-to-face situation, indicating that the use of mobile technologies was not impersonal.

Using Zoom VC allowed Eric to facilitate synchronous communication but also strengthen the relationships between on-campus and distance student teachers. Such interactions likely enabled student teachers to create a peer group to call on when they join their profession as newly qualified teachers. The way Eric used Zoom VC seem to support student teachers to develop a sense of collegiality and belonging because he stated that:

> It's really about trying to build that relationship between them. And so I use Zoom to allow distance students to join us, if they're able, to make sure that they can see what we're doing in the classroom. So I walk around the class with a camera so that they can see the entire class and that if we are doing an activity together, they can see what's going on. And I try to encourage them to take part in that activity with someone that's in the classroom as well, so they don't feel isolated.

Teacher educators used discussion forums as virtual spaces beyond physical spaces to facilitate debates through asynchronous communication. This allowed student teachers to engage in collaborative learning conversations from different locations and times, meaning the forums

supported convenient communication. Since student teachers had their own devices, it seems they did not have to be at a specific place to participate in their learning. Also, some teacher educators used discussion forums to create a great sense of learning community. A student teacher commented on how she benefited by reading his peers' forum postings:

> Discussion forums are potentially more valuable, I read each other's thoughts on readings and things within those forum postings. And lecturers are also able to trade in on those as well. So they are a really good place for asking questions to lecturers that other people in the course can also answer. (ST20, Group 4, July, 2018)

Teacher educators explicitly conveyed the rules that guided student teachers when they were communicating online. For example, the following excerpt was posted on one course site:

> We ask that you think carefully about how you will interact online. It is important to be respectful and thoughtful. The forums are here for you to debate, challenge and ponder the content covered in this course. Therefore you need to think carefully before responding to forum posts. We look forward to hearing your thoughts and ideas. Remember that any postings made to forums on this website are open to everyone. If your post is personal, we suggest you e-mail us directly.

The findings suggest that Peter stressed the importance of being kind, and courteous by accepting and valuing everyone's work. This also included receiving feedback positively and respectfully:

> I'm quite happy for them to talk to each other through the forum space after they have left the class, and it might be that sometimes they have a task that they have to do and they might want to share ideas. But, I still encourage that they respect everyone's work, especially when providing feedback to their peers' work, that appropriate words are used.

In summary, the findings revealed that collaboration was the most common strategy in teacher educators' practices, specifically relating to using mobile technologies as collaborative tools to support communication, for group work including distance student teachers to meet virtually. Student teachers were encouraged to work together as they sought advice from their peers and teacher educators, construct new knowledge, and actively engage in activities that fostered a sense of community. These practices appeared to have positively impacted on the preparation of student teachers to acquire skills needed for the future workforce. However, the majority of

the illustrations portrayed the mobility of the devices and student teachers rather than their learning experiences.

All teacher educators used a range of mobile technologies to facilitate group activities and share multimodal resources. Padlet and Zoom VC were the most commonly-used tools to enhance collaboration. Other mobile technologies included Kahoot, Adobe Connect VC, Facebook, discussion forums, and Google Docs. Student teachers acknowledged that the use of mobile technologies enhanced collaborative learning as well as their interactions. For example, more than 83% of the student teacher participants either agreed or strongly agreed that they mostly used mobile technologies during their coursework to communicate, share learning resources, and digital evidence of their learning, e.g. publishing their work on online platforms. Authentic learning was another strategy teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning.

Theme 2: Authentic Learning

Illustrations from seven teacher educators showed that they used mobile technologies to support authentic learning. Authentic learning is an important part of education in the 21st century, and in the context of this study, findings categorised under this theme included aspects linked to how teacher educators integrated mobile technologies into their practices to promote student teachers' learning of a variety of real-world tasks, guided student teachers to use mobile technologies as learning tools in authentic contexts and facilitated learning that was seamlessly integrated with authentic assessments. In this study, Kearney et al.'s (2012) definition of authenticity will be used, learners engaging in tasks that provide real-world relevance and personal meaning. Teacher educators varied the conditions under which learning took place by allowing student teachers to encounter the tasks in real-world settings. Also, teacher educators integrated mobile technologies into their teaching to leverage situated and experiential learning, making learning relevant and meaningful. Most of the illustrations present the mobility of the devices, the student teachers, and their learning experiences.

Perform Real-World Tasks

Results showed that teacher educators were intentional in the design of real-world tasks that applied to school contexts. Teacher educators modelled a situation that student teachers might do using mobile technologies in school contexts. For example, Grace supported

autonomous learning by allowing student teachers to use their smartphones during the workshops to document print making processes, but also control their own learning processes. It seems smartphones enabled student teachers to capture their learning process, edit their prints on the devices and later replay and learn what they were designing. She said:

> All of my workshops each week when they come in are all set up ready for their learning and its modelling classroom practices. The first thing they do is use their phones to take a snapshot. I actively encourage them to have their devices out all the time. I'm forever getting them to take photos as they are working through printmaking processes . . . For example, te reo Māori and Pacifica motifs and designs. They will often be working directly from their phones, actually with those designs. So within a class they will be pulling them out [phones] and using them all the time. And like I say to them, visual records are really good things.

Student teachers worked on tasks that were related to their studies and those tasks carried out in schools. This could be seen as authentic learning since student teachers were likely to capitalise on these tasks in their future practices. For example, it appeared that Eric used situations from the real-world to design assignments. During the interview, Eric said, "I suppose what I am trying to do in terms of the design of like the assignments and the use of the technologies is always find things that are real in terms of their use and application." Similarly, as presented in the illustrative narrative, using mobile technologies enabled Esther to share with the student teachers a short video clip to illustrate a storytelling technique that student teachers could use in their practices. Student teachers reviewed the video on their own and engaged in deeper discussions during their class session. Student teachers' responses showed that 66% of them either agreed or strongly agreed that they used mobile technologies during their coursework to work on real-world tasks which they were likely to meet in life beyond school. According to the findings, working on real-world tasks was seamlessly integrated with authentic assessments, enabling student teachers to develop skills that they were likely to transfer to school classrooms.

Another aspect of authentic learning was manifested by instances where Sam designed a real-world task that was seamlessly integrated with an authentic assessment. During the interview, Sam said "so I'm working with them [student teachers] to address everything that's done for Years Eleven, Twelve and Thirteen in terms of biology in schools. So in those activities, I address practices that biology teachers use in their classes." Student teachers identified relevant

resources and activities applicable to their future students, as they engaged at deeper levels in problem-solving to accomplish their learning goals. For example, I observed that the main task was for student teachers: *"to find an activity that would challenge their [school] students about being human, about the three stages that characterise human evolution—bipedalism, tool manufacture, and predictive intelligence . . . The trick was to find something which repeatedly sent a chill down their spine."* Sam stated that "such stages are easy to learn, but are so intrinsic, they prove difficult for students to comprehend deeply, and grasp their evolutionary significance." The assessment approach that Sam used for this task appeared to be authentic. Student teachers were required to either use images, stories, audios, videos, or artefacts in a MS word document to showcase their understanding of the content, then upload their tasks to Dropbox within the course LMS. This finding suggests that by integrating mobile technologies into the task supported student teachers to create deeper meaning into their learning. Sam promoted practical relevance by guiding student teachers to work on an activity that was authentic to the environment in which the activity would be used.

Jim also used mobile technologies so that student teachers could understanding a real-world problem. He said, "many students will have software which in effect turns a laptop or a tablet into a recording studio. I can do it on my phone with GarageBand as a tuner for musical instruments to engage students in creative activities." When asked how student teachers used their mobile devices, it appears Jim supported a sense of learner agency in readiness for their profession. Jim said that student teachers "did song writing exercises using their mobile devices. What I'm trying to do is get them to think about how they would actually teach a song. I have a very strong experiential approach . . . so we learn by doing." Using mobile technologies meant that Jim did not need access to specialist equipment to facilitate learning.

In addition, Jim said he facilitated weekly discussion forums by guiding student teachers to manage and construct their learning. In this way, the forums allowed student teachers the flexibility of contributing to the learning from different times, and locations to build up their own knowledge, simply, learning was not constrained to a particular place and class time. Jim said, "I tend to plan the forums week by week and not pre-plan the whole lot because often I like the flexibility especially if I haven't done something the previous week, and I give them what my expectations are each week." Through discussion forums, observations of online practices revealed that student teachers appeared to have discussed how the use of mobile technologies in their course mediates authentic learning. Three student teachers in Jim's class

posted as follows. “Utilizing new technologies not only makes music education more fun thus engaging, but it also links students’ in-school musical experiences more closely with their out-of-school musical experiences making their music education more relevant to their lives” (Online discussion forum, August, 2017). “Other apps and software, such as GarageBand easily facilitates composition. They allow sound clips to be dragged and dropped into any order and put together very easily” (Online discussion forum, August, 2017). “A music education system that utilises new technologies assists students in developing skills that are needed to succeed in the 21st century . . . We now have headphones, portable music players, and online streaming which can be accessed using mobile devices” (Online discussion forum, August, 2017). Just as performing real-world tasks enhanced student teachers’ meaningful learning, so did authentic contexts for learning.

Authentic Contexts for Learning

The findings revealed that teacher educators facilitated authentic learning by guiding student teachers to use mobile technologies as learning tools in authentic contexts. These contexts included: field trips, the library, in schools during teaching practice, and a realistic learning environment generated by student teachers. This indicates there was no distinction between formal and informal learning settings since student teachers used mobile devices to access information in less formal settings that supported what they learned in their courses. Results indicated that teacher educators used mobile technologies to support student teachers’ situated learning experiences in different authentic contexts through social interaction. The ability of mobile devices to gather evidence and data enabled student teachers’ access to the evidence so that it was much more authentic. For example, student teachers used their smartphones and iPads to capture images from authentic contexts created artefacts which they later shared with their peers, and used as reflective prompts to think about specific teaching and learning concepts. This was confirmed by survey data where the majority of the student teacher participants (76%) either agreed or strongly agreed that they used mobile technologies during their coursework to learn in real-world contexts, outside locations off-campus.

The use of mobile technologies enabled learning to occur in environments that supported knowledge construction. For example, Kate and Esther (they co-teach in Programme A) designed real-world tasks that allowed student teachers to learn how to apply their knowledge of using mobile technologies in authentic learning contexts. They organised for student teachers to use their mobile devices during field trips. Distinct features of mobile devices—

portability and connectivity—permitted student teachers to use their devices inside and outside their classrooms to experience learning that had real-world relevance. It appeared student teachers worked on a challenging inquiry to gain knowledge and skills in these informal settings. They were expected to research activities that school students would be interested in, and the kinds of questions they might ask. The aim was for student teachers to think about integrated experiences that they could see for their future students relating to what they had learned in their coursework. During the interview, Esther said, ". . . we looked at each of the domains that we cover which is technology, science, visual arts, music, physically active play, and social dramatic play . . . we discussed how the language of those domains could be used with [school] students." These activities provided insight into a school student approach to learning, indicating that the learning was authentic since student teachers practised the kind of activities that they would encounter in schools.

Esther described how student teachers used their mobile devices during field trips. She said, "we usually have three trips. One to the art gallery, one to the playground, and one to the museum." It appears Esther designed tasks for student teachers to perform in a context that applied to school classrooms. At the art gallery, student teachers were required to use their mobile devices to capture images of artwork, interpret what school students might think about the pieces of artwork, and identify a type of domain language around visual arts which they could use to describe a piece of art to school students. Esther said that student teachers were to "choose a piece of artwork for their students, gather information, and get into groups to present the language of art, and how if you had a group of [school] students, you would talk to them about the piece of artwork." This illustrates that the learning environment was authentic and seemed to have positively influenced the learning processes and learning outcomes of student teachers since there was appropriate connection between the learning and student teachers' professional context. Also, working in groups implied they could explore multiple perspectives from their peers, rendering student teachers' learning experiences real and relevant. Furthermore, Esther said "there were lots of wonderful experiences that student teachers could think about from a [school] student's perspective, and they [student teachers] used their phones to take photos." By having the photos, student teachers could likely reflect more accurately about school students' perspectives. In addition, it seems the use of mobile devices made it easier to share with the group and the entire class what they were talking about than it would have been in non-technologically supported group work.

At the playground, activities involved student teachers taking photos and initiating their thinking about a real-life context for their future students' learning experiences. Kate said that the student teachers "learned about various ways different aged learners can play on diverse equipment and test boundaries. . . . They [student teachers] used their devices to take photos to use in their learning stories. The tool of assessment for [the programme] is learning stories." The use of mobile device cameras helped student teachers take photos to create learning stories which appeared to have been enriched by different photos they took. In addition, it is likely that student teachers customised their learning because they were using their own mobile devices to take photos, and developed contextualised ideas for their task. Esther and Kate used an assessment strategy that could be seen as authentic since the student teachers chose how to construct the learning stories using the photos, and were being assessed using the same strategy that they were likely to use in their future practices. These experiences appeared to stimulate student teachers' thinking to articulate what they were learning as well as reflect upon the process. This is yet another instance of an authentic way of learning to use mobile devices since incorporating photos into learning stories enabled student teachers to provide much more evidence of the construction of knowledge.

The student teachers' trip to the museum entailed visiting the Discovery Room. Findings revealed that student teachers used their mobile devices to search the internet for information related to their tasks. Esther explained that "in the Discovery Room, students had to look at the skeleton. We made them work in groups to hypothesize what it [the skeleton] looked like." This was followed by student teachers using "their mobile devices to see what it actually looked like, from the hypothesis, and they discovered more about it.…They were scanning and finding information and talking about what they had thought it looked like, and what it actually looked like." According to the findings, using mobile devices to search the internet supported on-demand access to information, and allowed new knowledge to be immediately applied to the current task, and reflect about future practice. Furthermore, using mobile internet access enabled student teachers to decide for themselves which sources of information they would use. This process appeared to support meaningful learning since student teachers integrated new experiences with prior knowledge.

After their field trips, the student teachers were expected to present their findings, and receive feedback from the entire class. This experience suggests that student teachers' learning advanced through social interaction and social construction of knowledge. Throughout the

places student teachers visited, findings indicated that the tasks provided an opportunity to experience as learners would, which student teachers could capitalise on as teachers. These illustrations have portrayed the mobility of the devices, the student teachers, and their learning experiences.

Another illustration of how student teachers engaged in a real-world task in an authentic context was explained in Rachael's narrative. Rachael described how she designed a real-world task where student teachers visited the library to create found poems that were aided by the photos (of book titles) they took using their smartphones. The photos allowed student teachers to reflect further about the poems they were creating. Findings revealed that student teachers had control over their learning content by designing visual presentations of their found poems which they shared with their peers, and worked in pairs to plan a lesson based on the type of found poems they had created. Planning a lesson formed part of an authentic assessment that Rachael seamlessly integrated into this task. The findings appear to suggest that learning was enhanced using mobile technologies and that student teachers practised an activity they were likely to do in their careers, but also created new meaning in the process, making it authentic learning.

Teaching practice also emerged as an authentic context that supported student teachers' learning with mobile technologies. Rachael said "we provided students with learning activities based on experiences that occur in class and tasks that they were required to complete while on teaching practice." It is likely that since some of the student teachers were in schools with ILEs, the authenticity was very clear to them as they participated in the professional community. I observed student teachers enrolled in Programme D, using the discussion forum to deliberate various ways they saw schoolteachers use mobile technologies in their subjects, as indicated in the following excerpts from three student teachers. "The use of technology has made practical changes to the way music is taught. I was impressed by the speed with which the students, when supported by the e-tools, were able to learn a melody" (Online discussion forum, August, 2017).

> I saw the use of mobile technologies in all of the science classes. Students were using devices to research on projects . . . they used Google maps and collaborative work on Google docs . . . Google earth and videos on YouTube to look at different areas around the world that had volcanic activity and the difference in the appearance of these volcanoes. The devices were an important aspect of supporting student learning . . .

> they also provide a greater visual understanding that would not be able to be achieved in their absence. (Online discussion forum, August, 2017)

> I also observed how beneficial technology can be for student's learning and achievement in English. I have come to this conclusion because many of the students in my classes had higher learning needs and technology allowed them to use Spellcheck and editing software to create a higher standard of work than if they had handwritten their work. (Online discussion forum, August, 2017)

By sharing their experiences made it as real-world as possible, and student teachers were likely to make meaningful use of mobile technologies to enhance their own practices.

Interview data showed that exploring the affordances of mobile technologies appeared to have fostered the ability for student teachers to use mobile technologies during their teaching practice. For example, during her school visits, Grace found that student teachers had implemented what they had learned from their coursework. She said "when I went out on placement, I saw many of the assignments I had marked, but customised for that group of students. So it really is meaningful." It is likely that student teachers were informed about how to use mobile technologies to facilitate teaching and learning. This experience could be interpreted that using mobile technologies during coursework increased the confidence student teachers were building as future teachers. Jim also talked about his school visits by explaining how a student teacher had integrated mobile technologies into her practices:

> I was watching a student teaching English at a school which had completed their first BYOD class and it was a Year Nine class. And it was fantastic. It was one of the best uses of technology and how it was working that I have seen for quite some time . . . She was actually teaching creative writing and she was using a whole raft of resources that the students were finding online and then shaping into their own particular work [using their devices]. It was very impressive because they were teenage boys who would require relatively firm handling, and she was a student, you would have thought she was quite quiet and a bit shy. But in the classroom she owned it. She was fantastic.

Peter designed real-world tasks to facilitate science learning in an authentic context that was enhanced by mobile technologies. The findings indicated that student teachers engaged in authentic experiential learning using their mobile devices to produce innovative and creative teaching resources which helped to expand their knowledge. Peter said, "If the tasks are not

connected with real-world then why are we doing it?" This theme developed when Peter mainly used Slowmation as a pedagogical tool, as presented in the illustrative narrative. Student teachers were assigned to conduct the experiments in small groups. They used their smartphones and iPads to take photos of still images, added narrations and produced short animated videos that applied to a future school context. Working in groups allowed student teachers to share reflections on practices that were transferable to a future school context. It seems the use of mobile devices (mainly smartphones and iPads) supported student teachers to take responsibility for content creation and share their findings with their peers and teacher educators. This could be seen as an authentic way of using their mobile devices. By learning through doing, Peter supported reflective learning since the tasks allowed for thoughtful observation and active experimentation.

In a physics course, findings showed how mobile technologies enabled each student teacher to investigate their experiences into their learning situations by working on a topic about real-world tasks and internalise their learning. It appears that student teachers acted autonomously, having to generate their own contexts that were student-driven, making their learning more real and meaningful. During the interview, Peter explained that "students can also choose their learning context, often for the area that they are applying this digital technology too, and the context they invariably choose is important to them, or that they know about, or they are familiar with." The findings suggest that Peter allowed student teachers to take ownership of their learning and have a sense of belonging. For example, when working on the analysis of motion, the task was authentic to the discipline because it was likely to promote the transfer of knowledge and skills to future classrooms. Student teachers used their mobile devices to act creatively by analysing their personal journey (individually) to and from the university—a familiar route (authentic setting)—to think through start and endpoints. The use of mobile devices enabled student teachers to access, observe and analyse data virtually in real-time which they later recorded and shared with their peers and afterwards reflected upon. Peter stated, "So I remember a couple of students, when they were looking at the analysis of motion, they chose their trip [personal journey] to and from the university and analysed that, and this was enhanced by technology." It is likely that since student teachers had an experience of the abstract concepts in themselves, teaching the concepts appeared relevant in preparation for a real-life context of the school classroom.

In conclusion, authentic learning was the second theme that emerged from the practices of seven teacher educators. Teacher educators were intentional in the design of real-world tasks that were transferable to school contexts. They integrated mobile technologies into their practices to support student teachers learn a variety of real-world tasks across different subjects in ways that student teachers could adopt and adapt in their future classrooms. Although I did not focus to observe particular subjects, the findings suggest that the way teacher educators used mobile technologies was influenced by their subjects. The authenticity of the tasks that had been set by teacher educators became clear to student teachers and it appeared to increase their engagement and confidence that they were building as future teachers. The teacher educators guided student teachers to use mobile technologies as learning tools in various authentic contexts through social interaction. Student teachers constructed knowledge, actively participated and applied knowledge to real-world problems as is clear in the data. It appeared student teachers enriched their learning from multiple ways their peers conceptualised their learning experiences.

Theme 3: Aligning Coursework with School Practices

Seven teacher educators described how they aligned coursework with school practices by encouraging student teachers to use apps that were commonly used in schools to support learning, and modelling the functionality of numerous apps. This strategy appeared to support student teachers to develop the skills to use apps in their own teaching, and interpret how they could use apps in specific educational contexts. The findings demonstrate that student teachers acquired a clear understanding of the types of learning outcomes the apps could support and increased the likelihood of using these tools in their own teaching practices. Teacher educators also emulated teaching approaches of ILEs in schools. Collaborative learning was a key teaching approach that emerged from the findings. It is likely that teacher educators transformed their pedagogic practices, as stated by Grace: “for us, it’s a rethink of practices. It’s beholden that our staff then keep up to date with what’s happening in schools. So there has to be an interface between the schools and the professional development for the staff [in ITE].” Although aligning coursework with school practices emerged as a separate theme, from another perspective it could be a subtheme in the theme of authentic learning since preparing student teachers for actual classroom teaching is an authentic experience. This subsection discusses how teacher educators encouraged student teachers to use apps and emulated teaching approaches of ILEs in schools.

Use of Apps

Teacher educators talked about how they encouraged student teachers to use apps that were commonly used in schools to support specific subject areas. Some of these apps were Kahoot, Padlet, and Google Docs. A student teacher expounded on how they implemented apps that they learned during their coursework by saying, "a lot of lecturers introduced us to Padlet, Google Docs, and Kahoot, and lots of people have done Kahoot while on placement. The other person [student teacher] that was on placement with me she also used Padlet quite a lot" (ST20, Group 4, July, 2018). This appeared to have a direct impact on the pedagogical integration of the apps by the student teachers since they had the autonomy to select the apps that were tailored to their own learning needs. This was confirmed by one student teacher who said, "I mean here, we are kind of taught to use technological tools, like they kind of encourage us to find those kinds of apps and digital resources and to use them in our [school] classrooms" (ST11, Group 3, July, 2018).

The findings indicated that teacher educators modelled the functionality of several apps by presenting student teachers with concrete examples of how to use the apps and their pedagogical affordances. Grace explained that "we get them to make digital resources. We say to them use the apps to create resources together. Here's a whole heap of apps that you can explore, and the students do the most delightful things." It is likely that the student teachers took control of their learning and owned the learning process by constructing knowledge with their peers. In addition, teacher educators were exposed to new insights as they read student teachers' work. A case in point is Jim's experience which suggests that he was not reluctant to learn from his students:

> I mean these students are just so quick and so capable of using the apps. And they are forever showing me things [to use apps] that I don't know about. And I have some really interesting examples with some of my research presentations and some of the work I've presented around the world.

Eric gave an example of an app (Kahoot) which student teachers were likely to use in their future school classrooms because he observed Kahoot in schools. "I used Kahoot because I've seen it in action in the schools and generally speaking there are many younger teachers who are using Kahoot in schools." It seems student teachers in Programme C valued the opportunity to explore the actual teaching associated with using Kahoot, as presented in the following example:

> Actually, in that same class, we had a whole lesson I think of an hour and a half learning how to use Kahoot as a teacher. Yeah, he [Eric] taught us how to not just play the game but how to create them. . . . We played Kahoot, as we said in our classes, but we were just like from the student side, until I learnt that you could create your own questions or you could search for quizzes that are already built that was like the other side of it as a teacher side. (ST18, Group 4, July, 2018)

Eric used Kahoot to support te reo Māori language learning. He said, "Kahoot is another really good way of getting the students engaged. I used it during Māori course, so I've used that as well to show them that when they go into their classrooms, that's another piece of technology that they can use." The findings revealed that using Kahoot to support learning was perceived positively by the student teachers. A student teacher affirmed that the use of Kahoot to practice Māori language was interactive and made them engage in their learning:

> During our Māori class, we used Kahoot for Māori vocabularies, which was cool. Our class became really competitive. The lecturer had put up a Māori phrase and then we'd have to click the right translation or an English phrase and we'd have to click the right Māori translation. So it was just sort of recapping stuff that we'd already learnt but in a fun, and interactive way. (ST3, Group 1, July, 2018)

It seems Google Docs were also commonly used in schools. For example, with the student teachers enrolled in Programme B, Grace explained that "I get all my students to use Google Docs. Often then schools will use Google Docs. We can't have someone [student teacher] going out on placement and then they are going to ask what Google Docs is?" As presented in the illustrative narratives, Rachael also expected student teachers to use Google Docs while working on their group tasks. It is likely that student teachers found it relevant to use some of the apps that they learned about during their coursework, and did not doubt the benefit of learning with mobile devices. One student teacher said, "I was with Year Seven and Eight and the school used Google Docs a lot. I liked that aspect that they could share their work . . . But I'd never seen Google Classroom until I went to my placement school" (ST11, Group 3, July, 2018). An online observation of classroom practices also revealed similar findings. A student teacher discussed how the use of Google Docs made it easier to facilitate instruction:

> During my placement, the school I was in would do a lot of Google Docs for just about everything, and because it was an open space . . . so there were ninety students, and three teachers, and four out of five days, one of those teachers would be absent. So there

> were a lot of relievers, and Google Docs made it really easy for anybody to come in and see what was happening that day. (Online discussion forum, August, 2017)

Comments emerging from the interviews indicated that some teacher educators focused on preparing student teachers to be competent in their future use of the apps. For example, Eric mentioned that "some of our schools use Google classroom, and so what I am trying to do is prepare our students not for actually using Google classroom, but just to be prepared to use digital technologies [including apps] in the class." Evidence suggests that some student teachers held positive attitudes about using apps, and developed their confidence in the use of apps to support future teaching. For example, during focus groups, two student teachers said, "my new understanding of apps will help me to incorporate these tools into my pedagogical practice in a meaningful way" (ST15, Group 3, July, 2018). "I see how I can use this knowledge as a teacher. The course has helped me gain a better understanding of the apps and has introduced me to many websites and apps to help me with my future teaching" (ST18, Group 4, July, 2018).

Observations of online activities revealed that student teachers acquired a clear understanding of the types of learning outcomes the apps could support. For example, student teachers interpreted how they could use the apps in their specific teaching subject areas, as posted by one student teacher. "For science teaching, the apps can be used to increase engagement due to the use of interactive software, and virtual laboratories . . . and games can also be more fun and interactive" (Online discussion forum, November, 2017). It seems to post online enabled student teachers to develop more ideas about integrating the apps into teaching and learning by reading what their peers had shared. As disclosed through online observations, student teachers in Programme D were required to explore how they could use apps to develop their practice, and then share their thoughts on the discussion forum. The following excerpt from their course site describes the task. *"Take this opportunity to explore and learn about some new digital technologies, tools and apps. Below you will find support notes to help you get started with your use of digital tools. Share your knowledge with others in the forum"* (July, 2017).

Although the majority of tasks were initially inspired by teacher educators, some of the student teachers appeared to initiate their own learning activities based on their prior knowledge and experiences. For instance, three student teachers referred to apps they learned during their

coursework and linked that knowledge with new information to structure their learning, as shown in the following selected excerpts:

> Voice Thread seemed to be similar to Jing that we used to annotate pictures at the start of science class. I decided to annotate my pictures using Voice Thread so that I could compare the two apps. … I preferred Voice Thread as I found it easier to figure out how to draw on the picture while creating the sound recording. I also found it easier to share onto the forum than with Jing. I am confident enough with my understanding of Voice Thread that I would use it with a class. (Online discussion forum, November, 2017)

> There are several apps, such as SoundBrush and TraceTune that allow children to draw pictures, which the app then converts into music based on colour, shape etc. Some of these even allow students to take a photo of a physical picture and convert it into music i.e. PhonoPaper. (Online discussion forum, August, 2017)

> Various apps and software provide instruments for students to create and explore sound without the need of a physical instrument. Students can harmonically analyse their favourite songs with apps such as Chordify and then play them on apps that play the chords for them such as Chordbot, while another student improvises a melody in instrumental breaks. These apps give the opportunity for students to not only compose but perform as well. Some schools have embraced this new technology to the extent that they have introduced iPad bands to their school ensembles. (Online discussion forum, November, 2017)

Encouraging student teachers to use apps that were commonly used in schools to support learning appeared to have increased the likelihood of student teachers using these tools during their teaching practice. When asked how the use of mobile technologies in their coursework inspired any of their practices during teaching practice, a student teacher replied, "I found Padlet to be great because it is quite easy to use and caters for all ages of kids. You can include videos, photos and words" (ST17, Group 4, July, 2018). As explained earlier, Padlet was the most common tool teacher educators integrated into their practices. Furthermore, it seems student teachers could link what they learned during their coursework with what they practised in schools. For example, in Programme D, I observed on the LMS course site that student teachers had an assignment about digital storytelling. Student teachers were expected to independently create digital stories, and also reflect how they would use the same approach

with school students. The teacher educator provided an outline of how to create digital stories using Photostory, as shown in Appendix I. Similarly, a student teacher posting on the discussion forum indicated a reflection of how he would use Photostory in his class. "Photostory would be useful for a class to create a photo story about themselves. …my Year Nine class is going on camp and it would be fun to have a Photostory about their experiences" (Online discussion forum, August, 2017). In addition, I observed that student teachers used Kahoot while on teaching practice to engage students, as posted by two student teachers: "I used Kahoot and the kids were really excited. I created like fifteen questions, and I handed out laptops to everyone. We did a rotation of three groups, so I ran three Kahoot. The engagement was high" (Online discussion forum, November, 2017).

> My favourite part of Kahoot during [lecturer's name] class was that it was very interactive. I had not used it before but now I have used it in my own classroom . . . It really gets the children involved in learning in a way that would not be possible in traditional quizzes. (Online discussion forum, August, 2017)

Student teachers in Programme B expressed varying views regarding how they learned to use the apps to develop their practice. One student teacher recounted how challenging it was to self-direct and self-regulate her learning. "I think there could be a bit more guidance about how to appropriately use the apps in the classroom and moderate their use. Because right now it's pretty much just like, go and find what works for you" (ST10, Group 3, July, 2018). This suggests that while some of the student teachers were confident and comfortable about their ability to use the apps, others needed more support and scaffolding to understand the practice of using the apps to support learning. This can be due to their differences in knowledge and skill levels, as indicated in their maturity with mobile technologies (see Chapter 3). Survey data likewise confirmed this. Student teacher participants were asked if they used educational apps during their coursework to create digital content. The results showed that 60% of them either agreed or strongly agreed, while 24% of them stated a neutral response, and 16% of them either disagreed or strongly disagreed.

Student teacher participants were also asked to identify the functions of mobile technologies that they found useful when they were in schools or early childhood centres during their teaching practice. An analysis of survey data revealed that over 74% of student teacher participants reported that they found the following seven functions useful: access theinternet(93%), send/receive an email (91%), take a photo (91%), watch a video (80%), play

music (77%), use educational apps (76%), and record a video (74%). The findings indicated that the most basic functions of mobile technologies were found to be very useful. For example, only 44% of student teacher participants either agreed or strongly agreed that playing a game was useful. An interpretation of this outcome may suggest that student teachers were challenged to use some emerging mobile technologies to support teaching and learning.

Emulate Teaching Approaches of ILEs in Schools

Emulating teaching approaches of ILEs in schools was another subtheme of aligning coursework with school practices. It emerged from the data that teacher educators signalled the importance of student teachers being informed about ILE teaching approaches because schools in New Zealand are implementing BYOD initiatives within ILEs. Jim said, "what we are trying to achieve is to model the kind of things [teaching approaches] that students will see in a secondary classroom and we've focused on the development of flexible learning environment [ILEs], on assessment for learning. . . ." Similarly, Grace explained that "I am focusing on primary schools to inform our practices here. Because I've been for many years absolutely committed to this notion of having to develop their digital literacies and understandings at this level." Grace's approach likely supported student teachers to build knowledge about their future practices by experiencing mobile technologies. She mentioned that "what I get them to do when they are doing that assignment by designing resources using their devices, I tell them to think about the level they are going to be teaching on their next placement."

Illustrations illuminated how teacher educators prepared student teachers with ways they could approach future teaching approaches of ILEs. Findings showed that 57% of student teacher participants either agreed or strongly agreed that their ITE programmes had stimulated them to think more deeply about how mobile technologies could influence the teaching approaches they use in their school classrooms. A key teaching approach that teacher educators emulated was collaborative learning. As presented, collaboration was the most common strategy teacher educators used in their practices which was enhanced by using mobile technologies. While explaining how she emulated teaching approaches of ILEs in schools, Grace reported that she incorporated collaborative learning in her course mainly to prepare student teachers to team teach with other teachers in school classrooms. She said "we encourage them [student teachers] to work collaboratively unless they can't. That's because the teachers and schools work collaboratively, so they have to learn how to achieve this. I had 130 students and probably out of that 15 worked individually." This was echoed by Peter, who mentioned that "we make it

really clear to them why it's collaborative . . . when you're working in schools now, you are more likely to be planning collaboratively than individually." It seems student teachers' preparation experiences aligned with the realities in school classrooms.

It appeared that being able to engage in a collaborative collegial relationship supported student teachers to facilitate teaching and learning in ILEs. This point was affirmed by two student teachers who talked about their experiences during teaching practice. One student teacher said, "I used Google Docs all the time, it was our main form of collaborating with the two collaborative teachers. I just loved how quick it was, how clear, if something had been finished you could just mark it as done" (ST13, Group 3, July, 2018). Another one stated that:

> Before I did my practicum, I never ever thought collaboration group work would work. Because I've never seen it successful and [although] our lecturers always talk about it, I never believed it. But when I did it during my practicum it worked really, really well. The school had brand new buildings, they had glass doors to separate the classes but then we would do collaborative learning. So we'd open the doors and the students would be put into groups. The teachers worked together and said collaboration halves their work. (ST15, Group 3, July, 2018)

In summary, aligning coursework with school practices was the third theme that evolved from the analyses of data. Two subthemes that emerged out of the data were based on how teacher educators encouraged student teachers to use apps and emulated teaching approaches of ILEs in schools. The findings suggest that aligning coursework with school practices enabled student teachers to relate their experiences during coursework with their teaching practices. Teacher educators inspired student teachers to use apps that were commonly used in schools to support teaching and learning. Some of these apps included Kahoot, Google Docs, and Padlet. The findings demonstrated that supporting student teachers to use apps, and motivating them to gain knowledge and skills in their uses, contributed to student teachers' intentions to use apps in their own teaching practices. The findings also indicated that student teachers acquired a clear understanding of the types of learning outcomes the apps could support. Teacher educators also prepared student teachers to teach in ILEs by emulating a key teaching approach—collaborative learning.

Student teachers' comments and postings on the LMS revealed a range of apps that they said they were using, suggesting they were capable of integrating the apps into teaching and

learning. Similarly, student teachers identified seven functions of mobile technologies that they found useful during their teaching practice. Finally, the last theme that advanced from the analyses of data is presented in the following subsection.

Theme 4: Learning Technology by Design

Teacher educators repeatedly talked about how they coached student teachers to learn with mobile technologies to design learning resources appropriate to the subjects they taught. This also included completing technology-related assignment tasks. As discussed, this theme overlapped with authentic learning and collaboration. It is likely that exploring how to use mobile technologies to design resources allowed student teachers to develop innovative and creative skills to present their learning in new ways, and learn effective use of technology in their teaching. For example, in a focus group, a student teacher talked about how he designed resources and used them during his teaching practice, including sharing them with other teachers. He said, "when I was on teaching practice I made lots of resources in Google Docs and I would share them with other teachers" (ST4, Group 1, July, 2018). Furthermore, more than half of the student teacher participants (68%) either agreed or strongly agreed that they could apply mobile technologies that they learned about in different teaching activities. In this subsection, I will present how student teachers used mobile technologies to design learning resources.

Design Learning Resources

Illustrations from five teacher educators showed how they coached student teachers to learn with mobile technologies by designing learning resources that were appropriate for the context in which they were going to teach. Some of the learning resources student teachers designed included movie trailers, a podcast relevant to their senior biology curriculum, and lesson plans. Teacher educators thoughtfully planned student-centred learning activities, and inquiry-based activities to promote creativity. This allowed student teachers to not only experience multiple examples of mobile technologies' enhanced learning activities but were also encouraged to be creative and innovative. For example, Peter said, "students used the Tracker software which lends itself to a whole range of different experiments . . . They explored whichever area they needed to develop. So it might be projectile motion, or look at some linear kinematics, two dimensional, or three dimensional." It seems this activity challenged student

teachers to develop their own preferred ways of designing resources, as they learned to develop their practical knowledge about the effective use of technology in their classrooms.

The use of mobile technologies supported student teachers to collaboratively design learning resources, and present their learning in new ways. Results showed 67% of student teacher participants either agreed or strongly agreed that during their coursework, they used mobile devices with their peers to create digital artefacts such as a video or audio podcast. In addition, they believed that they had sufficient opportunities to work with a range of mobile technologies. For example, student teachers engaged in fan fiction practices where they collaboratively created movie trailers. Grace stated that "students designed a unit . . . the whole focus was on movies. It was an example they could use with school students, they made their own movie trailers with all the credits and the music . . . it was all multimedia." Similarly, this was emphasised by Kate who said "we used Padlet for students to work together, they had to make digital resources and present them to the rest of their group. That way it is a bit clearer for them." This particular use of Padlet seems to have provided a realistic learning environment to facilitate collaboration and creativity. For example, a student teacher talked about how they used Padlet during their coursework to design an interactive learning resource that they could use with school students:

> We designed a resource that incorporated a bicultural approach. We used Padlet to design activities in Māori and English to support kids with their learning of food items in Māori. The resource had pictures of the food they could bring to school for lunch, and the correct Māori and English words . . . The students would also have worksheets to write the correct Māori word in the blank spaces. (ST11, Group 3, July, 2018)

In addition, results indicated that student teachers had to complete technology-related assignment tasks. Grace facilitated workshops by allowing student teachers to use their smartphones to video record their prints, which they could use as teaching resources in their school classrooms:

> I get them to use the visual recording for visual processes. We have made our assignments technology-rich, and so by documenting the process as they're going, they can actually use their phones to make resources for their assignments. Like going through the printmaking processes, a lot of them [student teachers] will video it, and then they will turn that into a teaching resource, and submit it as their assignment, so having their phones out is really good.

Furthermore, Grace preferred to use smartphones since student teachers were not physically restricted on where to use them. She perceived characteristics such as portable, lightweight, smaller in size, and easy to use:

> I encourage students within the class sessions to use their phones because they're small and portable, and we have sharing areas. So sometimes they will document things with photos and share them with everybody else. But it's really just because it's small and you have to remember that in a workshop situation, tables are full of printmaking stuff and if everybody had their laptops out, so actually I tell them to put their laptops away when we begin, but leave their phones out, because they can go into their pockets, they can go on the table beside them, so the size [of the devices] actually matters in a workshop situation.

Sam guided student teachers to create a podcast relevant to their senior biology curriculum, aiming to develop a strategy of improving students' listening skills. Sam provided an opportunity for student teachers to practice resource preparation for their future teaching, which was made possible by the recording facilities in their mobile devices. Student teachers could likely share these resources and so begin their career in schools with a bundle of teaching resources with which they were familiar. This activity appeared to support student teachers to link information about mobile technologies, and their emerging knowledge and skills of developing solutions to problems. Sam said "and they have to create their own digital resources . . . it brings it together in a really practical way. In fact, marking their assignments is so much fun, because they do all sorts of wonderful things." Similarly, Jim explained how student teachers used their mobile devices to design videos of songs:

> I get students to use their phones so that they can actually record themselves playing the guitar, then upload it in the Dropbox on the LMS if they want some formative feedback about how they're going. They also make up their own songs and they video them. You know, I say to them use the apps to actually create these resources.

The findings suggest that learning technology by design supported student teachers to expand their conception of the role of mobile technologies in teaching. For example, survey data indicated that student teacher participants believed they could use mobile technologies to enhance their teaching activities. This appeared to suggest that student teachers were willing and ready to adopt mobile technologies into their own practices. For example, 72% of student

teacher participants reported that they believed (either agreed or strongly agreed) they could select mobile technologies that enhance students' learning of a lesson. However, out of the 110 participants, 11% either disagreed or strongly disagreed that they had enough opportunities to work with a range of mobile technologies. As revealed through online observations, two student teachers enrolled in Programme A discussed different resources they had designed for their classrooms which incorporated mobile technologies. "I made an interactive resource consisting of four Glogster pages with digital technology embedded in them. Through this resource, I gave students the chance to engage in digital interaction and creation, and reflect on their learning using a digital reflective tool" (Online discussion forum, August, 2017).

> I designed a digital resource with the curriculum in mind, about well-being and communication as the main aspects of the strands of the curriculum. It included opportunities for students to interact, create and reflect through the use of digital technology . . . It also allowed students to be supported in digital citizenship through safe websites that are not threatening and are child friendly. (Online discussion forum, August, 2017)

During a focus group, student teachers enrolled in Programme D deliberated how they were required to individually design three lesson plans in their subject areas. One of the requirements was to list multiple means of presenting information to their students and engaging them. All nine student teachers mentioned that they planned to use mobile technologies in their lessons to present information, and engage their students. It seems student teachers preferred to incorporate mobile technologies and encourage their students to use mobile devices to explore different learning activities. For example, one of them said, "I planned to have Google Docs with the questions written out for students to answer, and gave them options of using their phones or a Chromebook to research the topic" (ST6, Group 2, July, 2018). The way another one explained, suggested that he designed to engage the students to be independent in their learning: "I planned on giving them a research task and they had to use their mobile devices and decide for themselves what they will google to find out facts" (ST8, Group 2, July, 2018).

Esther demonstrated to student teachers how they could explore the possibilities of mobile technologies while designing learning resources for their future classrooms:

> This is what I tell the students. What I am trying to do is model and teach you what you need to do in your own teaching. And everything they make is designed to use with students, so in having to use digital technologies to create it, they are then thinking,

> how would this work out if students are going to use it? And they just do the most remarkable things.

It appears that some older student teachers were limited in their knowledge of mobile technologies, and they may have received support from their peers who were younger in age. For example, Eric realised that:

> For the most part, younger students are happy to use technology. I think it's a little bit more challenging for our older students to give it a go unless they have already been using it previously. But once our older students have sort of gotten rid of being anxious, then they are quite happy to use it as well.

It seems that learning technology by design over time enabled student teachers to develop technical skills and competencies. For instance, Eric referred to changes he had identified in student teachers that were linked with the use of mobile technologies by saying, "if you look at what they [student teachers] design at the beginning of the year and then compare them to what they do at the end of the year, you can see how much the majority of them have developed in that time." At the same time, 90% of the student teacher participants either agreed or strongly agreed that they had technical skills to use mobile technologies in teaching and learning. Similarly, Esther talked about one student teacher who had never created a MS PowerPoint, but improved her skills as a result of continuous practice and seeing what her peers were designing:

> When she [student teacher] came in she was very scared when we first told her they had to do an assignment in MS PowerPoint. She said, 'I've never done this before, I can't do it.' After some time, she did an amazing MS PowerPoint. She started another course and she inserted a video into the MS PowerPoint. She sent me an assignment which she did for another course to show me how she has grown in her use of technology. Watching the student increase her ability with technology has been stunning.

Learning technology by design was the last theme that emerged from the analyses of data. The findings showed that teacher educators coached student teachers to learn with mobile technologies by designing learning resources, including completing technology-related assignment tasks. Some of the learning resources included movie trailers, Slowmation artefacts, a podcast relevant to their senior biology curriculum, and lesson plans. Teacher

educators thoughtfully planned learning activities which were student-centred and inquiry-based. It is likely that exploring how to use mobile technologies to design learning resources enabled student teachers to be creative and innovative and develop technical skills for effective use of classroom technologies.

The findings presented in this chapter have revealed differences in mobile learning practices of the eight teacher educators. Contributing factors to the differences in their mobile learning practices were their maturity with mobile technologies, the subjects they taught and the ITE programme design. A summary of the findings showing similarities and differences in mobile learning practices of Esther, Peter and Rachael is presented in Table 4.4 and Table 4.5 illustrates those of the other five teacher educators.

Table 4.5

Summary of Mobile Learning Practices of the Five Teacher Educators in Alphabetical Order of Their Pseudonyms

Pseudonyms	Self-rating adoption of technology	Pedagogical strategies	Assessment of student teachers	Examples of mobile technologies/ apps
Eric	5	Collaboration Authentic learning Emulating practices in schools Modelling	Group work Group presentations Discussion forum postings Individual assignments	Laptop, Zoom VC, Facebook, Dropbox, smartphone, Kahoot, MS PowerPoint, LMS.
Grace	6	Collaboration Authentic learning Project-based learning Emulating practices in schools Modelling	Group work Group presentations Discussion forum postings Individual assignments	Laptop, iPad, Zoom VC, smartphone, MS PowerPoint, Google Docs, LMS.
Jim	4	Collaboration Authentic learning Aligning coursework with school practices Modelling	Group work Group presentations Discussion forum postings Individual assignments	GarageBand, smartphones, MS PowerPoint, Laptop, LMS.
Kate	4	Collaboration Flipped learning Aligning coursework with school practices Modelling Authentic learning	Group work Online quizzes Group presentations Padlet postings Discussion forum postings Individual assignments	Laptop, video clips, Quizlet, Zoom VC, Adobe Connect VC, Dropbox, Padlet, smartphone, MS PowerPoint, LMS, Google Docs.
Sam	6	Collaboration Emulating practices in schools Authentic learning Modelling	Group presentations Group work Discussion forum postings Individual assignments	Laptop, iPad, MS PowerPoint, Google Docs, LMS, podcast, smartphone, video clips.

Chapter Summary

In this chapter, I have presented a rich description of the findings of a case of teacher educators' practices with mobile technologies across four ITE programmes. I used multiple sources of data to provide rich evidence for making informed conclusions about preparing student teachers to integrate mobile technologies into their teaching and learning. I have included teacher educators' quoted responses to exemplify key points. I have also triangulated key findings from student teachers' postings in discussion forums, their survey data and quoted responses during focus groups.

An examination of how teacher educators facilitated the learning process identified pedagogical strategies that they used to prepare student teachers. These strategies emerged as four interrelated themes: (1) collaboration, (2) authentic learning, (3) aligning coursework with school practices, and (4) learning technology by design. The themes illustrate how teacher educators integrated technological affordances of mobile technologies with pedagogical approaches to facilitate student teachers' learning. Illustrations that supported these themes depicted the aspect of mobile learning at three levels: (a) the mobility of the devices; (b) the mobility of student teachers; and (c) the mobility of the learning experiences. Some of the teacher educators' responses to the interview questions applied to more than one theme, leading to the themes to overlap, and mutually reinforce each other. However, some of the themes were distinct when looking at individual teacher educators' practices as seen in the three illustrative narratives.

This chapter begins with a brief description of the participants. Participants self-assessed their maturity with mobile technologies. Four of the eight teacher educators (Esther, Grace, Peter and Sam) reported that they were at the top-level, Stage 6 (*Creative application to new contexts*), suggesting that they integrated mobile technologies into the curriculum, and in the classroom as instructional tools. Teacher educators who rated themselves highly were teaching more than one subject, and had more years of teaching experience in ITE. Similarly, student teachers self-assessed their maturity with mobile technologies. Findings revealed that a majority (30%) reported that they were at Stage 5 (*Adaptation to other contexts*), which highlighted that they believed they were using mobile technologies to facilitate teaching and learning. Their responses suggest a positive indication that the majority (75%) believed they were confident and knowledgeable about the use of mobile technologies as instructional tools.

In the second section, I presented illustrative narratives of three teacher educators—Esther, Peter, and Rachael (all pseudonyms). Each of the teacher educators' narratives illustrates their mobile learning practices in three ITE programmes. The narratives illuminate the teaching approaches that each teacher educator used to design their courses and facilitate student teachers' learning for their future classrooms.

In the third section, I examined the findings from all eight teacher educators in thematic style. The four themes that emerged from the analyses were collaboration, authentic learning, aligning coursework with school practices and learning technology by design. *Collaboration* was the prevalent pedagogical strategy. Collaboration was reinforced using collaborative tools to create social constructivist learning environments and to prepare student teachers on how to collaborate with other teachers in school classrooms. Student teachers used a range of mobile technologies as information and learning tools to work in groups, communicate, and meet virtually especially distance student teachers. According to student teachers, working in groups enabled them to develop interpersonal relationships and collaborative skills. This case study found that Padlet was the most common tool that enhanced collaboration. However, the results of this case study suggest that the potential of mobile technologies to facilitate collaboration with experts is likely to be under-realised.

The findings show that teacher educators used a problem-based approach to facilitate *authentic learning.* They designed real-world tasks that student teachers would likely do with school students in different subject areas. The teacher educators guided student teachers to use mobile technologies as learning tools both inside and outside their classroom settings and facilitated learning that was seamlessly integrated with authentic assessments. Teaching practice also emerged as an authentic context that supported student teachers to learn with mobile technologies. *Authentic learning* overlapped with *learning technology by design* because student teachers used mobile technologies in authentic contexts to create learning resources that they were likely to use in their future school classrooms.

Teacher educators described how they *aligned coursework with school practices* by encouraging student teachers to use apps that are commonly used in schools to support learning. They also modelled the functionality of several apps which enabled student teachers to interpret how they could use apps in specific educational contexts. Student teachers also developed an

understanding of the types of learning outcomes the apps could support. The findings indicated that supporting student teachers to use apps, and motivating them to gain knowledge and skills in their uses, contributed to student teachers' intentions to use apps in their own teaching practices. During the interview sessions and classroom observations, it was clear that the teacher educators decided to take advantage of mobile technologies and emulate teaching approaches of ILEs to prepare student teachers for their future classrooms. Through such opportunities, student teachers related practices in ITE with practices in schools. *Aligning coursework with school practices* emerged as a separate theme. However, it could also be a subtheme in the theme, *authentic learning,* since preparing student teachers for their future classrooms is an authentic experience.

The last theme that developed from the analyses was *learning technology by design*. Teacher educators guided student teachers to learn with mobile technologies to design learning resources. Some of the resources included movie trailers, Slowmation artefacts, a podcast relevant to their senior biology curriculum, and lesson plans. The findings suggest that learning technology by design supported student teachers to expand their conception of the role of mobile technologies in teaching, and present their learning in new ways. Results showed that learning with mobile technologies to design resources enabled student teachers to develop innovative and technical skills they needed for their future practice. However, this theme overlapped with the theme of *collaboration*, and *authentic learning*. In the following chapter, the discussion and implications of the findings are presented.

CHAPTER 5: DISCUSSION AND CONCLUSION

Introduction

This chapter discusses the findings of this case study. The findings illuminate rich evidence about the pedagogical strategies that teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning, as reported in Chapter 4. These were the intentions of the eight teacher educators in their use of mobile technologies.

It is important to note that in contrast with many other studies (e.g. Jahnke, & Liebscher, 2020; MacCallum et al., 2017; Naylor & Gibbs, 2018; Tolosa, 2017), teacher educators in this case study were neither deliberately redesigning their courses to include learning with mobile technologies nor were they required by the ITE department to use mobile technologies in their teaching (e.g. Farley et al., 2015; Kearney & Maher, 2013; Mac Mahon et al., 2016). Instead, at their discretion, they employed mobile technologies to prepare student teachers for a future context which uses mobile technologies.

The discussion in this chapter is organised into three sections. This chapter starts with an overview of the integration of mobile technologies across the four ITE programmes. Factors that contributed to the successful integration of mobile technologies and the pedagogical strategies that teacher educators used in their practices are examined. The second section outlines how the findings fit with the iPAC framework (Burden & Kearney, 2017), identifying the original contributions. The third section is a discussion about teaching approaches that supported student teachers to develop knowledge and skills that were transferable to their own professional practices. This chapter ends by detailing the conclusion, the limitations of the study, and recommendations for future research.

Integration of Mobile Technologies across Four ITE Programmes

The need to prepare student teachers for school classrooms that now require mobile technologies has stimulated teacher education providers to integrate technology into ITE programmes. Writing about developing student teachers' integration skills, Foulger et al. (2017, p. 419) stressed that "teacher educators must model appropriate technology integration strategies for teacher candidates in courses, so the candidates, in turn, can effectively teach

with technology in PK-12 classrooms." This implies that technology integration practices should support student teachers to develop pedagogical concepts that may further help them use these practices in future situations. In this study, teacher educators sought to develop student teachers' knowledge and skills for effective use of classroom technologies by using mobile technologies in all the four ITE programmes. This curricular design was neither simply nor exclusively focused on having student teachers learn about mobile technologies. Rather, the teacher educators' responses in this study showed that their overarching aim was to prepare student teachers to integrate mobile technologies into their future classrooms. Therefore, they believed that modelling integration allowed student teachers to experience the kinds of pedagogical arrangements afforded by technology, facilitating their development of the knowledge and skills needed to similarly integrate mobile technologies with school students. In addition, teacher educators expected that student teachers would be able to draw on their knowledge and skills about mobile technologies during their teaching practice. To further explore this integrative approach, this section discusses the factors that contributed to the successful integration of mobile technologies, and the pedagogical strategies that exhibited the integration of mobile technologies.

Factors that Contributed to the Successful Integration of Mobile Technologies across the Four ITE Programmes

In their 2013 study, Foulger et al. showed that ITE programmes that integrated mobile technologies shared some key features, including expecting student teachers to own mobile devices or providing them with one, having teacher educators skilled in the use of mobile technologies, and requiring student teachers to design mobile lesson plans. Given that the four ITE programmes examined in this thesis case study took an integrative approach to mobile technologies, the following subsection discusses three factors that enabled this approach: 1) weaving the use of mobile technologies in courses, 2) teacher educators' knowledge and skills about the use of mobile technologies, and 3) access to mobile devices.

Weaving the use of Mobile Technologies in Courses

Researchers (e.g. Foulger et al., 2017; Nelson et al., 2019) have emphasised that weaving of technology in all courses in ITE programmes as well as during teaching practice gives student teachers the opportunity to know how technology can support teaching and learning across different subjects. They further argue that this enables student teachers to be prepared to use technology to support learning. However, the majority of studies have mainly

explored how one or two teacher educators used technology within a specific focus on a single technology course (e.g. Admiraal et al., 2017; Burke & Foulger, 2014; Mac Mahon et al., 2016), where teacher educator(s) "of the technology classes are incorporating mobile technology as part of the spectrum of technologies they introduce" (Foulger et al., 2013, p. 25). In contrast, this study provides insight into this complex task of integration beyond a single course. This study illuminates how eight teacher educators used mobile technologies in teaching several courses with the expressed focus on enabling student teachers to learn with mobile technologies in ways that modelled appropriate and integrated use of technology. This focus further supported student teachers to understand the pedagogical reasons (e.g. collaboration) for using mobile technologies in their own practices during teaching practice.

The findings from this study revealed that weaving mobile technologies in the courses enabled the teacher educators to prepare student teachers to transition into their future teaching. Student teachers were offered many opportunities to practice and experiment with mobile technologies in several courses, which mirrored the experiences they were more likely to encounter in their future classrooms. For example, in science courses Peter innovatively integrated a range of mobile technologies to prepare student teachers for the learning environments which they were expected to teach. Peter guided student teachers to use simulations, Kahoot and Slowmation to design animations of scientific concepts. Although Buabeng et al. (2015) found that the majority of teachers in New Zealand indicated that their ITE did not incorporate the use of technology into physics teaching, or focus on the use of inquiry and problem-based approaches, Peter's practices suggest that the advancement of mobile technologies seems to have provided new platforms that supported the design and facilitation of the science courses.

Responses from teacher educators who facilitated other courses indicated that the motivation for weaving mobile technologies in their courses stemmed from striving to find better ways to improve their practices and address ITE needs. Rarere-Briggs and Turnock's (2014) research and this finding support the premise that teacher educators use mobile technologies to allow student teachers flexibility in their learning. For example, Esther and Kate provided a flexible learning approach for distance student teachers by facilitating and recording weekly Adobe Connect sessions and then uploading them onto the course site for student teachers to access at anytime, anywhere. On a more basic level, this finding may simply reflect how the use of mobile technologies enabled the ITE programme to deliver a blended mode of learning and

enhance the online learning environments for distance student teachers in preparation for their future practice.

Teacher Educators' Knowledge and Skills about the Use of Mobile Technologies

Another factor that enabled the four ITE programmes to integrate mobile technologies was teacher educators' knowledge and skills about the use of mobile technologies. Other researchers have noted that a lack of knowledge and skills impedes teacher educators from modelling and exploring the effectiveness of teaching with mobile technologies (Burden & Hopkins, 2016; Burden & Kearney, 2017). As a result, student teachers graduate from their programmes feeling ill-prepared to use technology effectively in their own classrooms (Foulger et al., 2017). As presented in Chapter 3, five of the eight teacher educators responded that they were at the top two levels of maturity with mobile technologies integration. This finding suggests that most of the teacher educators in this case study believed they were integrating mobile technologies into the curriculum and in the classroom as instructional tools, indicating that they were proficient in the use of mobile technologies (Phelan, 2017). It is because of this that their responses imply that they were familiar, knowledgeable and skilled in the use of mobile technologies. These teacher educators can be regarded as innovators because the use of mobile technologies in ITE is yet to be considered a part of common teaching and learning practice and some teacher educators "continue to struggle with effective mobile pedagogical approaches" (Burden & Kearney, 2017, p. 111). According to Foulger et al. (2013), innovators are the first to explore the uncharted territory and preparing student teachers to use mobile technologies with school students is an innovation in itself, if it goes beyond an individual's current practice.

Burke and Foulger (2014) noted that institutions that facilitate the integration of mobile technologies expect teacher educators to use and to teach the use of mobile technologies in their courses. My findings, however, showed that teacher educators used several mobile technologies in their teaching due to their willingness to embrace change and try out new practices to prepare student teachers to work in the New Zealand context but this was not imposed by the ITE department. This study revealed that being knowledgeable and skilled about the use of mobile technologies in teaching promoted successful integration of mobile technologies which enabled the four ITE programmes to be structures for transfer of learning into practice.

Access to Mobile Devices

The third factor that enabled the integration of mobile technologies across the four ITE programmes was the expectation that student teachers bring their own mobile devices. Burden and Hopkins (2016) found that student teachers' lack of access to technology was a significant barrier to technology adoption. Crompton (2017), however, recognised that teacher educators also need access to mobile devices for integration to be possible. Farley et al. (2015) noted that many institutions have opted for BYOD strategies since it is expensive to supply devices to students. In this study, teacher educators relied on the devices that student teachers had by encouraging BYOD approach to support learning. Allowing student teachers to use their devices facilitated their learning in a variety of settings that could not have been possible with desktop computers. As presented in Chapter 3, 94% of student teachers owned more than one mobile device, confirming the findings of Farley et al. (2015) that the majority of student teachers had access to mobile devices and actively used them to support class-related activities. Ownership of mobile devices enabled student teachers to personalise their learning, and this is presented in the following section. Besides being given laptops by the institution for their professional use, the findings indicated that teacher educators also used their own devices. In addition, to ensure that all student teachers and teacher educators had access to mobile technologies, the institution provided free wireless networks which also promoted the integration of mobile technologies into their practices.

The findings of this study showed that integrating mobile technologies into the courses, teacher educators' knowledge and skills about the use of mobile technologies and access to mobile devices as well as internet connectivity, are important contributors to successful integration of mobile technologies into ITE programmes.

Pedagogical Strategies that Teacher Educators Used

To prepare student teachers to integrate mobile technologies successfully into their future classrooms, teacher educators are expected to implement a range of innovative strategies. Such strategies support student teachers to develop knowledge of good pedagogical practices, technical skills as well as content knowledge (Tondeur et al., 2012). It emerged from this study that the stimulating pedagogic strategies that teacher educators used were related to the integration of mobile technologies and similar to those underpinning co-operative practice in future-focused schools anchored by the New Zealand school curriculum core skill of self-managed learning, as identified by Rawlins and Kehrwald (2014). As presented in Chapter 4,

the pedagogical use of mobile technologies embedded in the courses and during teaching practice, motivated student teachers to integrate mobile technologies into their own professional practice and context. This finding is not surprising since student teachers' experiences with integration of technology into teaching contribute to the successful integration of technology into their future classrooms (Admiraal et al., 2017; Farjon et al., 2019). Some of the strategies will be discussed later in this chapter. The discussion about the integration of mobile technologies across the four ITE programmes now concludes with highlights of how teacher educators used mobile technologies as tools to support reflective practices and offer continuous feedback.

Reflect on Teaching and learning

The findings showed that teacher educators encouraged student teachers to reflect on pedagogy, which also included their use of mobile technologies. In contrast, Tondeur et al. (2012) identified the strategies that teacher educators used to prepare student teachers to integrate technology and found that student teachers reflected on their attitudes relating to using technology for teaching and learning. However, in this thesis case study, student teachers used discussion forums and OneNote to reflect on their teaching and learning processes, enabling them to translate their learning experiences into their own classrooms. On their LMS course site, they had an outline of how to create digital stories using Photostory and were required to generate personal meaning by posting messages on the discussion forum about their digital stories. Such a process of posting on their discussion forums facilitated metacognitive development since student teachers had time to reflect on their views before sharing with their peers. This thesis case study reports that online forums provided a medium for encouraging the development of reflective practice and professional learning in relation to the use of mobile technologies. In doing so, it seems student teachers engaged in a higher level of reflection since they built a set of ideas through group reflection and co-construction. In this way, this case study provides evidence that mobile technologies can support reflective practice, making possible the development of professional and pedagogical knowledge that student teachers can transfer into their own practices.

In addition, OneNote was adopted in Programme D for student teachers to reflect on personal practise throughout their preparation. Through self-reflection about their teaching and learning experiences during their teaching practice and coursework, student teachers connected new knowledge into knowledge they already had. Researchers have found the use of OneNote for

student teachers' eportfolio evidence to be resourceful in preparing student teachers for technology-rich ILE school cultures and one for showcasing their digital literacy (Astall et al., 2016). Besides being encouraged to reflect on their learning in light of relevant teaching standards (N. Davis, 2010; Kearney & Maher, 2019), student teachers in this study were expected to use eportfolios as a medium of linking evidence of the activities they observed during teaching practice and performed with school students and to reflect critically and document their learning process. Using their mobile devices, student teachers captured authentic examples of classroom experiences which they added as supporting artefacts to their eportfolios and managed documentation of their eportfolios within and outside the classrooms. This enabled student teachers to examine their assumptions and beliefs about teaching and evaluate how their current practices aligned with their beliefs. Weiner and Lamb (2020) refer to this type of learning as double-loop learning which supports people to transfer their knowledge and skills in meaningful ways. The evidence collected suggests that student teachers reflected critically on the pedagogical uses of mobile technologies. Such opportunities have been found to enable student teachers to understand how technology can support teaching and learning, have more positive beliefs about mobile technologies integration, and be more proficient about its constraints and affordances in teaching and learning (Kearney & Maher, 2019).

Offer Continuous Feedback

Another pedagogical strategy that teacher educators used was to provide continuous feedback to student teachers while the student teachers were working on their assessment tasks. However, it was entwined in all the pedagogical strategies that teacher educators used. Studies have not examined how teacher educators use mobile technologies to offer feedback to student teachers. This study revealed that teacher educators integrated formative assessment into their courses as a source of continuous feedback throughout the teaching and learning process. Interview data showed that student teachers used Padlet and discussion forums to work on formative assessment activities and support peer-peer feedback. Student teachers were expected to provide a supportive critique to their peers' work, ask questions, offer alternative views, or prove their ideas in response to them. Reading what others had posted seemed to have enabled student teachers to engage in reflective inquiry, problem-solving, and gain ideas that they could use in their own practices. Teacher educators modelled a variety of assessment practices that used mobile technologies, and provided assessments grounded in social constructivist theories of learning. For example, assessment was conducted using eportfolios,

group tasks on collaborative sites, group presentations and individual mandatory assignments. This finding suggests that teacher educators employed multiple assessment methods which served to facilitate deeper learning. Furthermore, all teacher educators facilitated online formative assessment as a pedagogical strategy that could support student teachers to achieve their course goals and expected learning outcomes. Based on these findings, I did not find providing continuous feedback to be helpful as a separate theme to distinguish the strategies teacher educators used; that is in contrast to the findings of Tondeur et al. (2012).

In this thesis case study, teacher educators designed their programmes to include pedagogical strategies that support the integration of mobile technologies into their practices so that student teachers could experience learning with mobile technologies. This study sheds light on how teacher educators prioritised a range of effective pedagogical approaches that enhanced the development of 21st century skills as they prepared student teachers for real classrooms, and for digitised knowledge societies. These findings suggest a shift in teacher educators' teaching practices towards constructive, creative teaching, and student-centred pedagogies was effective with mobile learning.

According to Scott (2015), such pedagogies help learners to acquire a better understanding of 21st century skills and competencies and become lifelong learners. From a social constructivist perspective (Vygotsky, 1978), pedagogical strategies that influence in a positive manner the integration of mobile technologies in ways that transfer to school contexts include collaboration, creating authentic opportunities, constructive and active learning, and providing formative assessment in the form of visual feedback to support student teachers during teaching practice (Burden & Kearney, 2017; Maher, 2018). Although there are a range of pedagogical affordances of mobile technologies that have transformed teacher educators' pedagogy, the iPAC framework (Burden & Kearney, 2017) highlights three, as discussed in the next section.

Fit with the iPAC Framework and Extending its Use

Earlier research in teacher education (Kearney & Maher, 2013; Kearney & Maher, 2019; Naylor & Gibbs, 2018; Phelan, 2017; Schuck, 2016) has used the iPAC framework (Burden & Kearney, 2017) to inform how mobile technologies support and enhance teaching and learning techniques. The iPAC framework identifies three distinctive pedagogical features of mobile learning: personalisation, authenticity, and collaboration. About these features, this

study exemplifies specifically how the use of mobile technologies enhanced the learning opportunities for student teachers. Although the study was not designed specifically to test the iPAC framework, based on the findings, the iPAC framework was found to be useful and this research identifies specific examples, as they apply to teacher preparation and thereby extending its use in this field by the illustrations, as discussed later in this section.

As I explored teacher educators' practices with mobile technologies, I did so from the perspectives of both teacher educators and student teachers. Because this is unusual, this study contributes to a deeper understanding of how teacher educators facilitated learning with mobile technologies, and how student teachers translated that learning in their preparation to become digitally competent teachers. In this section, I discuss how the findings fit with the iPAC framework by illustrating how teacher educators and student teachers engaged with mobile pedagogies: (a) collaboration, (b) authenticity, and (c) personalisation. This section finishes with a discussion of the findings to show how this study extends the iPAC framework by the illustrations.

Collaborative Learning Experiences

A distinctive feature of mobile learning identified in the iPAC framework (Burden & Kearney, 2017) that was evident in this study was collaboration. Collaboration consists of two subconstructs: conversations and data sharing. Collaboration is a key issue that is discussed in studies around the context of 21st century skills where students are engaged and motivated to learn (Kearney et al., 2015). With regard to mobile learning, existing literature suggests that mobile devices help m-learners to engage in learning conversations and digital content sharing across time and space while collaborating with their peers (Kearney et al., 2012; Viberg & Gronlund, 2013). Collaborative learning aligns with a sociocultural learning theory (Vygotsky, 1978) which maintains that learning is a social process derived from communicating with knowledgeable others as well as peers and that through mediation learners can advance within their ZPD. Vygotsky (1978) argued that a learner can only achieve ZPD through social interactions and collaboration with peers since such interactions challenge the learner to think at a higher level and move to the next cognitive development stage. With the support of knowledgeable others, learners can accomplish complex tasks that would be beyond their initial ability. A. J. Davis (2017) identified collaborative learning as being among teaching methods that facilitate the transfer of learning to new situations.

Studies have shown that iPads can support and enhance collaborative learning experiences of student teachers. For example, Naylor and Gibbs (2018) found that iPads enabled student teachers and college students to engage in face-to-face learning conversations while designing eBooks which were later shared throughout the group. Similarly, Kearney and Maher (2013) found that student teachers "mainly used the iPad to elicit small group, face-to-face peer learning conversations at (not through) the device" (p. 83). Although a specific feature of mobile devices is to enhance learning across a range of learning spaces, these studies indicated that student teachers did not engage in virtual learning conversations. The findings in this thesis case study extend the use of mobile devices as a collaborative focus by showing that student teachers used a range of mobile technologies to engage in computer-mediated learning conversations and co-construct knowledge while working on several group tasks. Student teachers' modes of online collaborative exchanges involved multimodal interactions. Furthermore, as presented in Chapter 4, data from student teachers showed that working in small groups enabled them to develop interpersonal, problem-solving, and collaboration skills that they could use in their future practices. The findings confirm those of previous research that underscores mobile devices support and enhance collaborative learning (Burden & Kearney, 2017; Kearney et al., 2015; MacCallum et al., 2017).

There was evidence from this study that teacher educators designed collaborative activities that promoted sharing of digital content and information within a social context. Besides student teachers engaging in face-to-face learning conversations at their devices, they used collaborative walls created on discussion forums, Padlet walls, Facebook, Zoom VC, and Google Docs to communicate multimodally with their peers. The space for group work that was created by the teacher educators, may be seen as a ZPD where student teachers supported one another in their learning and benefited from one another's contributions, knowledge, and experiences to develop their identity as teachers. For example, student teachers posted their findings on Padlet walls for all of them to see how other groups had responded to the tasks, and provide critical ideas at any time in response to their peers' work. Sharing of their work on Padlet walls meant that student teachers could receive support from the entire class and learn valuable aspects that they could transfer to their future practice. In addition, working on group tasks enabled student teachers to co-construct knowledge through social negotiations and critique their peers' work as they negotiated meaning in the various subject content. This finding suggests that student teachers learned from multidimensional perspectives, and engaged productively in problem-solving and critical reflection. This finding resonates with

the views of Naylor and Gibbs (2018) who posited that when student teachers are allowed to collaborate with their peers, they interchange ideas, enabling them to construct and share knowledge, which they can later connect to their own classroom practices. As presented in Esther's narrative, using Padlets was seen to support some of the student teachers to develop some learning from their peers' thinking. Esther's response suggests that sharing of content and information on Padlet walls allowed student teachers to contribute to the learning of their peers and deepen their understanding, as a result of what Liu (2016) calls exchange and contrast of different perspectives that enhance critical thinking skills. This movement from the periphery toward the centre reflects the student teachers' growing competence and ZPD progression. Thus, using mobile technologies to collaborate through group work activities enhanced student teachers' professional learning and prepared them to work in ILEs in schools, as discussed later in this chapter. These types of professional engagement lead student teachers to develop a supportive learning community.

Student teachers should be encouraged to use Facebook groups to collaborate with their peers and support their learning. The use of Facebook promotes timely peer feedback, strengthens collaborative learning conversations, enriches social relationships among students, and boosts their learning performance (Deng & Tavares, 2013; Kearney & Maher, 2019; Liu, 2016). In this thesis case study, student teachers reported that Facebook was an integral part of their lives because it enhanced collaboration through rich connections with their peers. They participated actively in their private Facebook groups to construct knowledge and enhance teaching practices. It seems learning conversations generated a body of knowledge that helped with student teachers' professional development. Student teachers also appreciated immediate feedback from their peers due to the news feeds feature on Facebook which enabled them to receive instant new updates whenever they posted.

Unlike Liu's (2016) study, where teacher educators created Facebook as an online platform for student teachers to engage in web-based discussions, student teachers in this thesis case study created their own Facebook groups to meet their learning needs collaboratively. The findings indicated that creating their Facebook group enabled them to form a learning community where they felt a sense of belonging and could readily access their members. A student teacher mentioned that they posted on their Facebook page multiple times a day, asked questions and that everyone was engaged to support one another. These findings suggest that Facebook enabled student teachers to establish a supportive network of relationships that they could

depend on. Pegrum et al. (2013) noted that while student teachers prepare for their future teaching, a supportive peer network established on the Facebook platform "may carry forward into the future, seeding their professional learning networks and thus influencing their lifelong learning as teachers" (p. 471). This suggests that using Facebook gives student teachers a means of continuing their own cohort and to have that extended professionalism, which is another form of transfer of learning into a future professional community; this is discussed further in the following section.

Collaborative tools allowed student teachers to comment both synchronously and asynchronously on a document and to engage in their group discussions. Like Burden and Maher's (2014), my research also revealed that these tools created a platform which supported learning anywhere and at any time. This enabled flexibility in working on group tasks. For example, because student teachers could use Google Docs from their devices, it enabled them to complete their work from anywhere, but more so generate content from different sources to extend their knowledge. I found that teacher educators assigned tasks that involved moderate to extensive virtual interactions and a blend of both face-to-face and online communications "*at* and *through* the device" (Kearney et al., 2015, p. 52) to support student teachers' learning. The ability to connect and communicate appeared to enable student teachers to create multiple presences and to support peer-learning, which played a significant role in developing student teachers' pedagogical and professional knowledge as teachers. These opportunities align with social constructivist principles (Vygotsky, 1978).

Vygotsky's theory of social constructivism reinforces that meaningful learning occurs when learners are actively involved in co-construction of knowledge. As presented in Chapter 4, the findings showed that collaborating on group tasks enabled student teachers to master concepts and skills within a supportive social context. However, the potential of mobile technologies to facilitate collaboration with experts who could provide useful professional networking opportunities are still under-realised. It became clear that teacher educators used collaborative tools to create a social constructivist learning environment and to enhance the development of interpersonal relations and cooperation skills student teachers need for the future workforce. This is perceived to be fundamental because student teachers need opportunities to participate in social activities, collaborate, and connect with their peers, not least because collaborative and co-teaching teaching practices are key strategies teachers use in the current school systems

(Nelson & Johnson, 2017). Teacher educators also used mobile technologies to create authentic learning experiences to solve real-life problems, which is discussed in the following subsection.

Authentic Learning Experiences

The second aspect of mobile learning identified in the iPAC framework that was clear in this study was authenticity. Burden and Kearney (2017) identified three subconstructs of authenticity: task, tool, and setting. As reviewed in Chapter 2, these subconstructs of authenticity describe "learners' involvement in rich, contextualised tasks, realistically making use of tools [usually discipline-specific ways], and participation in relevant real-life practices and processes" (Burden & Kearney, 2017, p. 112), in real-world contexts. The tasks can either be actual tasks or simulated tasks that provide learners with opportunities to connect directly with the real-world. Whereas the previous subsection detailed how teacher educators used mobile technologies to enhance collaborative learning, the discussion in this subsection centres on how teacher educators used mobile technologies to support authentic learning experiences of student teachers.

Real-World Relevance

Teacher educators set the tasks for student teachers that were related to their studies and those carried out in schools, implying the activities had a high transfer to a real-world setting. Student teachers supported each other to socially construct meaning by engaging in high levels of interactions to create found poems, Slowmation, visual recordings of their prints, and podcasts, which allowed them to transfer further. According to student teachers' survey data, it became apparent that 66% of them perceived that they used mobile technologies to work on authentic tasks. For example, as noted in the presentation of the interview data, one student teacher explained how they used Padlet to design activities in Māori and English to support school students with their learning about food items in Māori. The importance of student teachers to design resources in a collaborative way that they can use with school students, allows them to present their own thoughts and "engage in dialogue on learning from their pupils' perspective," which facilitates the development of pedagogical knowledge (Mac Mahon et al., 2016, p. 27). Although Tondeur et al. (2017, p. 174) found that student teachers were not given enough opportunities to engage in authentic tasks, my study revealed that teacher educators were intentional in the design of authentic learning activities to model a situation that student teachers might do using mobile technologies in schools.

According to Kearney et al. (2012), the tasks that teacher educators designed can be perceived as authentic in both simulated and actual participatory ways to provide real-world relevance and personal meaning to student teachers. Evidence from Peter and Jim showed that they used mobile technologies to simulate the tasks of real-world contexts to support student teachers perceive the learning activities as real and connect it with real-life applications. For example, Peter designed tasks to engage student teachers in a simulated form of real-world. He used PhET simulations for student teachers to watch the demonstrations of hazardous experiments. Another example of a task that was authentic, in a simulated way, was provided by Jim who said he used GarageBand to compose music. This enabled student teachers to experiment with instrumental sounds much like they would with real instruments. These tasks provided contexts for student teachers to practise activities that they were likely to encounter outside of their formal learning settings. The findings demonstrated that the use of simulations for facilitating sense-making orientation towards problem-solving so that student teachers could reason about what was happening in the situation, verbalise personal ideas, and modify existing ideas, also functioned to support the transfer of learning since a student teacher used PhET simulations during teaching practice, as discussed later in this chapter. One way of interpreting this finding is that providing student teachers with activities that were relevant in real-world may be seen to have enhanced their ability to transfer knowledge in real-life situations.

In contrast, the other tasks that teacher educators designed supported the use of tools in a realistic way (Burden & Kearney, 2017). For example, Grace described a real-world activity that served to support the transfer of learning where student teachers designed movie trailers as a resource that they could use with school students. Grace created an authentic learning environment for student teachers that reflected what they were expected to do in their own classrooms. Working on this kind of a task supported student teachers in developing the view that movie trailers are relevant and useful in the real-world and it could be seen as an authentic way of using mobile technologies such as in their own teaching in schools. For example, Burden and Maher (2014) noted that movie trailers are primarily used by schoolteachers with their pupils to summarise a topic or illustrate their understanding of a particular idea. Besides using movie trailers, schoolteachers reported that the use of apps support students' explanations (Passey & Zozimo, 2016). The finding in my research supports the aspect of making use of tools in a realistic way where the devices are used in a similar way to real-world practitioners in the discipline (Kearney et al., 2015). This indicates that student teachers used mobile

technologies as an innovative teaching strategy for them to learn how to support school students who produce knowledge mainly via mobile devices (Foulger et al., 2013). This is contrary to the results of two studies (i.e. Cuhadar, 2018; Tondeur et al., 2017). Those studies found that although scaffolding authentic technology experiences motivates student teachers to use technology in their own classrooms, student teachers reported it was the least commonly used strategy in their ITE programmes. In this thesis case, evidence from Grace suggests that incorporating tasks that are directly relevant to student teachers' future practices are more likely to provide opportunities for a successful transfer of learning into practice.

The opportunity to create digital resources that student teachers might use in their future practice provided the opportunity to gain first-hand experience and draw upon experiences from their coursework into their classroom practices to support school students' learning. This finding reflects earlier research (Admiraal et al., 2017; Naylor & Gibbs, 2018; Tolosa, 2017) where student teachers developed knowledge that they could transfer into their future classrooms by experiencing real-life problems that were related to their studies and school students' learning. These researchers' views on authentic learning suggest that learners engage in meaningful learning through fostering higher-order learning and the development of metacognitive skills both individually and collectively within a real-life context. In looking at how student teachers negotiated meaning as they worked on their group tasks, the findings suggest how social interaction was used to make meaning, which is a constructivist understanding of the creation of knowledge (Vygotsky, 1978). The findings seem to suggest that student teachers developed cognitive, creative, and technical skills which are relevant for teachers in the 21st century. Furthermore, these findings suggest that allowing student teachers to work on these activities helped them to make relevant connections between concepts and strategies learned in their coursework, and uses in school classrooms, including their daily life situations, which have been reported in similar studies (e.g. Kearney & Maher, 2014; Naylor & Gibbs, 2018).

With regard to participatory task authenticity where learners are physically located in real-world contexts to carry out the activities (Burden & Kearney, 2017), this case study found that mobile technologies enabled student teachers to learn in a variety of authentic learning environments. In this case study, student teachers used their mobile devices in their classrooms, during field trips, at home, and extended during their teaching practice. This finding supports the argument that "the greatest added value of mobile learning vis-à-vis PC learning lies in the

aspects that extend classroom interaction to other locations" (Baran, 2014, p. 18). Due to specific mobile affordances like portability, the immediacy of communication, evidence and data capturing, ease of sharing content, and interaction with the interface (Baran, 2014; Burden & Maher, 2014; MacCallum et al., 2017; Pegrum et al., 2013), the findings in my research show that student teachers exploited features of authenticity in both formal and informal settings. For example, student teachers visited the art gallery, the playground, the museum, and the library. They used their devices to take photos, capture data, search the internet, and upload information they had collected in the field to a collaborative wall. Learning in these contexts seems to have captured student teachers' attention to reflect how knowledge will be useful in their own practices. Back in their classrooms, the teacher educators helped student teachers to use the data they had collected to explore the learning tasks in groups. This finding affirms the view that knowledge construction extends beyond an individual to include social interactions and the learning environment.

Because student teachers were using cloud-based collaborative sites, they used a range of devices from different locations to access and manipulate their field data, before sharing their completed tasks. These findings resonate with Kearney et al.'s (2012) argument that mobile technologies "enable learning to occur in a multiplicity of more informal (physical and virtual) settings situated in the context about which the learning is occurring" (p. 4). Like Naylor and Gibbs (2018), my study found that mobile technologies supported location-based learning, enabling student teachers to reflect on their learning in realistic professional contexts. When learning occurs in an authentic context that reflects how knowledge will be used in real-life situations, it has the potential to support student teachers to deeply comprehend knowledge in their memory and enhance their ability to transfer knowledge to real-life situations (Diamond, 2019). Student teachers also developed strategies for learning outside the classroom using mobile technologies which enabled them to personalise their learning.

The findings relating to the third construct of the iPAC framework, personalisation are presented in the next subsection.

Personalised Learning Experiences

A third construct of the iPAC framework is personalisation. Personalisation is about learners having control over time, pace, and place—either physical or virtual—of their learning as well as tailoring their learning activities based on their preferences and needs (Burden &

Kearney, 2017; Kearney & Maher, 2019). As outlined in the iPAC framework, personalisation consists of the subconstructs of agency and customisation. If mobile learning experiences are appropriately designed, high levels of personalisation would mean learners can enjoy a high degree of agency and be able to customise tools and activities, which leads to a strong sense of ownership.

Many studies (Kearney & Maher, 2013, 2019; Phelan, 2017; Viberg & Gronlund, 2013) have emphasised aspects of personalisation as a theme that featured predominantly. However, the findings in this study indicated that personalisation did not emerge as a separate theme but it was interwoven in all the four themes. Teacher educators designed tasks for student teachers to use their mobile devices to experience both formal and informal learning in multiple contexts. The aspect of personalisation, especially learner agency and learner autonomy, were evident since all teacher educators encouraged student teachers to use their own personally selected tools and resources while working on their group tasks, taking into consideration their differences in skills level. For example, student teachers selected apps that were tailored to their own unique learning needs. This finding indicates that teacher educators created opportunities for student teachers to develop their own understanding of knowledge because they had to choose the apps that worked well for them and could later translate into practice. Exploration of knowledge is an effective technique for constructivist learning.

Furthermore, student teachers used their own mobile devices enabling them to customise their learning in terms of preferences, contextual needs and interests. As such, they were not constrained to specific places and times, but they continued learning from different locations including while on teaching practice. According to Burden and Kearney (2017), personalisation advocates that learning should not be restricted by place and time. In this thesis case study, teacher educators used the LMS course site as a repository of course materials for student teachers to access the programme content and explore information, independently, using their devices at a time, place, and pace that suited them. This finding was confirmed by student teachers' data that revealed more than 69% of them either agreed or strongly agreed that the use of mobile technologies during their coursework enabled them to learn independently, control the context of their learning, and manage the time and pace at which they learned.

Extending the iPAC Framework by Illustrations

The illustrations presented in my research extend the findings from previous studies (e.g. Burden & Kearney, 2017; Kearney & Maher, 2019; Naylor & Gibbs, 2018; Phelan, 2017) that were underpinned by the iPAC framework in four ways, namely: (1) a range of content areas in four ITE programmes (my research focused on various courses), (2) practices with a greater range of mobile tools, (3) the participants (both teacher educators and student teachers), and (4) mobile learning pedagogies that have been presented in Chapter 4. It is important to note that the iPAC framework diagram is not extended. Whereas previous research explored mobile learning practices in ITE (Jahnke & Liebscher, 2020; Kearney & Maher, 2013; Schuck, 2016), there has been a lack of attention given to teacher educators' pedagogical strategies that support student teachers to adopt and adapt such pedagogies into their future classrooms. Cochrane's (2014) main criticisms of the majority of mobile learning research was a lack of explicit underlying pedagogical theory, the importance of pedagogical integration, and explicit student and lecturer support and scaffolding. In addition, Burden and Kearney (2017) found "a scarcity of m-learning studies in teacher education exploring pedagogical insights, and the views of teacher educators themselves are often absent" (p. 110).

In trying to probe deeper into these areas, my research has contributed to the field of teacher education. My research provides an insight into how eight teacher educators embedded several effective strategies for content and delivery methods into their practices in ways that supported student teachers to transfer into their practices. Obtaining the views of both teacher educators and student teachers allowed their experiences to be explored in some depth to provide nuanced understandings of teacher educators' practices with mobile technologies. As seen from student teachers' responses, they indicated how teacher educators' practices supported them to use mobile technologies in school classrooms. My research also obtained student teachers' views about how they applied their learning in schools during teaching practice, as recommended by Maher (2018).

The findings show that teacher educators deployed a range of mobile technologies into their practices to create new learning opportunities. Many of the previous studies about preparing student teachers to integrate mobile technologies into their future classrooms are generally limited to the impact of a single mobile device (e.g. Burns-Sardone, 2014; Mac Mahon et al., 2016; Naylor & Gibbs, 2018; Pegrum et al., 2013) and, in particular, within a specific discipline area, such as, mathematics (e.g. Kearney & Maher, 2013; Tolosa, 2017). Vaughan and

Lawrence (2013) indicated that student teachers found mobile phones useful in their teaching practice since they could easily take photos and videos, while they preferred using laptops during their coursework to take notes and search the internet for relevant information. They, therefore, identified the need to use "appropriate device for the appropriate task [since] one size does not fit all when it comes to the appropriate use of mobile devices" (p. 69). From the perspective of preparing student teachers for a future where mobile devices abound, my research reinforced this need by highlighting mobile devices, apps and software student teachers used in various courses and during teaching practice.

In addition, studies (e.g. Burden & Hopkins, 2016; Kearney & Maher, 2013; Mac Mahon et al., 2016; Naylor & Gibbs, 2018) have mainly focused on student teachers' use of mobile devices that are loaned and controlled by their institutions, which could limit opportunities for personalised, authentic, and collaborative learning. These are important features of mobile learning described in the literature (Burden & Hopkins, 2016). Schuck et al. (2017, p. 130) noted "the increasing levels of student ownership of devices mean that learners now take control of their own learning technologies." In my research, student teachers used their own mobile devices which promoted ownership of the devices and they could demonstrate autonomy about context, time, and pace of their learning. This may reflect the positive response from the majority of student teachers (69%), that they used mobile technologies to learn independently, and allowing them to engage at a time, place and pace that suited them.

My research also extends the collaboration construct by illustrating how student teachers used mobile technologies to engage in virtual learning conversations and co-construct knowledge. As cited by Kearney et al. (2012), mobile devices support multimodal communication. However, Kearney and Maher (2013) found that student teachers did not engage in networked, asynchronous, and synchronous interactions in tasks, which is contrary to specific characteristics of mobile learning environments. Furthermore, Burden and Kearney (2017) found that teacher educators scored low on the items relating to online learning conversation, indicating that they were not "fully exploiting the affordances of m-devices that support the elements of dialogue and conversation that might be described as virtual and distant" (p. 120). The findings reported in this thesis case study could be more reliable because there were multiple sources of data rather than Burden and Kearney (2017), who used an online survey to collect data from teacher educators. Their findings were based on how teacher educators self-rated their use of the three distinctive features of mobile learning while referring to a range of

task contexts they were given. In my research, the findings showed that mobile technologies supported student teachers to engage in asynchronous and synchronous communication to perform and coordinate task-related activities. Student teachers received real-time peer-to-peer feedback, shared digital content and enabled continuity of their learning conversations using collaborative tools especially for those who were absent. This indicates that student teachers could still participate in their group tasks despite their differences in time and place.

A further contribution of my research is that it was clear from the findings that the virtual, networked-based features of mobile learning were explored with distance student teachers. The use of mobile technologies enabled distance student teachers to create virtual learning communities and that they constructed meaning through virtual learning conversations, thus creating cognitive presence. This finding affirms West and Williams' (2017) argument that cognitive presence allows online learners to have access to one another although they might be dispersed through time and space.

In this section, I have discussed how mobile technologies positively affected and enhanced the learning opportunities of student teachers. The discussion entailed how the findings fit with the iPAC framework by illustrating how teacher educators and student teachers engaged with mobile pedagogies: (a) collaboration, (b) authenticity, and (c) personalisation. I have completed the discussion in this section by illuminating how my research extends the iPAC framework by illustrations, as summarised in Table 4.6. The following section is a discussion about how teacher educators facilitated transfer of learning.

Table 4.6
Featured Illustrations that Extend the iPAC Framework

Dimensions	Illustrations
Courses and ITE programmes	Various courses in four ITE programmes and also during teaching practice
Mobile tools	A range of mobile devices, apps and software; mobile devices owned by student teachers
Participants	Teacher educators and student teachers
Mobile learning pedagogies	Collaboration, authentic learning, aligning coursework with school practices, learning technology by design and reflecting on teaching and learning
Collaboration construct	Virtual learning conversations both asynchronous and synchronous

Far Transfer of Learning into Professional Practice

This section begins with a brief review of literature related to transfer of learning into professional practice within which the findings are then discussed.

Perspectives on the Transfer of Learning

Transfer of learning is the ability to apply effectively what is learned in one context to new contexts. Although this concept of transfer has a long tradition in cognitive theory (Diamond, 2019), Hager and Hodkinson (2009) have critiqued the use of the concept transfer because they believe it is an unsatisfactory way of understanding learning. They argued that transfer is a metaphor and it is important to recognise that it is the learner who moves and not learning itself since learning does not transcend its context. Hager and Hodkinson (2009) identified the movement of a learner from one context to another as a fundamental condition for transfer of learning.

A perspective on transfer of learning that is more commonly adopted in teacher education is that expressed by A. J. Davis (2017), who argued that the learner, the task, and the instructional contexts are the three crucial conditions needed to facilitate what she called "far transfer." Although other researchers have also spoken to this (see Chapter 2), A. J. Davis's (2017) argument has been particularly helpful for me in my research and I have opted to use this framework. According to A. J. Davis (2017), *far transfer* involves purposeful and conscious application of knowledge and skills to different kinds of contexts and performances, "one important skill being the ability of the student [student teacher] to make effective judgements in the new situation" (p. 130). Weiner and Lamb (2020) have likewise identified that when learners are engaged in opportunities that help them to transform and reconstruct what they already know, it facilitates new ways of thinking and doing that helps to shift their underlying assumptions about their current practices, hence increasing the motivation to transfer learning to novel contexts.

To understand the process by which far transfer may occur, A. J. Davis's (2017) argument for the concept of far transfer draws from two theoretical views, cognitive perspectives and sociocultural learning theory. Cognitive perspectives view learning as an active construction of knowledge structures in which learners contribute to the process of understanding new information via prior knowledge or schema. Motivation is seen as intrinsic as learners seek to

make sense between their existing knowledge and how it reflects what they observe and experience. Two cognitive processes that explain far transfer are information processing and metacognition (A. J. Davis, 2017). Information processing theory describes the internal mental structures and processes that occur during the construction of knowledge. The theory illuminates far transfer based on how prior knowledge is accessed and retrieved in the circumstances of its deployment. Metacognition is the process of thinking about one's own thinking or learning. Metacognition is highly connected to high-order processing through reflection which is a key practice in professional learning and development. As A. J. Davis (2017) pointed out, student teachers' ability to transfer learning is increased when they engage in metacognitive practices such as active learning, self-monitoring and reflection-in-action. Cognitive perspectives help us to understand that transfer of learning entails recognising similarities between new situations and previous situations through the formation of general principles and then using cognitive structures to fashion an understanding of the new context.

According to A. J. Davis (2017), a sociocultural view of far transfer recognises the social and cultural dimensions. The social practice in which learning takes place influences learners to collectively construct knowledge through the community of practice (Wenger, 1998), thus enabling the prospect for transfer to novel contexts. A. J. Davis (2017) draws on Wenger's (1998) ideas of communities of practice, which argued that, although learning involves internal mental structures and processes, it mainly reflects the development of practices and ability to negotiate meaning socially and contextually. These mental structures and processes occur by interacting with members of the community which leads to identity formation. Wenger (1998) identified three characteristics of a community of practice: (1) mutual engagement where members work together to negotiate meaning, (2) negotiation of a joint enterprise through a communal response that supports a common goal which creates relations of mutual accountability, and (3) development of a shared repertoire where members create resources that the community adapts for negotiating meaning as part of the practice.

West and Williams (2017) see communities of practice as a learning community. They identified the boundaries of a community to figure out the meaning of a learning community. These boundaries included: (1) members of a learning community having access to one another through a common meeting place despite their time and space, (2) building relationships which promote a sense of belonging and trust among members, (3) sharing the common vision and goals of the learning community and (4) members being involved in the functions of the

learning community. In this way, learning communities enable members to constantly learn new skills which build both personal and group understanding and develop insights into a future application. Learning communities offer opportunities for the scaffolding by the most knowledgeable other which increases the ability to transfer learning to new contexts. Thus, this conceptualisation of transfer of learning takes advantage of Vygotsky's development theory of ZPD which argues that with the support of more knowledgeable others, the cognitive development of a learner can be achieved independently (see Chapter 2). Barak (2017) explained a sociocultural perspective as "learning processes that involve peer interactions challenge the learner to think at a higher level and move forward to the next cognitive development stage" (p. 285). Similarly, A. J. Davis (2017) argued that when learners engage with complex tasks within social and cultural contexts, it fosters the development of metacognitive skills which aids in the successful transfer of learning.

Given the goal of teacher preparation is to provide student teachers with opportunities to develop knowledge and skills that they can use in their future classrooms, an understanding of how to achieve a successful transfer of professional learning into school practices is valuable to the field. Although there are many ways of examining transfer of learning, to deepen my theorising of the findings, I will draw on these two theoretical lenses. (1) The cognitive theory, based on information processing and metacognition as it relates to reflection. (2) The sociocultural learning theory focusing on the concept of the learning community. Therefore, the discussion in this section is about how teacher educators designed and deployed teaching and learning activities. It explores how teacher educators sought to develop student teachers' knowledge and skills to support far transfer in ways that enhanced the integration of mobile technologies into their future practices. The discussion is presented in three parts: (1) use of apps to support teaching and learning, (2) emulating teaching approaches of ILEs in schools, and (3) teaching practice. Each of these is discussed in the following subsections.

Using Apps to Support Teaching and learning

Teacher educators nurtured student teachers' preparation for future teaching and learning by creating learning environments that were relevant and reflected the real-world. As presented in Chapter 4, teacher educators were aware of the apps, websites, and web-based software that were being used in schools and prioritised those that were helpful in teacher preparation to mediate student teachers' far transfer of learning. This is illustrated with evidence from two teacher educators. During the interview, Eric said he had used Kahoot since

he saw it being used in schools, while Rachael used Google Docs because student teachers informed her that schoolteachers were using Google Docs. Allowing student teachers to see similarities between contexts helps them to adapt to new environments, but also, according to A. J. Davis (2017), it allows their personal schema to encompass new information and evolve which enables far transfer to occur—make an effective judgement in the new contexts.

Research shows that modelling strategies for teaching with technology and opportunities for practice and experimentation with technology, support student teachers to transfer technology integration knowledge and skills to the classrooms (Admiraal et al., 2017; Brenner & Brill, 2016). As Admiraal et al. (2017) explained, modelling entails engaging student teachers in their own experiential learning context, using technology to facilitate successful transfer to the real-world classroom. Thus, modelling is congruent with the sociocultural theory of learning to practice in a social context. Naylor and Gibbs (2018) noted that this kind of modelling enables student teachers to become confident using the technology, but also "aware of the potential benefits that mobile technology can add to learning in schools today" (p. 74). Other researchers have documented positive outcomes of modelling, including challenging student teachers' intention to integrate technology (Nelson et al., 2019), impacting positively on student teachers' perceptions toward the use of mobile technologies (Pegrum et al., 2013) and developing student teachers' pedagogical practices (Phelan, 2017).

The findings reported in this thesis confirm the existing literature on the importance of modelling. Teacher educators modelled the functionality of several apps (including mobile technologies) in their own teaching by presenting student teachers with concrete examples of the teaching associated with the apps within specific subject domains. This kind of experiential modelling and engagement could be considered as a form of ZPD scaffolding. The findings showed that encouraging student teachers to use apps for their own learning and educational purposes enabled them to develop an understanding of the types of learning outcomes that these apps could support. It also fostered positive attitudes and increased confidence towards student teachers' use of the apps in schools to support students' learning. For example, as presented in Chapter 4, a student teacher acknowledged that her new understanding of apps will help her to integrate the apps into her pedagogical practice in meaningful ways. These findings reaffirm research reporting that student teachers' confidence in the use of mobile devices, attitudes and beliefs affect the adoption and the use of mobile technologies in their own practices (Burden & Hopkin, 2016). Student teachers in this thesis case study also

acknowledged that using mobile technologies during their coursework enabled them to gain a better understanding of the apps, many websites, and web-based software that they could use in their own practices. According to A. J. Davis (2017), purposeful and conscious analysis of information enables far transfer to occur. Being able to develop these forms of knowledge could be considered that student teachers engaged in information processing that enabled them to understand the educational reasons for using mobile technologies in a way that facilitated far transfer to their own classrooms.

Maher (2018) noted that when student teachers are actively involved in the use of mobile devices and their apps, it allows them to recognise opportunities that they could provide for school students. From this perspective, Tondeur et al. (2017) argued that besides looking at examples of apps, student teachers can successfully integrate technology into their future classrooms, if they practice and interpret those examples in specific educational contexts. The findings reported in this thesis strengthen this argument. Teacher educators facilitated discussion of student teachers so that they collaboratively shared the meaning of how they would integrate the apps into their own lessons to create teaching resources and achieve their learning objectives. This fostered collaborative knowledge building as well as supported student teachers to deeply reflect upon their own practices. In this case, far transfer of learning was more likely to occur since, as A. J. Davis (2017, p. 134) argued, "learning interventions that involve active learning show positive transfer results." Providing student teachers opportunities to purposefully discuss the educational value of various apps enabled them to develop knowledge and skills about the use of apps to support learning. In addition, engaging in discussions also informed student teachers how they could create meaningful learning experiences for school students and across a range of potential learning contexts. Purposefully reflecting and discussing support the metacognitive thinking about their own practices which facilitates far transfer.

A. J. Davis (2017) has argued that when learners see the relevance of what they are learning, they will be motivated to learn how they could transfer. As reported in Chapter 4, student teachers mentioned that during their teaching practice, they used some of the apps and web-based software they observed teacher educators use. It seems student teachers found that the apps they used during their coursework were relevant to their practical teaching practices. This far transfer of learning fits with the information processing theory, which maintains that learners can retrieve and recognise relevant knowledge and skills and transform them into the

new context (A. J. Davis, 2017). Although far transfer occurred, it is likely that the challenges student teachers encounter when they join schools can negatively affect how they integrate mobile technologies into their practices. For example, Tondeur et al. (2017) found that new graduates were using the same apps that they used when they were in teaching practice. However, only a few of them used technology as a pedagogical tool due to facing difficulties in transitioning from ITE to actual professional practice. This could be attributed to the impact of barriers to the integration of mobile technologies in schools (Burden & Hopkins, 2016), which in turn hinders successful transfer.

In this thesis case study, student teachers' learning to use the apps was an on-going process that helped them to link their past and present experiences. Some student teachers were more active than others and built up on their prior knowledge. They explored more apps which they had not been exposed to during their coursework, hence continued to develop their conceptual understanding of using various apps to support their practices. This case study found that such an active mental engagement to make personal meaning through the use of apps motivated far transfer of learning to school classrooms. As A. J. Davis (2017) argued, creating personal meaning is a key aspect of metacognition which supports far transfer. For example, as presented in Chapter 4, a student teacher decided to use Voice Thread to annotate his photos so that he could compare it with Jing which they used in their science class. The student teacher also said that he was confident he could use Voice Thread in his own classroom. Making comparisons between one's concepts and experiences leads to a deeper understanding. In this context, a high level of conceptual growth occurs which enables far transfer. Such an active process of abstraction in learning, according to A. J. Davis (2017), facilitates positive transfer results because learners can abstract principles of knowledge and understanding to other novel contexts.

Maher (2018) stressed student teachers need to be informed about the apps that are being used in schools to support constructivist pedagogies that enable deeper learning. In contrast, Kearney et al. (2015) noted a vast array of apps that schoolteachers use, making it challenging for teacher educators to meet this goal. The findings presented in this thesis case study provide insights into how teacher educators in one context were working through this curriculum challenge. Teacher educators prioritised those apps being used in the local school contexts to bring coherence between ITE and the practices in schools. Through this intentional approach to aligning the selection of apps and strategies to the local contexts where the student teachers

were undertaking their teaching practice, the teacher educators were enabling the conditions in which far transfer was more likely to occur.

Emulating Teaching Approaches of ILEs in Schools: Seeking Congruence

Admiraal et al. (2017) argued that successful integration of technology into teaching and learning is enhanced when practices in ITE programmes and schools are congruent. Although many New Zealand schools are implementing ILEs, not all student teachers were guaranteed teaching practice opportunities in these settings. However, all student teachers needed to be prepared to work in such environments, given the national education policy context. The findings revealed that the teacher educators intentionally set up the learning communities and classes to support student teachers to learn to teach in ILEs, whether they had their teaching practice in ILEs or not. This helped student teachers to begin to understand some of the ways mobile technologies and related pedagogical practices could be used, both for working with school students but also in enabling collaborative teaching relationships.

From the interviews with teacher educators, it became apparent that they recognised that to achieve far transfer of learning, the creation of coherence between ITE programmes and practices in schools was fundamental in order that student teachers could understand the underlying practices of teaching in ILEs. For example, Peter worked with science teachers in schools to keep himself well-informed with issues relevant to the courses which made him more aware of the current practices in schools (B, 2015; obscured). The findings showed that teacher educators modelled teaching approaches of ILEs in schools which supported the transfer of knowledge from courses to school classrooms, since what student teachers learned became meaningful and relevant when they were in schools. Teacher educators incorporated collaborative learning in their courses to support the development of student teachers who could learn together as professionals and develop the collaborative skills to teach in ILEs. This finding resonates with Nelson and Johnson (2017) who argued that teacher educators should seek anchoring practices that contribute to alignment with ILEs so that they can support student teachers to learn how to teach in ILEs. Focus group interviews with student teachers who were in schools with ILEs suggested the relevance appeared to be very clear to them about their experiences with mobile technologies in schools, and consequently, feel ready to transition into their profession.

Nelson and Johnson (2017) found that student teachers were mainly challenged to teach in virtual spaces in ILEs because of the proprietary nature of the platforms that were being used in schools. This was not the case for this thesis case study. Student teachers were expected to use Google Docs to collaborate with their peers while working on their group tasks. They used their own devices and were familiar with Google Docs which was commonly used in schools to support collaboration in virtual spaces. Diamond (2019) argued that far transfer occurs when a situation prompts the use of learned knowledge. The use of Google Docs helps facilitate collaboration in virtual spaces and this is similar to the collaborative approaches that student teachers encounter while student teaching in ILEs. It is, therefore, likely that student teachers were able to make appropriate and relevant connections when they saw how collaboration was facilitated in the real-world and transfer their learning. This does appear, however, to be highly dependent on what student teachers conceptualise as similar across contexts (Diamond, 2019). Although teacher educators and student teachers alike did not have a variety of open learning spaces within their classrooms similar to ILEs (e.g. Fletcher et al., 2017), using collaborative tools allowed student teachers to create learning spaces where they personalised their learning (anywhere at any time) and collaborated with their peers. Through peer interactions they also had access to other contexts through their peers' sharing of teaching successes and challenges with the tools.

Besides student teachers being encouraged to engage in metacognition about what they had learned and observed teacher educators do, another condition that fostered the development of far transfer was forming a learning community. According to West and Williams (2017), learning communities support student teachers to develop personal and professional qualities they need in their professional careers. The findings reported in this thesis indicated that learning communities enabled student teachers to experience successful collaborative learning with their peers, which helped them value its potential and tried it with school students. For example, as reported in Chapter 4, a student teacher stated that she never believed collaboration would work until when she tried it during teaching practice and found that it worked well. These data indicate her preconceived idea about the relevance of collaboration to her future teaching appeared to make meaning after using the same approach in her teaching and what she saw in schools. In this case, far transfer occurred because she linked her current situation to prior exemplars she had observed during coursework. A. J. Davis (2017) argued that far transfer occurs when learners can abstract principles of knowledge and understanding from a particular learning experience to deal with another situation. This thesis case study found that

using collaborative tools enabled student teachers to develop knowledge and skills to collaborate in schools. Although it was not a requirement, this case study found that because of their professional obligations, teacher educators were responding by adapting their pedagogies to what was happening in the larger education culture of schools in New Zealand.

The teacher educators in this case study engaged student teachers in their own learning with mobile technologies to develop professional knowledge, skills, and dispositions, as well as pedagogical skills and practices to implement into their own classrooms. Such findings are significant because they reinforce A. J. Davis's (2017) argument that teacher educators facilitate relevant learning activities in a learning community to help student teachers "make meaningful patterns from learning experiences, to transfer learning to new situations and, especially, to understand how they transfer that learning" (p. 136). The mobility of the device(s) with the student teachers facilitated on-going learning in various settings, especially during their teaching practice and coursework where they collaborated with their peers and developed a supportive learning community. This finding suggests that teacher educators facilitated the conditions in which far transfer was more likely to occur by encouraging student teachers to learn from one another and adapt new ideas from their peers. For example, as presented in Chapter 4, Grace explained that they encouraged student teachers to learn how to work collaboratively because schoolteachers work collaboratively.

In summary, far transfer is a fundamental aspect of teacher education. Given that far transfer does not occur spontaneously (A. J. Davis, 2017), this case study found that it was beneficial for teacher educators to focus on encouraging student teachers to develop the ability to transfer their learning by practising transfer. To do this, teacher educators engaged student teachers with a variety of strategies. For example, teacher educators intentionally selected the apps and modelled teaching approaches of ILEs in schools to align with the local context and strengthen the potential for far transfer to school classrooms. This enabled student teachers to learn about school practices during their coursework. Findings indicated that when student teachers were on teaching practice, they also experienced some of the technological and pedagogical activities that they learned during their coursework. In addition, student teachers used some of the apps and approaches they learned in their own classroom instruction while on teaching practice because it seemed relevant. These findings reaffirm A. J. Davis's (2017) argument that engaging in information processing to identify similarities between novel situations and previous situations enables far transfer to occur. This case study found that far transfer is more

likely to occur when student teachers engage in congruent meaningful learning activities and interact with their peers to co-construct knowledge.

Teaching Practice

According to Nordin (2014), teaching practice helps student teachers to develop their professional identity, but also "transfer the knowledge and skills gained during university studies to the school classroom" (p. 8). This view is supported by Tondeur et al. (2017) who found that teaching practice was a key factor that positively influenced new graduates to use technology in their own teaching. Maslin and Smith (2017) asserted that during teaching practice, the opportunity to use technology coupled with guidance from mentor teachers supports student teachers to integrate technology into their practices. However, if student teachers have limited opportunities to observe and experience mobile pedagogies in their teaching practice, they are more likely to be challenged when they have to navigate the uncharted territory when they graduate (Burden & Kearney, 2017).

The findings reported in this thesis indicated that teaching practice helped student teachers to practice with mobile technologies and consolidate their digital teaching practices. This case study found that the extent to which student teachers used mobile technologies in their teaching practice was influenced by their coursework experiences, which is consistent with sociocultural view of learning (Kearney et al., 2012). For example, as presented in Chapter 4, a student teacher talked about how he used PhET simulations with school students after watching Peter perform scientific experiments using PhET simulations. This finding affirms the view of Howland et al. (2012) that meaningful real-world tasks or tasks that are "simulated in problem-based learning environment are not only better understood and remembered, but also are more consistently transferred to new situations" (p. 4).

Furthermore, student teachers also discussed how mentor teachers integrated mobile technologies into the classrooms which further informed their practices since they were able to draw from multiple and divergent practices. This finding from my study reflects Vygotsky's (1978) view that purposeful interactions with knowledgeable others provide opportunities for scaffolding which support learners to carry out complex tasks, and internalise new concepts and skills. The ability to articulate a conceptual understanding of experience is related to what Weiner and Lamb (2020) call double-loop learning, which implies shifting of one's mental

models and the assimilation of new experiences that enhances far transfer. Examining how student teachers applied technology in secondary schools during their teaching practice, Admiraal et al. (2017) found that both mentor teachers and teacher educators acting as role models motivated far transfer of learning to school classrooms. However, according to Maslin and Smith (2017), student teachers "encountered coursework educators and ATs [mentor teachers] who were unable or unwilling to lead, model, and support the growth of digital pedagogical confidence" (p. 54). Although student teachers in this thesis case study reported that they observed mentor teachers teaching with mobile technologies, the evidence collected does not allow one to determine if the observed practice influenced their teaching practices. It is likely that student teachers can have varying experiences during teaching practice that may at times have enabled and at times constrained their use of mobile technologies. This limitation will be discussed in the next section.

Conclusion and Recommendations

This section concludes this thesis by illuminating the key findings and clarifying the contributions this thesis makes to the field of teacher education and teacher educators' knowledge and use of mobile technologies, and preparation of student teachers for contemporary teaching practice. It also reviews the limitations of the study and ends by recommending areas for future research.

Conclusion

The purpose of this instrumental case study was to examine how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers. It sought to identify pedagogical strategies that teacher educators used to prepare student teachers to integrate mobile technologies into their teaching and learning. One unique feature has been to exemplify teacher educators' mobile learning practices from the perspectives of both teacher educators and their student teachers, unlike previous studies that did not simultaneously examine the views of both (e.g. Mac Mahon et al., 2016; Naylor & Gibbs, 2018; Tolosa, 2017). This enabled the findings to be more informative since different people perceive similar experiences in different ways. Combining the views increased the understanding of the theoretical and practical aspects about how teacher educators supported student teachers to develop knowledge and skills associated with the use of mobile technologies.

This case study has illustrated different ways mobile technologies were used in four ITE programmes to prepare student teachers for their future classrooms. Based on the findings, this study lends itself to a set of conclusions that help extend both theory and practice around the use of mobile technologies in the teacher education contexts. The ensuing subsections present the three key contributions of this case study, namely: (1) the strength of integrating mobile technologies into ITE, (2) teacher educators' mobile learning pedagogies, and (3) enabling far transfer.

The Strength of Integrating Mobile Technologies into ITE

This case study found that teacher educators sought to develop student teachers' knowledge and skills by modelling the integration of mobile technologies into the courses they facilitated, using methods that can be linked to school classrooms. The strategy involved was integrating mobile technologies into coursework and teaching practice in all the four ITE programmes. The overall finding showed that there was no focus on a specific skills-based course or a separate technology course for student teachers to learn basic to more advanced technologies. Rather, the integrated approach provided the opportunity for student teachers to know how a range of mobile technologies can support teaching and learning across different subjects. Furthermore, teacher educators created learning communities that allowed student teachers to innovatively use mobile technologies to solve complex problems, create and share digital evidence of their learning. This case study presented evidence that teacher educators integrated technological affordances of mobile technologies with pedagogical approaches to serve ITE. In addition, so that student teachers could understand the pedagogical reasons for using mobile technologies in their own practices and also integrate mobile technologies with school students during teaching practice.

The findings highlighted in this thesis illustrates the positive outcomes that accrue when teacher educators model innovative strategies for mobile technologies integration to support student teachers apply the acquired knowledge and skills into their future practices. The evidence from this study has shown that the majority of student teachers exhibited positive attitudes towards the use of mobile technologies in the classroom, and as a teaching and learning tool. As reported in this study, taking an integrative approach to learning with mobile technologies across multiple programmes can be an effective model of ITE. However, there are factors that need

to be considered for integration to be successful. The evidence obtained from multiple sources has provided an illustration that the strategies teacher educators used, access to mobile devices and the internet, teacher educators' knowledge and skills in the use of mobile technologies as well as their willingness to incorporate mobile technologies into their courses are essential. Addressing these factors will then illuminate how teacher education providers encourage teacher educators to embrace innovative pedagogy as they support student teachers to do the same in their practices. In addition to the earlier points, this also includes addressing teacher educators' beliefs and concerns about integrating mobile technologies into their practices. More importantly, Newhouse et al. (2015) identified support from the institution—policies that incorporate the meaningful integration of mobile technologies and a conscious effort from the leadership to advocate the integration of mobile technologies.

Teacher Educators' Mobile Learning Pedagogies

This case study provides insights into teacher educators' mobile learning pedagogies that they used to support student teachers to integrate mobile technologies into their teaching and learning. These strategies include collaborative learning, aligning coursework with school practices, authentic learning, learning technology by design, and reflecting on teaching and learning. The iPAC framework (Burden & Kearney, 2017) was found to be useful to exemplify how mobile technologies enhanced and supported the teaching and learning of student teachers. Two constructs of the iPAC framework—collaboration and authenticity were most prominent in teacher educators' practices. However, the third construct, personalisation, did not emerge as a separate strategy but was an entwined feature of collaboration and authenticity. This case study extends the findings from previous studies that were underpinned by this framework by the range of content areas, mobile tools, the participants as well as mobile learning pedagogies.

A key finding of this case study was that teacher educators used mobile technologies to enhance collaborative learning of student teachers. This teaching strategy reinforced scaffolding, enabling student teachers to support one another in their learning and advance their professional identity, which aligns with social constructivism principles (Vygotsky, 1978). Teacher educators supported student teachers' learning by assigning tasks that involved moderate to extensive virtual interactions and a blend of both face-to-face and online communications. This in turn enabled student teachers to use their devices to create collaborative spaces and engage in computer-mediated learning conversations and co-construct knowledge while working on several group tasks. Student teachers participated in both asynchronous and synchronous

communication to coordinate task-related activities, receive peer feedback, and share digital content. The findings highlighted here show that participating in a collaborative and supportive community of learners enabled student teachers to develop interpersonal, problem-solving, and collaboration skills that they could use in their future practices.

Using virtual collaborative spaces allowed student teachers to contribute to their learning community from different locations and at different times, meaning their learning was not bounded by time and place. The virtual space was a common meeting place for student teachers to hold both social and intellectual interactions. Furthermore, more than 70% of student teacher participants either agreed or strongly agreed that they used mobile technologies during their coursework to communicate, share learning resources as well as control the context, time, and pace of their learning. This study has illuminated how teacher educators supported student teachers to exploit the affordances of mobile technologies by engaging in virtual learning conversations to co-construct knowledge. It has identified specific examples of these, thus extending the findings from previous studies that have used the iPAC framework to inform research on mobile learning practices in ITE (e.g. Burden & Kearney, 2017; Kearney & Maher, 2013, 2019; Kearney et al., 2015; Naylor & Gibbs, 2018; Tolosa, 2017).

The majority of schools in New Zealand are implementing ILEs and it is expected that student teachers be supported to understand the underlying concepts and/or pedagogies in ILEs. The findings revealed that teacher educators emulated teaching approaches of ILEs by emphasising collaborative learning. Student teachers experienced coherence between their coursework and practices in schools. This is a key contribution of this case study because preparing student teachers to work in ILEs has not been previously researched in such depth in the New Zealand context. Furthermore, these findings shed light on policy orientation regarding future-focused teaching and learning in New Zealand schooling. The findings illuminate how teacher educators are responding to the policy and practice context, by preparing student teachers for the changing landscape in New Zealand schooling. This case study found that because of their professional obligations and their beliefs, teacher educators were responding by adapting their pedagogies to what is happening in the culture of schools in New Zealand. Given the positive impact of creating coherence between ITE programmes and practices in schools, it would be beneficial for more teacher educators to consider engaging student teachers with school practices.

Another pedagogical strategy that was evident in the findings is authentic learning. Interviews with teacher educators revealed that they were intentional in the design of authentic tasks to model a situation that student teachers might do using mobile technologies in schools. Teacher educators designed both actual tasks and simulated tasks that were related to student teachers' studies on campus and those carried out in schools. Working on these tasks enabled student teachers to use mobile technologies to design resources to support their own teaching and learning with school students. Creating their own resources is well suited to constructivist learning. Furthermore, this finding suggests that learning technology by design enabled student teachers to engage in metacognitive practices as they developed both their professional identity and teaching philosophy. More than 55% of student teachers perceived that they used mobile technologies during their coursework to work on authentic tasks which enabled them to think more deeply about how mobile technologies could influence the teaching approaches they use in their classrooms.

In addition, the findings revealed that teacher educators used mobile technologies to facilitate meaningful learning of student teachers in multiple authentic contexts. The portable devices enabled student teachers to collect data for later reflection as well as analyse and visualise the knowledge gained from the evidence. Student teachers used their mobile devices in their classrooms, during field trips, at home, and during teaching practice to support their learning. Learning in both physical and virtual spaces that were either formal and/or informal enabled student teachers to reflect how knowledge will be useful in their own practices. Teacher educators also created learning environments that were relevant and reflected the real-world by prioritising use in their practices the apps, websites, and web-based software that were being used in schools.

Lastly, evidence from this study has shown that teacher educators used discussion forums and OneNote to provide opportunities for reflection on practice. Reflection is an authentic and relevant practice needed for quality teaching. These types of reflections enabled student teachers to examine their assumptions and beliefs about teaching and evaluate how their current practices align with their beliefs. Reflecting on personal practice can support student teachers to develop professional and pedagogical knowledge for their future practices.

This case study highlights the specific ways teacher educators structured learning to enable collaborative and authentic learning of student teachers. The study extends current

conceptualisation of mobile learning practices in teacher education by identifying the pedagogical strategies that teacher educators can begin to think about as they support student teachers to effectively integrate mobile technologies into their practices. This is particularly relevant to the increase of mobile learning, including BYOD in schools at a time when increasing economic pressures are also forcing ITE to be more flexible and effective in using innovative classroom approaches that encompass cloud-based mobile learning. Baran et al. (2019) noted that research which examines teacher educators' use of strategies, and exemplary practices that connect ITE courses with teaching practice has rarely been undertaken.

Understanding pedagogical strategies used in the four ITE programmes may guide practice in the design, development, and implementation of mobile technologies experiences in teacher education programmes. As mentioned by Mills et al. (2010), exposing student teachers to a variety of teaching scenarios gives them the knowledge and understanding they need for their teaching careers. So these student teachers must have had opportunities to reflect explicitly on their experiences and pedagogical beliefs so that they were able to personally construct knowledge as they consider the future use of mobile technologies in their own teaching.

Enabling Far Transfer

Previous research studies have explored mobile learning practices in ITE (e.g. Kearney & Maher, 2019; Jahnke & Liebscher, 2020; Schuck, 2016). However, few studies have investigated teacher educators' pedagogical strategies that support student teachers to adopt and adapt such pedagogies into their future classrooms. In addition to highlighting how mobile technologies offered new learning opportunities for student teachers, the evidence from this study provides insights into how teacher educators supported student teachers to understand how they might be able to integrate mobile technologies into their practices during teaching practice. Therefore, this case study highlights the specific ways teacher educators enabled the conditions in which far transfer (A. J. Davis, 2017) was more likely to occur. The study provides nuanced understanding of what far transfer of learning entails from both a theoretical perspective and practical aspect. The findings in this study help to explain the far transfer strategies that teacher educators used to prepare student teachers for their school classrooms that now use mobile technologies to support learning.

The findings in this study revealed that teacher educators supported student teachers to develop knowledge and skills associated with the use of mobile technologies, but also pedagogical skills and practices to implement into their future classrooms. Teacher educators modelled strategies for teaching with mobile technologies by engaging student teachers in their own experiential learning. The findings revealed that enabling student teachers to use mobile technologies for their own learning as well as seeing teacher educators use them in the classroom supported student teachers to bring into their awareness how that understanding might be adapted to new contexts. Interviews with student teachers revealed that they used in their own school classrooms the resources they designed and the apps and web-based software that they were introduced to during their coursework, enabling them to connect theory to practice.

One area that this case study uniquely illuminates is student teachers' actual use of mobile technologies during their coursework, and how they translated what they learned into their own practices in schools during teaching practice. Student teachers purposefully discussed the educational value of various apps and how they could create meaningful learning experiences for school students and across a range of potential learning contexts. Such activities enabled student teachers to deeply reflect on their own practices, facilitating far transfer to occur. Preparing student teachers in ways that support their successful engagement in novel situations is essential since their preparation in ITE should improve their performance in schools. The findings suggested that student teachers perceived that what they were learning was relevant and applicable to practical teaching practices, which according to A. J. Davis (2017) allows for far transfer to take place.

Limitations of the Study

A case study by its nature tries to delimit the framework of the phenomena in order to conduct the research. Because I set those delimiting parameters, there are four limitations to this study that should be noted. First, this study cannot address the question about how integration might have happened in an institution where ITE programmes are much more separated. Teacher educators who participated in this study were all teaching on multiple ITE programmes. So the notion of integration illuminates how multiple teacher educators working across ITE programmes bring the view of integration into multiple ITE programmes at the same time. A study in a context where teacher educators are isolated in different ITE programmes might differ from the one reported in this thesis.

Second, these results are specific to four 1-year ITE programmes in one institution of higher learning in New Zealand where the study was conducted. This may account for the fact that conditions for integrating mobile technologies may vary in different teacher education providers based on their contextual conditions—institutions' culture, policies, access to infrastructure, and geographical location, especially remote areas that have challenges with accessing the internet. Therefore, the findings in this thesis cannot be generalised to mobile learning practices in different institutions within New Zealand or other countries. For example, although the use of mobile technologies to support learning is increasing worldwide, Passey and Zozimo (2016) noted a lack of congruence between ITE and schools.

Third, while the significance of teaching practice is acknowledged, the data for this study did not address in a robust manner how student teachers implemented the use of mobile technologies during their teaching practice. The study mainly relied on self-reported data from 20 student teachers who participated in focus groups.

Finally, data obtained from the interviews were limited to participants' opinions and self-interpretation of how they incorporated mobile technologies into their teaching and learning.

Recommendations for Future Research

This study leads to the following recommendations for future research in the light of findings from this study.

1. One of the strengths of this study is including the perspectives of teacher educators and the student teachers they are currently teaching. On this basis, further research about preparing student teachers for their future classrooms and how they transfer mobile pedagogical practices into their teaching is one deep question to be pursued using a larger sample of teacher educators and student teachers. In this respect, the discussion can be extended by conducting a study in various ITE departments to determine how the findings are similar or vary and to increase the opportunities for generalising the findings to other ITE departments.
2. In the future, a potential area of research could explore how teacher educators model best practice with mobile technologies across all their courses and how these may translate to a diverse range of schools worldwide. This might generate alternative insights into how student teachers learn with mobile technologies in a pedagogically appropriate manner which is not evident in this study. Furthermore, studies are

recommended to examine how mentor teachers in partner schools support student teachers to use mobile technologies during their teaching practice, including efforts to ensure congruence between the pedagogical practices in schools and ITE.

3. This study was conducted for a duration of one academic year. To broaden the understanding in this topic, there is a need for a longitudinal view of study to examine in a far more extensive way how student teachers use mobile technologies in their ITE programmes and then following them into their first year of practice in schools. In addition, a follow-up study with the same student teachers using other methods such as observation, to explore how they are integrating mobile technologies into their practices, and if there are any connections (or not) with their ITE learning experiences with mobile technologies would be a fruitful area of future research. Future research in this area could offer more insights into how their espoused positive theories about using mobile technologies for teaching and learning purposes align with their theories-in-use. Such research could benefit teacher educators in understanding the approaches that support student teachers to integrate mobile technologies into their future practices.

Concluding Remarks

The increasing BYOD initiatives in the majority of state schools in New Zealand as well as redesigning of school classrooms as ILEs motivated the researcher to study how teacher educators prepare student teachers for their future school classrooms. New Zealand was a practical site to conduct this research and to explore how teacher educators used mobile technologies to influence the teaching and learning experiences of student teachers. Literature indicates that the educational landscape in this 21st century is characterised by the use of ICT in teaching and learning. While the integration of ICT into teacher education has been studied extensively, few studies have explored mobile pedagogical approaches that teacher educators use. More importantly, how teacher educators integrate mobile technologies into their practices to support student teachers to use mobile technologies in their own teaching is an understudied area.

This research adds to the literature by providing conceptual and practical insights into the preparation of student teachers to use mobile technologies in their future school classrooms. The findings illustrated in this thesis case study provide evidence of successful far transfer including the use of mobile technologies during their coursework that many student teachers

transferred into their own pedagogy when on teaching practice. Teacher educators prepared student teachers to understand the underlying practices of teaching in ILEs. The case study also contributes to the theoretical implications by identifying the relevance of the iPAC framework (Burden & Kearney, 2017) to study mobile learning practices in teacher education. A key finding from this research revealed that collaboration and authenticity identified in the iPAC framework featured predominantly in teacher educators' practices. Although the profound changes underway in schools pose significant challenges to teacher preparation, the findings highlighted in this thesis case study illustrates how teacher educators can prepare student teachers to learn with mobile technologies in order to be able to use them flexibly in school classrooms.

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Appendices

Appendix A: Teacher Educators' Information Sheet and Consent Form

Email: carolyne.obonyo@pg.canterbury.ac.nz

Use of Mobile Technologies in Initial Teacher Education
Information Sheet for Teacher Educators

My name is Carolyne Obonyo. I am a PhD candidate at the College of Education, Health and Human Development, University of Canterbury. I am working on a research project about the use of mobile technologies in initial teacher education (ITE). This research will examine how you use mobile technologies and how it affects the teaching and learning experiences of student teachers. I will also investigate student teachers' perspectives about the use of mobile technologies in preparing them for classroom teaching/early childhood centres.

I would like to invite you to participate in my study. If you choose to participate, your participation may include any or all of the following whichever you choose: (i) Take part in 1:1 semi-structured open-ended interview for 30 minutes. I am interested in any stories you will have to share about how you have used mobile technologies to prepare student teachers for classroom teaching. Interviews will be recorded for accuracy. The interview can be held at a time and place convenient for you at the university. (ii) You are also invited to volunteer an opportunity for me to observe your teaching (both face-to-face and online) on one occasion at your convenience. Please note that student teachers will also be invited to participate in this study through an online survey.

Please note that participation in this study is voluntary. If you do participate, you have the right to withdraw from the study at any time without penalty. If you withdraw, I will do my best to remove any information relating to you, provided this is practically achievable.

I will take particular care to ensure the confidentiality of all information gathered for this research. All data collected will be securely stored in password protected computers and locked storage at the University of Canterbury for 10 years then destroyed. I will also take care to ensure anonymity of you, your students, and the university, in publications of the findings. Names and identifying details in any verbal, written or published reports will be changed into pseudonyms. No other parties beyond me will have access to the original data or transcripts. A copy of the interview transcript will be made available to you to check for accuracy; you may also retain a copy for your own use. Also, a copy of the report on the findings of the study will be made available to you.

If you would like more information or have any questions about this research, you can contact me, Carolyne Obonyo (carolyne.obonyo@pg.canterbury.ac.nz) or my supervisors, Distinguished Professor Niki Davis (niki.davis@canterbury.ac.nz) and Professor Letitia Fickel

(letitia.fickel@canterbury.ac.nz). They will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Educational Research Human Ethics Committee and you can address any complaints to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz Office Phone: (03) 364 2987 ext. 45588.

If you are willing to participate, please sign the consent form and return it to me. Please retain this information sheet.

Carolyne Obonyo
Contact details:
Carolyne Obonyo, PhD Candidate,
School of Educational Studies and Leadership,
University of Canterbury, Private Bag 4800,
Christchurch 8140, NEW ZEALAND
Email: carolyne.obonyo@pg.canterbury.ac.nz
Office: Wheki 352

Consent Form for Teacher Educators

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Email: carolyne.obonyo@pg.canterbury.ac.nz

Use of Mobile Technologies in Initial Teacher Education

□ I understand the aims and purposes of the research study undertaken by Carolyne Obonyo.
□ The study has been explained to me and I understand the information that was given to me on the Information sheet.
□ I understand that my involvement will include (i) a 1:1 semi-structured open-ended interview for 30 minutes, concerning how I have been facilitating mobile learning within the programmes and how the use of mobile technologies has affected the teaching and learning experiences of student teachers. And (ii) I may also volunteer for my teaching to be observed (both face-to-face and online) on one occasion at my convenience.
□ I understand that my participation is voluntary and that I may withdraw at any stage without penalty.
□ I understand that any information or opinions I provide will be kept confidential to the researcher and that any published or reported results will not identify me.
□ I understand that all information will be treated confidentially and will be used for research purposes only, that data will be kept in locked and secure facilities and/or in password protected electronic form and will be deleted after 10 years.

□ I understand that within these restrictions, the findings may be submitted for publication to national or international journals or presented at educational conferences.
□ I understand that I will receive a copy of the research results if I provide my email address below.
□ I understand that I can contact the researcher, Carolyne Obonyo for further information, and if I have any complaints, I can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee.

By signing below, I agree to participate in this research study.

Name: _____

Date: _____

Signature: _____ (if returning by email please type your name)

Email address: _____

Please return this completed consent form to me by hand or by email. If you have any questions about this research, please do not hesitate to contact me. Details are at the top of this letter.

Thank you for your contribution to this study.

Appendix B: Student Teachers' Information Sheet and Consent Forms

Email: carolyne.obonyo@pg.canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Use of Mobile Technologies in Initial Teacher Education
Information Sheet for Student Teachers

My name is Carolyne Obonyo. I am a PhD candidate at the College of Education, Health and Human Development, University of Canterbury. I am working on a research project about the use of mobile technologies in Initial Teacher Education (ITE). This research will explore how your lecturers use mobile technologies and how it affects your teaching and learning experiences. In addition, your perspectives about the use of mobile technologies in preparing you for classroom teaching.

I would like to invite you to participate in my study. If you choose to participate, your participation will include completing an online questionnaire. I am interested in your views about how the use of mobile technologies has impacted your ITE studies and in what ways it may have prepared you for classroom teaching. In appreciation of your time, you will receive a $10.00 Westfield gift voucher.

Please note that participation in this study is voluntary. If you do participate, you have the right to withdraw from the study at any time without penalty. If you withdraw, I will do my best to remove any information relating to you, provided this is practically achievable.

I will take particular care to ensure the confidentiality of all information gathered for this research. All data collected will be securely stored in password protected computers and locked storage at the University of Canterbury for 10 years then destroyed. I will also take care to ensure anonymity of you, your lecturers and the university in publications of the findings. Names and identifying details in any verbal, written or published reports will be changed into pseudonyms. No other parties beyond me will have access to the original data or transcripts. A copy of the report on the findings of the study will be made available to you.

If you would like more information or have any questions about this research, you can contact me, Carolyne Obonyo (carolyne.obonyo@pg.canterbury.ac.nz) or my supervisors, Distinguished Professor Niki Davis (niki.davis@canterbury.ac.nz) and Professor Letitia Fickel (letitia.fickel@canterbury.ac.nz). They will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Educational Research Human Ethics Committee and you can address any complaints to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz Office Phone: (03) 364 2987 ext. 45588.

If you are willing to participate, please sign the consent form and return it to me. Please retain this information sheet.

Carolyne Obonyo

Contact details:
Carolyne Obonyo, PhD Candidate
College of Education, Health and Human Development,
School of Educational Studies and Leadership,
University of Canterbury, Private Bag 4800,
Christchurch 8140, NEW ZEALAND
Email: carolyne.obonyo@pg.canterbury.ac.nz
Office: Wheki 352

Consent Form for Student Teachers

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Email: carolyne.obonyo@pg.canterbury.ac.nz

Use of Mobile Technologies in Initial Teacher Education
Consent Form for Student Teachers

□ I understand the aims and purposes of the research study undertaken by Carolyne Obonyo.
□ The study has been explained to me and I understand the information that was given to me on the information sheet.
□ I understand that my involvement include completing an online questionnaire concerning my views about how the use of mobile technologies has impacted my ITE studies, and in what ways it may have prepared me for classroom teaching.
□ I understand that my participation is voluntary and that I may withdraw at any stage without penalty, and will not influence my grades in any way.
□ I understand that any information or opinions I provide will be kept confidential to the researcher and that any published or reported results will not identify me.
□ I understand that all information will be treated confidentially and will be used for research purposes only, that data will be kept in locked and secure facilities and/or in password protected electronic form and will be deleted after 10 years.
□ I understand that within these restrictions, the findings may be submitted for publication to national or international journals or presented at educational conferences.
□ I understand that I will receive a copy of the research results if I provide my email address below.

□ I understand that I can contact the researcher, Carolyne Obonyo for further information, and if I have any complaints, I can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee.

By signing below, I agree to participate in this research study.

Name: _____

Date: _____

Signature: _____ (if returning by email please type your name)

Email address: _____

Please return this completed consent form to me by hand or by email. If you have any questions about this research, please do not hesitate to contact me. Details are at the top of this letter.

Thank you for your contribution to this study.

Consent Form for Focus Groups

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Email: carolyne.obonyo@pg.canterbury.ac.nz

Use of Mobile Technologies in Initial Teacher Education
Consent Form for Student Teachers'-Focus Groups

□ I understand the aims and purposes of the research study undertaken by Carolyne Obonyo.
□ The study has been explained to me and I understand the information that was given to me on the information sheet.
□ I understand that my involvement will include: (i) Participating in a focus group interview of 4-5 students for 40 minutes, to talk about how I have been using mobile technologies in my ITE studies, and how I have been prepared to teach in innovative learning environments (ILEs) in schools. And (ii) I may also volunteer to talk more about my learning experiences using a collection of my lesson plans, e-portfolios, and reflective journals.
□ I understand that my participation is voluntary and that I may withdraw at any stage without penalty, and will not influence my grades in any way.
□ I understand that any information or opinions I provide will be kept confidential to the researcher and that any published or reported results will not identify me.

□ I understand that all information will be treated confidentially and will be used for research purposes only, that data will be kept in locked and secure facilities and/or in password protected electronic form and will be deleted after 10 years.
□ I understand that within these restrictions, the findings may be submitted for publication to national or international journals or presented at educational conferences.
□ I understand that I will receive a copy of the research results if I provide my email address below.
□ I understand that I can contact the researcher, Carolyne Obonyo for further information, and if I have any complaints, I can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee.

By signing below, I agree to participate in this research study.

Name: _____

Date: _____

Signature: _____ (if returning by email please type your name)

Email address: _____

Please return this completed consent form to me by hand or by email. If you have any questions about this research, please do not hesitate to contact me. Details are at the top of this letter.

Appendix C: Online Questionnaire

Student Teachers' Survey about Mobile Technologies in Initial Teacher Education

Important Note: This survey is being conducted by Carolyne Obonyo, PhD candidate at the University of Canterbury. The aim of this survey is to gather data about the use of mobile technologies in initial teacher education (ITE). Mobile technologies in this survey refer to mobile devices such as smartphones, iPads, laptops, and tablets, including mobile applications and web-based platforms that can be used to support teaching and learning. If you choose to participate, your participation will include completing an online questionnaire which will take approximately 20 minutes of your time. In appreciation of your time, you will receive a gift voucher. Participation is voluntary and your responses will be kept confidential.

Submitting this survey means that you have read and understood the information sheet that was emailed to you and that you understand completing the survey signals your agreement for your answers to be used for the purposes of this study. The Educational Research Human Ethics Committee has reviewed and approved this research study.

Thank you for your time and feedback.

Section A: Background Information

1. What is your gender?
   - Male [ ]
   - Female [ ]
   - Other [ ]

2. Please indicate your age
   - 18-22 [ ]
   - 23-27 [ ]
   - 28-32+ [ ]

3. What type of mobile devices do you own? (Please tick all that apply):
   - Smart phone [ ]
   - Laptop [ ]
   - iPad [ ]
   - Tablet [ ]
   - PDA [ ]
   - Other (please specify) _____

4. Which programme are you enrolled in?
   - Programme A [ ]
   - Programme B [ ]
   - Programme C [ ]
   - Programme D [ ]

5. Stages of Adoption of Technology

Please read the descriptions of each of the six stages related to adoption of technology. Select only one stage, the one that best describes where you are in the adoption of mobile technologies for teaching and learning

Stage 1: Awareness

I am aware that mobile technologies exists but have not used it - perhaps I'm even avoiding it. I am anxious about the prospect of using mobile technologies for teaching and learning.

Stage 2: Learning the process

I am currently trying to learn the basics. I am sometimes frustrated using mobile technologies. I lack confidence when using mobile technologies for teaching and learning.

Stage 3: Understanding and application of the process

I am beginning to understand the process of using mobile technologies and can think of specific tasks in which it might be useful for teaching and learning.

Stage 4: Familiarity and confidence

I am gaining a sense of confidence in using the mobile technologies for specific tasks. I am starting to feel comfortable using mobile technologies for teaching and learning.

Stage 5: Adaptation to other contexts

I think about the mobile technologies as a tool(s) to help me and am no longer concerned about it as technology. I can use it in many applications and as an instructional aid for teaching and learning.

Stage 6: Creative application to new contexts

I can apply what I know about mobile technologies in the classroom. I am able to use it as an instructional tool and integrate it into the curriculum.

Section B

6. Use of mobile technologies in your ITE programme

Please read each of the following statements, and respond by selecting the option that most closely matches your level of agreement or disagreement as to how you use mobile technologies in your ITE programme.

SD=Strongly Disagree D=Disagree N=Neutral A=Agree SA=Strongly Agree

1.	Controlling the time, and pace at which I learn	SD	D	N	A	SA
2.	Having an opportunity to learn independent	SD	D	N	A	SA
3.	Controlling the context of my learning	SD	D	N	A	SA
4.	Working on real-life tasks which I am likely to encounter beyond school	SD	D	N	A	SA
5.	Learning in a place outside the classroom that is a real-world context	SD	D	N	A	SA
6.	Using education apps to create digital content	SD	D	N	A	SA
7.	Using mobile device with a other(s) to create digital artefacts, e.g. video or audio podcast	SD	D	N	A	SA
8.	Communicating online with my lecturers, my peers					

or with other people outside the class, e.g. via email, discussion forums, or social media	SD	D	N	A	SA
9. Sharing learning resources and digital content, e.g. videos, photos, and documents	SD	D	N	A	SA
10. Sharing digital evidence of my learning, e.g. publishing my work on online platforms	SD	D	N	A	SA

7. Useful functions of mobile technologies in school(s)/ECE centres

Please read each of the following statements, and respond by selecting the option that most closely matches your level of agreement or disagreement that each of the functions of mobile technologies listed below are useful during your teaching practice.

SD=Strongly Disagree D=Disagree N=Neutral A=Agree SA=Strongly Agree

11. Send/receive text message	SD	D	N	A	SA
12. Send/receive email	SD	D	N	A	SA
13. Take a photo	SD	D	N	A	SA
14. Access the internet	SD	D	N	A	SA
15. Record a video	SD	D	N	A	SA
16. Watch a video	SD	D	N	A	SA
17. Play music	SD	D	N	A	SA
18. Play a game	SD	D	N	A	SA
19. Use educational apps	SD	D	N	A	SA
20. Use social networking site	SD	D	N	A	SA

8. Pedagogical beliefs about the use of mobile technologies in teaching and learning

Please read each of the following statements, and respond by selecting the option that most closely matches your level of agreement or disagreement that each of the following is your pedagogical belief about the use of mobile technologies in teaching and learning

SD=Strongly Disagree D=Disagree N=Neutral A=Agree SA=Strongly Agree

21. I can learn to use new mobile technologies easily	SD	D	N	A	SA
22. I know about a lot of different mobile technologies	SD	D	N	A	SA
23. I have the technical skills I need to use mobile technolo	SD	D	N	A	SA
24. I am thinking critically about how to use mobile technologies in my classroom/ECE centre	SD	D	N	A	SA
25. I have had sufficient opportunities to work with a range of mobile technologies	SD	D	N	A	SA
26. I can choose mobile technologies that enhance the teaching approaches for a lesson/activity	SD	D	N	A	SA

27. I can choose mobile technologies that enhance students'

learning of a lesson/activity	SD	D	N	A	SA
28. I can apply mobile technologies that I am learning about to different teaching activities	SD	D	N	A	SA
29. Mobile technologies have been used to support my learning and teaching experiences in the programme	SD	D	N	A	SA
30. My ITE programme has stimulated me to think more deeply about how mobile technologies could influence the teaching approaches I use in my classroom	SD	D	N	A	SA

9. Any comments that you may wish to include are welcome

END OF SURVEY!

Appendix D: Semi-structured Interview Protocol for Teacher Educators

A. Demographic questions

1. Please tell me about your current role and responsibilities in ITE?
2. How many years have you been teaching?
3. What type of mobile devices do you own?
4. How would you rate your maturity with mobile technologies from one to six based on this scale? (Appendix F)

B. Use of mobile technologies

1. Please explain any ways in which your mobile learning activities allow students to:
    a. Control the context of their learning (e.g. where the activities occur?)
    b. Learn independently?
    c. Control their learning pace, and time?
2. Please explain any ways in which your mobile learning activities allow students to:
    a. Use educational apps to create digital content?
    b. Use their mobile technologies to access real-life tasks that they are likely to encounter outside schools?
    c. Generate their own learning environment, e.g. authentic learning in a place outside the classroom?
3. Please explain any ways in which your mobile learning activities allow students:
    a. To work together with their peers on shared learning projects, and share learning resources?
    b. To share digital evidence of their learning progress?
    c. To communicate online with their peers or with other people outside the class? (e.g. via email, skype, or social media)
4. Can you please describe a lesson in which you used mobile technologies to support your teaching practice? (Why?) Do you think this supported students in their own learning? Do you have anything I can see or read later about that? (maybe something on LMS course site and/or a resource you have used?)
5. What changes can you identify in your students that may be linked with the use of mobile technologies in ITE?
6. Do you have any final thoughts or recommendations about the use of mobile technologies?

Appendix E: Observation Protocol

1. Opportunity to Collaborate

a. Learners work together to create digital content using their mobile devices
b. Learners sharing digital data and information
c. Collaborative construction of knowledge
d. Peer-to-peer, face-to-face and or online discussions

2. Opportunity to Personalise Learning

a. Activities enable learners to make their own choice (anytime, anywhere)
b. Learners had an opportunity to customise their devices according to their own preferences
c. Learners had an opportunity to control the context of their learning
d. Provide personalised feedback

3. Authenticity

a. Use educational apps to create meaningful products and explore the possibilities of mobile technologies as cognitive tools
b. Complex tasks being investigated by learners using their mobile devices
c. Opportunities for learners to learn in a realistic learning space both formal and informal settings
d. Learning tasks of real-world relevance that engage learners in their learning

Appendix F: Stages of Adoption of Technology Scale (Knezek et al., 2000)

Stages of adoption of technology

Please read the descriptions of each of the six stages related to adoption of technology. Select only one stage, the one that best describes your maturity with mobile technologies for teaching and learning

Stage 1: Awareness

I am aware that mobile technologies exists but have not used it - perhaps I'm even avoiding it. I am anxious about the prospect of using mobile technologies for teaching and learning.

Stage 2: Learning the process

I am currently trying to learn the basics. I am sometimes frustrated using mobile technologies. I lack confidence when using mobile technologies for teaching and learning

Stage 3: Understanding and application of the process

I am beginning to understand the process of using mobile technologies and can think of specific tasks in which it might be useful for teaching and learning

Stage 4: Familiarity and confidence

I am gaining a sense of confidence in using the mobile technologies for specific tasks. I am starting to feel comfortable using mobile technologies for teaching and learning

Stage 5: Adaptation to other contexts

I think about the mobile technologies as a tool(s) to help me and am no longer concerned about it as technology. I can use it in many applications and as an instructional aid for teaching and learning

Stage 6: Creative application to new contexts

I can apply what I know about mobile technologies in the classroom. I am able to use it as an instructional tool and integrate it into the curriculum

Appendix G: Focus Group Interview Protocol

Focus Group Interview for Student Teachers

Introduction: The purpose of this focus group interview is to gather your views about how your programme of study has prepared you to integrate mobile technologies in your teaching and learning. Participation in this interview is voluntary and your responses will be kept confidential. The Educational Research Human Ethics Committee has reviewed and approved this research study.

1. **General perceptions and experiences about the use of mobile technologies in initial teacher education (ITE) programme.**

a. What learning for experiences with the use of mobile technologies did you find most meaningful supporting you to integrate mobile technologies in your teaching practice?
b. How has it influenced any of your practices during your teaching practice in schools?

2. **General perceptions and experiences about the use of mobile technologies in schools.**

a. Describe how you integrated mobile technologies during your teaching practice?
b. How have practices in ILEs influenced your use of mobile technologies?
c. Have you had to modify your teaching to accommodate these practices? (How?)
d. What have you seen happening in ILEs that informs or challenges your practice in relation to your preparation?
e. Does anyone have anything else they would like to say?

Appendix H: Ethical Approval Letter for the Research

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson
Telephone: +64 03 364 2987, Extn 45588
Email: human-ethics@canterbury.ac.nz

Ref: 2016/53/ERHEC

5 October 2016

Carolyne Nekesa Obonyo
EDSL
UNIVERSITY OF CANTERBURY

Dear Carolyne

Thank you for providing the revised documents in support of your application to the Educational Research Human Ethics Committee. I am very pleased to inform you that your research proposal "Use of Mobile Technologies in Initial Teacher Education" has been granted ethical approval.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 4th October 2016.

Should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please let me know.

We wish you well for your research.

Yours sincerely

pp R. Robinson

Patrick Shepherd
Chair
Educational Research Human Ethics Committee

Please note that ethical approval relates only to the ethical elements of the relationship between the researcher, research participants and other stakeholders. The granting of approval by the Educational Research Human Ethics Committee should not be interpreted as comment on the methodology, legality, value or any other matters relating to this research.

F E S

Appendix I: How to Create Digital Stories Using Photostory

Telling Digital Stories Using Photostory 3.
Photostory 3 is a free download from Microsoft available off the web. You do need to be running Windows XP
http://www.microsoft.com/windowsxp/using/digitalphotography/photostory/default.mspx Do a google search on photostory.

Photostory is quite an intuitive programme and there are lots of helpful supportive hyperlinks to help you out e.g. Learn more about editing your pictures
Click on **Begin a new story**, and then the **Next** tab.

Import and arrange your pictures.
Click on **Import pictures.** Know where your photos are held. You can import your photos one at a time, or as a group. Click on the photo of your choice so that it is selected, and has the blue frame around the photo. Then click OK, and repeat the process again until you have all the photos you want.
OR
Press Ctrl A so all the photos in that folder will be selected, then press OK
OR
Click on the first photo you want and hold Ctrl key and click on the others randomly that you require.
Now press OK.

To make changes to your photos.
Click on the photo and a small tool bar appears under the photo. This will allow to, change the colour balance, remove red eye, rotate your photos, crop, Hold your mouse on the options to know what each one offers.
Use the arrows at the side of the screen to scroll through the photos or delete any that are no longer needed.
To change the order of your photos, click on the photo, hold and drag to reposition.
When your photos are looking good, click **Next,**

Add a title to your pictures.
Again this is intuitive. Click on the photo you want to add a caption too. To choose your font, click on the A icon and choose your required size and font.. Ok when you have the desired font and size. From the other icons on the
screen click where you would like the text to be placed on your photo. Experiment with the options and colours
Check out the **Effects,** but again ask yourself, will this add value to your presentation.
Click **Next** to move on

Narrate your picture and customise motion.
Narration
To record sound you will need a microphone/ designated headset. Plug the pink microphone end into your computer. Click on the Red button in the centre of the screen to record your narration. Don't forget to click stop!
Click Preview to review your work. The little bent arrow allows you to delete your narration and re
record if necessary. Your sound files are often saved as wave files (wmv). I save mine to the desktop
You can add music to run in the background of your presentation, however music will play over your narration. You have to choose one or the other. The **Preview** Button allows you to listen to your selection. Press Next when finished.. the computer will prompt you to save your files. I always save to the desk top because these are the files I am currently working on. File them in a specially created folder, later

Click on the **Customise motion box** for lots of options.
Motion and Duration allows you to use "Ken Burns" effect and glide over your photo. Ken Burns effect is the moving effect that moves your pictures across the screen.

Tick the box **Specify start and end position of motion.**
Use the curser, click on the handles and drag the corners of your photo to the position you want your photo to start from. Repeat the process for the end position on the second photo. Click the **Preview** button to ensure the photos will move the way you have planned.
The sound that you have recorded will help to govern how long the picture stays on the screen, eg if you have 15 seconds of narration, then the photo will stay on the screen for longer than 15 seconds.

Transition tab on the top of the screen
Transition is the effect between slides. Experiment with the options, but again ask your self does the transition I
have chosen, add value to my presentation, or does it detract? Choose the transition of your choice, if you choose to use them, and either press Preview or Save and then Close.
Save your creation to……?
When you click save this project Photostory will save your project usually to your documents folder. You can continue working on your master piece, or return and edit pieces at any stage.
When your masterpiece is perfect then click the next screen which has a **save this project to play on other computers** button. This move will render your project together and save it as a wmv file. The computer will put this the finished, complete copy of your story in you're My Video folder.