THE LIVED EXPERIENCES OF ICT AND ENGINEERING TEACHING FACULTY IN HIGHER EDUCATION INSTITUTIONS IN IRELAND AND THE UNITED KINGDOM, WHO ADOPT AND IMPLEMENT MOBILE TECHNOLOGY ENHANCED LEARNING INITIATIVES: A PHENOMENOLOGICAL INVESTIGATION

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This thesis results entirely from my own work and has not been offered previously for any other degree or diploma.

I declare that the word-length conforms to the permitted maximum at 51,879 words.

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Date *3rd December 2018*

Abstract

This qualitative phenomenological study was designed to gain an in-depth understanding of the perceptions and lived experiences of information and communications technology teaching faculty and engineering teaching faculty in higher education institutions (all participant and institutional names herein are pseudonyms) who adopt and implement Mobile Technology Enhanced Learning. The theoretical framework was based upon innovation research and informed by applying Rogers's Diffusion of Innovation and Wenger's Communities of Practice theories. Purposeful sampling was used to target twelve information and communications technology and engineering teachers in Ireland and the United Kingdom who utilised a variety of mobile devices across multiple platforms to enhance teaching and learning. Using phenomenological reduction to analyse data gathered through in-depth, semi-structured interviews, observations, and an online focus group, the study revealed several overarching lessons. Participants experienced feelings of frustration, anxiety and uncertainty due to inadequate and obsolete mobile tools, issues with unreliable technical infrastructure and wireless networking connectivity, and time constraints arising from a sharp learning curve. Participants felt many higher education institute executives need to consult teachers when formulating and implementing an adoption strategy as they perceived a lack of appreciation by many higher education institute executives of their needs for successful adoption and implementation. Participants clearly required significantly more mobile Technology Enhanced Learning focused pedagogies. Learning about mobile Technology Enhanced Learning was mostly personal, predominantly through informal discussions but also professional learning communities of practice. Participants also required more collaboration and networked learning and practically focused continuing professional development and the associated time to acquire it. Participants perceived increased learner collaboration, global communication, motivation, engagement and achievement, and larger number of resources and improved teaching. Most significantly, teachers recognised the superior ability of mobile Technology Enhanced Learning to convey information and communications technology and engineering concepts to learners and consequently improved attrition rates.

Keywords:

Communities of Practice, CPD, Diffusion of Innovations, learner, mobile learning, mobile technologies, mobile TEL, PLC, teacher, technology adoption, technology enhanced learning, technology implementation, TEL.

Copyright

Dedication

This endeavour is dedicated to my wife, Sinead. Thank you for your relentless support during all of this.

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I cannot explain enough how grateful I am to my supervisor, Dr Murat Oztok. He took me under his wing and helped me succeed when I was challenged by “the system”. His sense of positivity, persistence, and belief in me made this possible. He is the kind of supervisor that every doctoral learner should have.

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Thank you to my family, my wife Sinead, and my children Ronan, Ciara, Aoife, and Niamh, who have supported me throughout this journey. You all supported me through this process for many years with endless patience.

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Finally, thank you to the ICT and engineering teachers who participated in this study. I appreciate your willingness to give back and help me finish this journey.

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List of Abbreviations

CoP	Communities of Practice (Wenger, 2007)
CPD	Continuing Professional Development
DOI	Diffusion of Innovation Theory (Rogers, 1995; Sahin, 2006)
E-Learning	Electronic Learning
HE	Higher Education
HEI	Higher Education Institute
ICT	Information and Communications Technology
MIS	Management Information Systems
M-Learning	Mobile Learning
m-TEL	Mobile TEL
PC	Personal Computer
PD	Professional Development
PLC	Professional Learning Communities
PLN	Personal Learning Network
RLO	Reusable Learning Object
RQ	Research Question
TEL	Technology Enhanced Learning
TPCK	Technological Pedagogical Content Knowledge (Mishra & Koehler, 2006)
TPACK	Technological Pedagogical and Content Knowledge (Mishra & Koehler, 2006)

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Chapter 1: Introduction

This chapter introduces the research. I begin by describing the context of the research. I explain the rationale, purpose and significance of the study. I outline my interest in the area. I explain the philosophical approach of this research and identify my research questions (RQs). The chapter is concluded with an overview of the structure of the remainder of my thesis.

1.1 Overview

Mobile computing devices have gradually been introduced into educational contexts over the past 2 decades (Sung, Chang, & Liu, 2016). Over time these mobile computing devices have reduced in size from larger personal computers (PCs) to not so large laptops (Sung, Chang, & Liu, 2016). Recent advances in mobile technology have led most people to carry their own individual small mobile devices[1] that contain exceptional computing power. With mobile devices becoming more popular and affordable (Hintze, Hintze, Findling, & Mayrhofer, 2017) demands for new teaching and instructional approaches have arisen. As a result, many higher education institutes (HEIs)[2] have begun to implement technology enhanced learning (TEL)[3] initiatives facilitated by small mobile devices such as smartphones as a strategy for addressing the diverse needs of teachers[4] and learners[5] within certain disciplines (Lin, 2015). TEL in the context of this study is used to describe learning which spans a spectrum of learning delivery modes; from face-to-face/web-enhanced to learning that is delivered as part of a blended/hybrid approach to that which is delivered fully online (Allen & Seaman, 2010). These TEL initiatives are being adopted on field trips and in mobile learning environments as well as the laboratory and classroom (Sharples, 2013). Thus, the importance of ascertaining the impact of TEL adoption facilitated by small mobile devices and the affordances concerned with device mobility within these disciplines is huge (Clark, 2013; Traxler & Wishart, 2011). For the purposes of this study, TEL facilitated by small mobile devices (PDAs, Tablet

[1] Small mobile devices in this context are specifically PDAs, Tablet PCs, Smartphones and Phablets and are not PCs, Laptops, 2-in-1 PCs and 2-in-1 Laptops
[2] Institutes of higher and further education or tertiary education
[3] Learning that is enhanced, supported, mediated or assessed with the use of educational technologies
[4] HEI Teaching faculty including lecturers, facilitators, tutors, trainers, teaching assistants and mentors both online and campus-based
[5] HEI Scholars including full-time, part-time, online and campus-based undergraduates and postgraduates

PCs, Smartphones and Phablets) is referred to as mobile TEL (m-TEL). PCs, Laptops, 2-in-1 PCs and 2-in-1 Laptops are not included in this study due to their greater size, higher cost and reduced mobility. I have not found the term mobile TEL, or the abbreviation m-TEL used in any related literature available. As such, it is a new term with no currently agreed definition. Issues and challenges exist when adopting and implementing m-TEL initiatives. Previous research into the obstacles for technology integration with mobile devices indicates such obstacles include access, vision, attitudes, time and professional development (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012) and these same issues and challenges exist for m-TEL initiatives.

1.2 Rationale and Significance of the Study

1.2.1 Research Background

In the past decade, mobile technology innovations have driven significant advances for information and communications technology (ICT) and engineering disciplines within HEIs which traditionally experience high dropout rates. These same technologies impact how HEI teachers within these disciplines address difficulties in learning concepts which mostly appear abstract to their learners (Abhyankar & Ganapathy, 2014). The adoption of these innovations is occurring at a growing rate, as there is a rapid release of new technology. Many teachers who continue to struggle with technology integration have been inundated with continuous changing technology initiatives, including mobile TEL (Mitchell, Simpson, & Adachi, 2017; Oliver, 2012). Since the introduction and learning of new innovations in HEIs is extremely complex (Wall, 2015), HEIs are spending large sums of money on professional development (PD) to prepare teachers for effective adoption of TEL initiatives (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurer, & Sendurer, 2012; Kopcha, 2010; Surej, 2015). However, questions remain as to how teaching faculty perceive the adoption and implementation of these mobile TEL initiatives.

1.2.2 Research Problem and Research Justification

1.2.2.1 Technological Problem Statement and Research Justification

Today we are faced with the technological problem of how ICT and engineering teachers translate HEI executives' intentions for mobile TEL so that they effectively adopt and integrate mobile technological tools and devices into their teaching and learning.

There is an urgent need to address this, as today there is something missing in the teaching and learning of ICT and engineering concepts and complex relationships in the classroom. It is critical that HEI teachers within these disciplines understand that effective adoption and implementation of mobile TEL can address difficulties in learning concepts which mostly appear abstract to their learners (Abhyankar & Ganapathy, 2014) and deepen learners' understanding of complex relationships (Johnson et al., 2010). Consequently, it is crucial that they can identify appropriate pedagogies. If we do not address this, teachers will incorrectly see mobile TEL as technology looking for a solution rather than a means to resolve this problem.

It is also important to address the above technological problem because as ICT and engineering teachers educate learners in today's digital world, they need to become facilitators of instruction who use a variety of technology tools. This is so that learners develop digital literacy and attain essential communication, collaboration, critical thinking, and problem-solving skills needed to succeed in a global digital economy. However, educational researchers and teachers remain uncertain about the comparative benefit of mobile TEL (Kirkwood & Price, 2014; Lui & Han, 2010; Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014).

Research indicates that teachers use technology at a basic level (Koehler & Mishra, 2009; Straumsheim, Jaschik, & Lederman, 2015). This can be attributed to teachers' negative perceptions of technology (Crompton, 2013). In addition, mobile TEL devices are relatively new cognitive tools and are not being used to their full potential by teachers (Greener & Wakefield, 2015). However, it is apparent that teachers feel ill prepared for integrating mobile TEL across curriculum areas to enhance the learning (Koehler & Mishra, 2009). Professional development on the adoption of mobile TEL devices is lacking (Frohberg et al., 2009; Sung**,** Chang, & Liu**,** 2016).

This study investigates how mobile TEL addresses the technological problem above, specifically within the disciplines of ICT and engineering.

1.2.2.2 Pedagogical Problem Statement and Research Justification

Today we are also faced with the pedagogical problem of the impact of mobile technology on the way we teach and learn within ICT and engineering.

It is important to address this as many researchers and educational leaders believe that using mobile technologies in themselves does not have any impact on the way people teach and learn. Also, while mobile TEL has become more commonplace in HEIs (Krull & Duart, 2017), the innovation of ICT and engineering department-wide mobile TEL is relatively new and requires investigation.

Researchers and educational leaders believe mobile technology will address the pedagogical needs for greater learner achievement, efficiency, and critical thinking skills (Bebell & O'Dwyer, 2010). HEIs have reported practical benefits for learners participating in technology immersion initiatives. For example, studies reported that learners who participated in these programmes had better attitudes toward learning than their counterparts (Bebell & O'Dwyer, 2010; Gulek & Demirtas, 2005). Mobile technology has also addressed the pedagogical need for contingent mobile learning, situated learning, learning in dead-time and small bursts and has addressed issues with physiological or cognitive differences (Traxler & Wishart, 2011).

While it can be argued that the use of technology for learning can support constructivist approaches (Sandholtz, Ringstaff, & Dwyer, 1997), implementing technology into classes does not imply a radical change of the didactics. According to Yelland (2006), learning with technology needs more than making learning activities digital; it is also about addressing the pedagogical need for creating contexts for authentic learning that use new technologies in integrated and meaningful ways to enhance the production of knowledge and the communication and dissemination of ideas. Teachers in technology immersion environments have responded with much doubt. Misuse of computing and mobile devices, including cheating, taking and sharing inappropriate photos and videos, bullying, playing games, and participating in social networking sites during classes have been reported (Roblyer & Doering, 2013). Furthermore, I have seen many teachers view technology as a distraction and a hindrance to standards-based instruction.

Potential to address more specific pedagogical needs are many: global communication and enhanced critical thinking skills; learning through learner collaboration in contrast to traditional pedagogical models based on the teacher transferring knowledge to learners without any participation from the learners (Peng et al., 2009). In addition, mobile learning transforms the learning process and changes the ways of learning, creating new opportunities beyond the traditional classroom, offering flexibility and mobility in learning, expanding the learning experience in terms of time and place (Lam, Yau, & Cheung, 2010). This study investigates how within the disciplines of ICT and engineering mobile TEL addresses the pedagogical needs of greater learner achievement, greater efficiency, greater critical thinking, better attitudes towards learning, contingent mobile learning, situated learning, learning in dead-time and small bursts, issues with physiological or cognitive differences, and flexibility and mobility in learning.

1.2.3 Research Purpose

The purpose of this qualitative research is to provide a phenomenological view of how ICT and engineering teachers in HEIs in Ireland and the United Kingdom (UK) (all participant and institutional names herein are pseudonyms) perceive the adoption[6] of mobile TEL initiatives. It also aims to explore how they perceive the adoption impacts the teaching and pedagogy used. To my knowledge this is an underexplored topic in HEIs in Ireland and the UK. Thus, it will build on the available literature. Research outcomes will provide valuable insight into whether mobile TEL environments[7] prove valuable assets to learn about the concepts that mostly appear abstract to ICT and engineering learners and consequently reduce the high dropout rates within the disciplines.

[6] The adoption process is defined as the way through which an individual or a group seeks and processes information about an innovation, then forms an attitude and decides to either adopt or reject the innovation (Rogers, 2003).

[7] TEL environments are defined as classrooms both physical and virtual, where teachers and learners use a variety of TEL technologies and devices across multiple platforms to enhance their learning.

Given the research purpose, Rogers's Diffusion of Innovation (DOI) theory is a commonly-used model in adoption-diffusion literature (Ensminger, Surry, Porter, & Wright, 2004; Straub, 2009). DOI proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. Wenger's Communities of Practice (CoP) theory was also appropriate for this research, as it provided the basis for the collaboration among participants as they sought to learn more about mobile TEL and its adoption (Wenger, 2007). This theory advised that groups of people with shared concerns, beliefs and knowledge collaborate to achieve an aim and better their practice (Wenger, 2007).

1.2.4 Significance of the Study

Within the disciplines of ICT and engineering today the problem of learner attrition rates can be attributed in part to difficulties in learning concepts which mostly appear abstract to learners. Such difficulties result from deductive teaching practices which are classroom-based due to the lack of adoption of mobile technology enhanced learning within these disciplines (Abhyankar & Ganapathy, 2014). It is believed that mobile TEL adoption will prove a valuable asset in overcoming these difficulties in learning concepts by situating these learners in real-world learning scenarios, anytime, anywhere and providing a learning environment that enables such learners to access digital learning resources (Abhyankar & Ganapathy, 2014; Handal et al., 2013).

Mobile TEL technologies have become more commonplace in higher education (HE) environments (Brett, 2011; Liu, Han, & Li, 2010; Tremblay, 2010; Unal, Bodur, & Unal, 2012). Related literature on teaching and pedagogies related to instances of mobile learning in HEIs is not scant and is a solid research base (Bebell & O'Dwyer, 2010; Gulek & Demirtas, 2005; Lam, Yau, & Cheung, 2010; Peng et al., 2009; Traxler & Wishart, 2011). However, it is not strong and does not provide enough detail regarding the specific research problems. For example, regarding the effective adoption and integration of mobile technological tools and devices into teaching and learning within ICT and engineering, this is understudied. Similarly, the impact of mobile technology on the way we teach and learn within ICT and engineering is

understudied. Thus, my study is located within innovation research and considers how the adoption of mobile TEL may be perceived to be an innovation.

To identify ways to assist ICT and engineering teachers in the adoption and implementation of mobile TEL initiatives, HEI policy makers and executives must attempt to understand how teachers feel about adopting mobile TEL. By listening to the voices of teachers during the adoption process, HEI policy makers and executives may be more cognisant of providing assistance to teachers in the effective use of the innovation.

1.3 Situation to Researcher

This study is significant to me as a mentor teacher-facilitator for ICT and engineering HEI undergraduate and postgraduate learners in Ireland and the UK. Commencing in 2006, I started using PCs and laptop computers to integrate technology into lessons, and by 2015, I and most teachers in HEIs I work with were implementing mobile TEL initiatives. The implementation of the initiatives has provided opportunities for professional and personal growth. As a mentor-facilitator I provide training and advice to teachers as they try to integrate mobile TEL technologies into their teaching. Working with educators who have struggled to effectively integrate technology developed a curiosity about educator perspectives during the adoption and implementation process. Particularly, I wondered how they felt about using mobile TEL technologies and devices to overcome the difficulties in learning concepts which mostly appear abstract to learners and how their perceptions impacted the adoption process and the teaching and pedagogies used. I hoped to gain valuable insight into the successes and failures HEI teachers experienced so that I could more effectively mentor new and experienced teacher-facilitators. As a mentor facilitator in a master's degree programme for Software Engineering in one HEI, I also hoped to be able to provide in-depth analysis of the programme in comparison to the mobile TEL initiative. Thus, interpretive axiological assumptions were used in this research as some of the experiences represented my interpretation and presentation of the research topic. As I investigated participants' experiences, I studied the phenomenon through the lens of a social constructivist framework (Creswell, 2013).

1.4 Philosophical Approach

To understand the purpose and position of this research, it is necessary to outline my own ontological and epistemological presuppositions (philosophical approach) underlying this study. My position is taken from a constructivist/interpretivist paradigm where the view of the world is that knowledge is based on experiences that are socially constructed (Creswell, 2009) and emphasises the importance of personal perspective and interpretation.

The overarching research question used to guide this research and to provide information on ICT and engineering teachers' perceptions and experiences in HEIs during the adoption and integration of mobile TEL was: how do ICT and engineering HEI teachers perceive mobile TEL? My aim was to understand the experience of these teachers in the context of their day-to-day activities within their normal working environment.

There are many factors that could potentially influence a HEI teacher in their decision to adopt and implement mobile TEL in this context. Social science research is concerned with human behaviour in society (Creswell, 2007). It is a subjective rather than objective activity which is reliant on human interpretations (Cohen, Manion, & Morrison, 2007) and recognises the influence of a complex mix of uncontrollable variables and unpredictable interactions (Tobin & Kincheloe, 2006).

A constructivist perspective acknowledges that individuals create meanings in the interactions between these uncontrollable variables and unpredictable interactions (Lee, 2012). As meanings can be varied and multiple, the researcher must make sense of them by interpreting the participants' personal and complex views of the situation (Creswell, 2007). This is done to get "an in-depth understanding of how meaning is created in every day life and the real-world" (Travis, 1999, p. 1042).

An interpretivist perspective recognises the researcher's values and their ontological and epistemological perspective. Thus, the researcher plays a key role in interpreting the research data. This means there were no right or wrong answers to my research questions and I did not seek to identify a generalisable cause and effect. Moses and Knutsen (2007, p. 194) assert, "Truth isn't just 'out there'. Knowledge about the social world is always knowledge-in-context; it is socially situated and has social consequences. As a result, knowledge is always somebody's knowledge".

Ontology concerns the nature of being in the world (Tobin & Kincheloe, 2006). It is a theory of existence (Lee, 2012) and defines how the nature of reality is understood. The constructivist/interpretive perspective taken in this research informs my ontological position. I believe that a reality exists and that individuals have their own perception and interpretation of it in context.

This research was based in the context of participants' workplaces and is sensitive to the teachers and places studied. The pedagogical and technological choices of teachers at their HEIs are not objective phenomena. Every individual has a different and subjective interpretation of these choices. Their choices may be influenced by their previous experiences and actions, by the actions of their peers around them and by the social and cultural structures of which they are a part. Therefore, knowledge is subjective, influenced by interactions and socially constructed.

Epistemology is a theory of knowledge (Lee, 2012). Given my ontological beliefs that reality exists, and individuals have their own subjective perception of reality, my epistemological perspective is that evidence of this reality can be understood by examining the subjective accounts and reflections of the phenomena from each participant. Indeed, Guba and Lincoln (1994) outline that human behaviour can only be understood when considered alongside the meanings and purposes of the human actors to their activities. Guba and Lincoln state that, "qualitative data, it is asserted, can provide rich insight into human behaviour" (1994, p. 106).

Thus, I sought a method that allowed exploration of the lived experiences of ICT and engineering teachers as they adopted and implemented mobile TEL initiatives and consequently chose phenomenology.

1.5 Research Questions

The overarching research question used to guide this research and to provide information on ICT and engineering teachers' perceptions and experiences in HEIs during the adoption and integration of mobile TEL is as follows:

1. *How do ICT and engineering HEI teachers perceive mobile TEL?*

Given the focus of Rogers's DOI model (which proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system) and Wenger's CoP (which provides the basis for the collaboration among participants as they seek to learn about an adoption), the sub research questions below sought to understand phenomenologically the structure of how ICT and engineering HEI teachers perceive the implementation of mobile TEL initiatives.

1.1 How do they perceive the mobile TEL innovation itself?

1.1.1 How does it affect the way a person teaches?

1.1.2 How does it affect the pedagogies used?

With constraints on time and increased assessment demands, many teachers have doubted the usefulness of mobile devices (Liu, Han, & Li, 2010; Reed, 2014). Due to smaller screen sizes, reduced resolution, and lack of data input impeding the use of mobile devices, teachers question the potential of mobile learning because the perceived return on adoption is low (Liu, Han, & Li, 2010; Marinakou & Giousmpasoglou, 2014; Pegrum et al., 2013). Although teachers are familiar with mobile devices, many doubt their usefulness for teaching and learning (Liu, Han, & Li, 2010; Ottenbriet-Leftwich, Glazewski, Newby, & Ertmer, 2010). Adoption of mobile TEL is then negatively impacted by this perceived usefulness (Crompton, 2013).

1.2 What are their attempts to communicate that innovation to others?

1.2.1 How do teacher values, beliefs, professional needs, and past experiences with technology impact the adoption?

Research on the impact of mobile technology adoption on teachers' pedagogy indicates that they have not necessarily changed their practice to more learner focused instruction. Teachers have continued to use a teacher-focused didactic approach while acknowledging the adoption of technology to aid subject commitment and learning based on their own value beliefs, that is where they believe the

technology can help them achieve the instructional goals they perceive most important (Ertmer & Ottenbreit-Leftwich, 2010; Kim, Kim, Lee, Spector, & DeMeester, 2013). Many teachers question the usefulness of mobile devices for teaching and learning (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). Although research has reported positive outcomes for ICT and engineering learners in TEL environments, and the considerable investments by HEIs in mobile technology and professional development, teachers remain uncertain about the benefits of adopting mobile technology initiatives (Chen et al., 2009; Ertmer et al., 2012; Hwang & Wu, 2014; Roblyer & Doering, 2013; Sharples, Arnedillo-Sanchez, Milrad, & Vavoula, 2009; Shih et al., 2011).

1.3 How does the innovation become integrated into the time and space of practice?

1.3.1 What guidance (collaboration and networked learning sources) do teachers use to develop, distribute, source and learn about mobile TEL initiatives?

Sharing of knowledge reduces uncertainty about any adoption of an innovation (Rogers, 2003) and this knowledge sharing requires communication to provide and process the knowledge. Although collaboration and networked learning are crucial for improving teachers' practice with mobile technology, in HEI educational environments seclusion prevails (Gourlay, 2011). Lack of interaction and seclusion are the primary barriers for online teacher professional development (Miller, 2015). This teacher seclusion results in teachers having little time and prospect to discuss their anxieties about mobile technology integration. Thus, continuing professional development (CPD) must be rooted in social and educational practices. Gast, Schildkamp, and van der Veen (2017) asserted that most professional development activities in HEIs focus on individual teachers rather than working together in teams where teaches must collaborate. Cifuentes, Maxwell, and Bulu (2011) asserted that effective technology integration must include social activity within a learning community. This community, which can include formal or informal knowledge sharing, affords prospects for teachers to engage in collaborative discussions and

practices, establish trusting relationships, and learn from each other's teaching (Wenger, McDermott, & Snyder, 2002).

1.4 What are its interactions with the wider surrounding social system?

1.4.1 What are teacher perceived obstacles for mobile TEL adoption?

1.4.2 What are teacher perceived benefits for mobile TEL adoption?

Research into the obstacles for technology integration with mobile devices reveals such obstacles include access, vision, attitudes, time and professional development (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). In addition, teachers doubt the value of mobile technology due to time constraints and assessment demands (Gregory & Lodge, 2015; Liu, Han, & Li, 2010; Reed, 2014). Mobile learning technologies have been used in HE settings and offer many benefits. Research indicates portability, ease of use, and size as reasons to integrate mobile devices into learning environments (Khaddage, Lattemann, & Bray, 2011; Munawar & Cukier, 2011). Also, mobile technologies allow better access and possibilities for task-based, personalised learning for the learner-driven element of their digital lifestyles (Khaddage, Lattemann, & Bray, 2011; Kopcha, 2010; Munawar & Cukier, 2011). Clearly teachers must possess the required knowledge and ability, but policy makers, heads of department and HEI executive must also appreciate the obstacles and benefits teachers face and how mobile TEL can best be diffused and adopted (Abrahams, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). This appreciation will hopefully lead to resolutions that will assist in the adoption and integration process.

These research questions were suitable for this research as Creswell (2013) contended, "Qualitative research questions are open-ended, evolving, and non-directional . . . restate the purpose of the study in more specific terms . . . start with a word such as 'what' or 'how' rather than 'why'. . . and are few in number . . ." (p. 138).

1.6 Delimitations

Participants in this study were limited to twelve ICT and engineering teachers who were participants of mobile TEL initiatives within their HEIs. Only teachers who participated in the mobile TEL initiatives were chosen, as they were able to provide detailed descriptions of the initial experience, including obstacles, needed resources, the impact on planning and teaching and the successes and failures. Additionally, teachers from only seven HEIs were chosen because these were the only HEIs with schools participating in mobile TEL initiatives at the time.

1.7 Definition of Terms

To aid in the understanding of the study, this section contains important definitions of key terms used throughout this study.

Adoption – the decision to fully incorporate the innovation into one's ongoing practice (Rogers, 2003)

Communication – a process in which individuals or groups reach a mutual understanding by creating and sharing information with each other (Rogers, 2003)

Collaboration – a process in which individuals work interdependently for the purpose of analysing, impacting, and improving professional practice (Dufour, Dufour, & Eaker, 2008)

Communication channels – the ways in which messages are transmitted from one person or group to another (Rogers, 2003)

Diffusion – a social process in which an "innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003)

Electronic Learning – learning conducted via electronic media, typically the Internet

Innovation-decision process – gradually reducing uncertainty, this is the process through which an individual or group seeks and processes information about an innovation, then forms an attitude, and decides to adopt or reject the innovation (Rogers, 2003)

Mobile devices – portable multifunctional devices that can connect to the Internet

Mobile learning – a learning strategy concentrating on the instructional approaches utilised with the use of a variety of multiple mobile devices and platforms

Mobile TEL – learning that is enhanced, supported, mediated or assessed with the use of educational technologies using small mobile devices

Professional learning communities – in continuous practice-based learning, educators work collaboratively in "ongoing processes of collectively inquiry and action research to achieve better results for students" (Dufour, Dufour, & Eaker, 2008)

TEL environments – classrooms both physical and virtual, where teachers and learners use a variety of TEL technologies and devices across multiple platforms to enhance their learning

Relative advantage – the degree to which an individual or group believes the innovation is better than the idea it replaces (Rogers, 2003)

Technology Enhanced Learning – learning that is enhanced, supported, mediated or assessed with the use of educational technologies

1.8 Overview of the Thesis

The following is an overview of the chapters that form the remainder of my thesis.

- Chapter two outlines my theoretical framework.
- Chapter three provides an overview of relevant literature.
- Chapter four explains my research methodology in detail.
- Chapter five details my research findings.
- Chapter six discusses my findings related to the relevant literature and my theoretical framework. It also outlines the research limitations, implications and recommendations, future research and research summary.

Chapter 2: Theoretical Framework

2.1 Overview

The purpose of this chapter is to outline the theoretical framework used for my research study: Rogers's (1995) Diffusion of Innovation theory (DOI) and Wenger's (2007) Communities of Practice (CoP) theory.

2.2 Introduction

Many alternative models have been developed to comprehend technology adoption. Straub (2009) suggests that the Concerns-Based Adoption Model (CBAM), the Technology Acceptance Model (TAM), the United Theory of Acceptance and Use of Technology (UTAUT) and the Diffusion of Innovations (DOI) are four of the main ones.

The CBAM was developed to comprehend change in schools from a top-down perspective (Anderson, 1997). It focuses on mandated change and ignores teachers' preferences (Straub, 2009). I decided against using this model due to the focus on the school context and because I also wanted to understand teachers' preferences for the adoption and implementation of educational technologies.

The TAM was developed by Davis (1989) to understand an individual's perception of a technology innovation and focused upon the perceived ease of use and the perceived usefulness. The TAM has mostly been used in information systems literature and stresses the ideas of instrumentality and extrinsic motivation, whilst disregarding an individual's subjective feelings and holistic experience (Zhang, Zhao, & Tan, 2008). Criticisms of this model include the lack of recognition of individual differences and that it does not account for previous experience (Agarwal & Prasad, 1998). The TAM was rejected for my study due to the lack of individual differences.

The UTAUT was developed by Venkatesh, Morris, Davis, and Davis (2003) who examined eight of the most common theoretical frameworks for technology adoption and use and subsequently combined the most salient characteristics of each. This model largely studies mandated rather than optional technologies and does not identify the influences relevant for educational institutions (Straub, 2009). Thus, it was decided against as a framework for my study.

Rogers's (1995) DOI is an extensively cited model that has been used to study many different innovations (White, 2007). Ensminger et al. (2004) and Straub (2009) contend that DOI is the most influential model in adoption-diffusion literature. It originates in 1962 from a rural agricultural and sociology background (Hornik, 2004). Prescott (1995) asserts that it is appropriate to use to study information technology innovations, despite its agricultural origins. It is now widespread in the literature examining the introduction of new technologies (Wilson & Stacey, 2004).

Although the DOI has been used widely, this model has its critics (Lyytinen & Damsgaard, 2001). Straub (2009) proposes that the DOI is principally descriptive rather than prescriptive and does not explain how to facilitate adoption. Furthermore, Straub suggests that future adoption research should focus on how individuals understand, adopt and learn about technologies outside of the formal perspective and not just on what is offered by the formal institutional setting.

However, after reviewing the different models, DOI was deemed to be the most appropriate to inform this research. Rogers's (1995) DOI theory provided a means for exploring why ICT and engineering teachers adopted mobile TEL initiatives, what characteristics are similar among them, and what social networks may have played a role in their decision to pursue mobile TEL at this point in their careers. The actions of these teachers demonstrate characteristics of innovators or early adopters of this technology to enhance learning. Analysis of their responses provided insight into the value of mobile TEL for ICT and engineering teachers and how the profession may further adopt mobile technologies into HEIs.

2.3 Theoretical Framework

With the advent of mobile educational technology, HEI policy makers and teachers have been faced with the task of educating learners by means of related TEL skills. As O'Donnell and Sharpe (2012) assert, "The use of technologies in education has altered the ways in which lecturers and students can interact …" (p. 1). TEL should be integrated into the teaching practices and pedagogies as an effort to keep abreast of the technological environment that our global society operates. Just as rapidly as technology has progressed over the last number of years, teachers have needed to make speedy changes to the types of mobile technologies used in their teaching

environments and the strategies used to implement these mobile technologies. Integrating innovative technology during HEI teaching practices inevitably demands teachers to acquire new technological and pedagogical skills (Kirkwood, 2014). Teachers need skills to be able to transform the learning content, the so-called Technological Pedagogical Content Knowledge (TPCK or TPACK) (Koehler & Mishra, 2009).

Professional development for ICT and engineering teachers is crucial when mobile TEL is integrated into their syllabus (Derting, Ebert-May, Henkel, Maher, Arnold, & Passmore, 2016; Ertmer & Ottenbreit-Leftwich, 2010). So that mobile technology can be used for the purpose of developing learners' higher-order thinking, creativity and problem-solving skills, teachers must be able to understand how to use the technology for instruction. However, they often lack the knowledge necessary to do so (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2010). As the teaching environment for ICT and engineering teachers continues to change from being PC and laptop-based to being mobile, it is crucial to comprehend how the adoption of new mobile technologies impact teachers' practices and the pedagogy used in mobile learning environments. Thus, the theoretical framework for this research study included Rogers's (1995) Diffusion of Innovation theory (DOI) and Wenger's (2007) Communities of Practice (CoP) theory. The remaining two sections of this chapter outline the reasons for this choice of theoretical framework and the details of each theory.

2.3.1 Diffusion of Innovation (DOI)

When answering research questions on technology adoption, DOI is arguably the most commonly-used model in adoption-diffusion literature (Ensminger, Surry, Porter, & Wright, 2004; Straub, 2009) and is widely cited (White, 2007). Thus, it is suitable to answer my primary research question and guide the evaluation of participant responses.

In this study, the attributes that affect both individual adoption and the larger collective diffusion of an innovation as identified by Rogers (2003) have been applied. The attributes in the theory provide a framework that helps in understanding the effect on pedagogies used and why some teachers use mobile TEL easily in

carrying out their teaching while others do not. Diffusion of innovations theory also helps education practitioners to identify qualities that will make the use of mobile TEL more appealing to potential users. Thus, it helps to answer research question 1.1.

Rogers's (2003) theory offers strong possibilities for examining the practice of teachers working to communicate technology integration on their campuses and helps to answer research question 1.2. The channels of communication used during its adoption can alter the perceptions and beliefs about the innovation. While the attributes of an innovation will influence the rate of adoption, so will the characteristics of individuals involved in the process (Petherbridge, 2007). Rogers (2003) suggests an individual's personal traits or predispositions affect the way they react to change and the length of time they require to pass through the innovation-decision making process.

Rogers (2003) claims that it is essentially a framework to understand the integration and spread of an innovation over time throughout the members of a social system and is highly suited to answering my research question 1.3. In HEIs, this can be achieved through training or mobile TEL professional development.

DOI claims to provide a broad foundation for understanding the factors that influence an individual when they adopt an innovation (Straub, 2009). When encountering obstacles in innovation diffusion, this framework and its principles assist teachers leading an innovation in understanding key issues involved in the innovation process, including —the attributes of innovations that help or hinder their adoption, categories of adopters, the innovation-decision process that occurs in using an innovation, and the power of opinion leaders in the adoption process (Petherbridge, 2007, p. 39). The diffusion theory can also be used to explain, predict and account for factors that increase the use of mobile TEL. Thus, it is perfectly suited to answering research question 1.4.

Rogers (1995) asserted potential adopters learn about innovations from three sources; firstly, their own research, secondly through interactions with others and thirdly through change agents.

Rate of Adoption

The adoption rate is the speed at which an innovation is adopted and is measured by how long it takes for a percentage of the social system to adopt an innovation (Rogers, 1995; Sahin, 2006). Rogers (1995) posited that the rate of adoption can increase when an innovation is considered superior to earlier adopted innovations. Five characteristics are essential to the adoption process: relative advantage, compatibility, complexity, trialability and observability (Rogers, 2003; Sahin, 2006; Schauer-Crabb, 2002). Rogers (2003) claims that generally, relative advantage and compatibility are the most important predictors. The characteristics of each are described in Table 1.

Characteristic	*Description*
Relative advantage	Perception of the innovation is superior
Compatibility	Innovation meets needs of user; matches cultural norms
Complexity	Difficulty of innovation to understand or use
Trialability	Degree of experimentation with innovation
Observability	Dissemination of results

Table 1 Essential Characteristics for Adoption (Rogers, 1995)

Categories of Adoption

Rogers (1995) posited that there are five adopter categories in a social system: innovators, early adopters, early majority, late majority and laggards (Figure 1). The bell-shaped distribution is reported to be a stable empirical finding (Rogers, 2003).

Figure 1 Various Adopters (Rogers, 2003, p. 655)

Innovators are the venturesome who are interested in the technical aspects and are risk takers. Early Adopters are 'tech savvy', respected and considered as change agents with the greatest degree of opinion about the new ideas. They examine the innovation as regards its benefits and are willing to try it out, provide help and advice to other adopters. The Early Majority is deliberate and more concerned with professionalism. They are willing to adopt the innovation once the majority in society has adopted it. The Late Majority is sceptical and believes less in new ideas and always makes sure that there are people ready to solve their problems before adoption. They are unlikely to feel safe to adopt until they have removed uncertainty about the innovation. The pressure of peers is necessary to motivate their adoption of an innovation. They do not adopt until most others in their social system have done so. Laggards are most likely to stick to the "old and traditional" ways. They are very critical towards adopting new ideas, and innovation is accepted only if it becomes tradition.

Process of Adoption

Rogers's (1995) DOI theory expresses the process of adopting innovations over time (Figure 2).

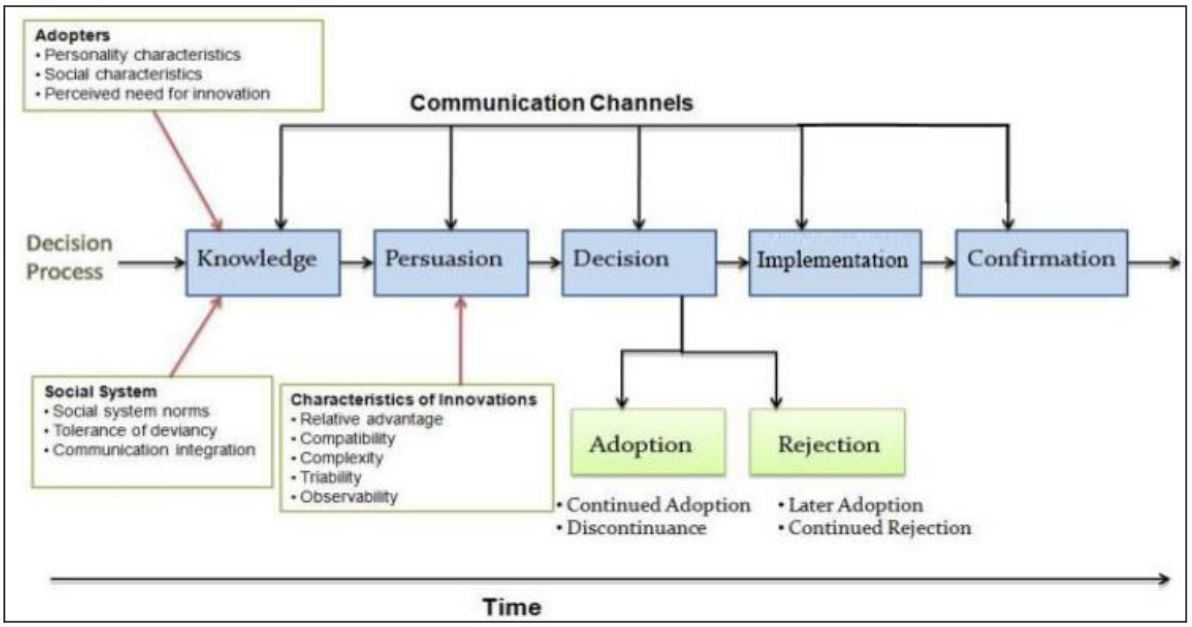

Figure 2 Diffusion of Innovation Process (Rogers, 2003)

The process comprises four essential elements: innovation or adopters, communication channels, time and social system (Sahin, 2006). The innovation-decision process includes five stages that are reached over time: knowledge, persuasion, decision, implementation and confirmation (Rogers, 1995).

The adoption process starts with an individual enquiring about the innovation by asking what, how and why questions. Sahin (2006) asserts that knowledge acquired in this step includes awareness knowledge, how to knowledge and principles knowledge. As the individual develops positive or negative attitudes about the innovation, a more affective stage occurs called the persuasion stage. Subsequently the decision stage occurs where the individual chooses to either adopt or reject the innovation. At this stage two types of rejection may occur, active or passive rejection. An active rejection may occur when a previously adopted innovation is later rejected, that is a discontinuance decision (Sahin, 2006). The next stage, the implementation of the innovation may bring about new concerns or uncertainties. During implementation, reinvention may occur and can affect the speed in which an innovation can occur. This is “the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation” (Sahin, 2006, p. 14). The final stage of the adoption process, the confirmation stage happens when

a potential adopter makes a decision about the adoption but looks for assistance for making their decision (Sahin, 2006).

Correspondingly, Damanpour (1988) and Rogers (1983) describe the adoption process as one that occurs in two stages over time, initiation and implementation. Initiation happens as social systems gather information, conceptualise and plan for the adoption of an innovation, leading up to the decision to adopt (Damanpour, 1988; Rogers, 1983; Zaltman, Duncan, & Holbek, 1973). Subsequently, implementation begins (Damanpour, 1988; Rogers, 1995; Schauer-Crabb, 2002). Rogers (1983) describes this stage as the events, actions, and decisions involved in using an innovation. The implementation stage is composed of three sequential phases: redefining or restructuring, clarifying the innovation to establish its advantages and usefulness and incorporating the innovation into routine practice as the innovation is used regularly (Rogers, 1995; Schauer-Crabb, 2002).

Suggesting that change takes time and that communication about an innovation occurs through channels in social systems, Rogers (1995) asserted that an innovation may be adopted or rejected at any point during implementation. The process of technology integration is an evolutionary one, and teachers' beliefs, pedagogy, and technology skills gradually build upon each other and co-evolve as technology is introduced and assimilated into the institution's culture (Kopcha, 2010).

In summary, this theory is appropriate for my study because ICT and engineering HEI teachers use mobile devices across multiple platforms in novel, innovative ways. In addition, the channels of communication during the adoption may change the perceptions and beliefs about the innovation. All in all, technology is constantly changing, and introduction of new mobile TEL technologies is ongoing; hence, the theory provides an understanding of how to introduce new ideas into the social system and sustain them. For this study, DOI brought out perceptions and factors affecting the adoption of mobile TEL by ICT and engineering teachers in HEIs.

2.3.2 Communities of Practice (CoP)

The term community of practice is usually attributed to Lave and Wenger's ground-breaking book on situated learning (Lave & Wenger, 1991), although the term was simultaneously in use by Brown and Duguid who worked with Lave and Wenger

(Brown & Duguid, 1991), and can be traced back to work by Julian Orr (1990) and even earlier to Edward Constant (1987). Constant (1987) argued that the combination of “practice” and “community” was the best grain size at which to describe knowledge. Constant (1987) highlighted how knowledge was embedded in practices, and how communities of practitioners who shared practices might be the correct unit of analysis to examine knowledge. Orr (1990) discovered that work groups solved challenging problems by recounting stories of past issues to one another and by finding in the stories clues about how to resolve the issues. Brown and Duguid (1991) posited that the spread of knowledge can be described by looking at communities of people who share practices.

Subsequently, Wenger’s descriptive Communities of Practice theory advised that groups of people with shared concerns, beliefs and knowledge collaborate to achieve an aim and better their practice (Wenger, 1998). Viewing the social theory of learning as the foundation of a CoP, learning takes place within the context of our experiences (Wenger, 1998). Wenger (1998) argued that CoPs are a central part of life, albeit that they are informal. Learning that takes place for the individual learner but also as part of a community and group comprises mutual engagement and shared practices. Sharing practices, our comprehension is further advanced and negotiated and subsequently becomes the basis of unity (Wenger, 1998).

Over time, the concept of community of practice has evolved from a descriptive one (Lave, 1987; Lave & Wenger, 1991) to a more prescriptive one (Wenger, McDermott, & Snyder, 2002). The prescription concept is not about making space for people to appropriate a joint enterprise, as it was in communities of practice; rather, the idea is to create or foster new groupings of people who work effectively on similar or parallel, not joint, practices, to invent new practices. As this study focused on ICT and engineering teachers jointly appropriating mobile TEL initiatives, and not on inventing new mobile TEL practices, the descriptive concept was more appropriate.

Thus, Wenger’s descriptive Communities of Practice theory is the second theory that framed this research. It is suitable for answering my primary research question, providing the basis for collaboration among participants as they sought to learn more about mobile TEL adoption and implementation.

Kahan (2004), Pyrko**,** Dorfler, and Eden (2017), and Wenger (2007) suggested identity, engagement and innovation as important reasons for the development of CoPs for improving professional practice.

Identity

CoPs have been defined as paths to "learning and knowledge sharing because they are driven through social interactions" (Kahan, 2004, p. 31). Wenger (2007) argued that human interaction was crucial for the creation of one's identity. As these interactions may occur anywhere and anytime, CoPs may exist wherever people meet, share knowledge, and learn to improve practice (Fitzsimmons, 2007). In today's digital world, the concept of identity has changed (Fitzsimmons, 2007; Kahan, 2004). Consequently, interactions may occur informally during breaks at work, a field setting or virtually through social networking, blogs, and discussion forums (Kahan, 2004; Pyrko**,** Dorfler, & Eden, 2017; Wenger, 2007) or indeed via mobile interactions when members communicate via mobile technology such as smartphones (Kietzmann et al., 2013). As a member's interactions increase, their social circle grows also (Kahan, 2004).

Engagement

Wenger (2007) asserts that the identity of individuals or groups is directly related to their engagement in society. Consequently, the objective of a CoP is to achieve active member engagement (Pyrko**,** Dorfler, & Eden, 2017). Such engagement enables individuals or groups to solve problems and communicate stories of their practice (Kahan, 2004; Wenger, 2007). The ensuing interactions generate the identity of the engaged individuals or groups (Pyrko**,** Dorfler, & Eden, 2017). Wenger (2007) contended that making experiences, knowledge and therefore stories explicit is a crucial element in creating value between professionals in a CoP.

Innovation

When experiences are revealed, the resultant knowledge becomes an innate element of the community culture. Wenger (2007) believes consequently the CoP starts to value the distribution of knowledge and innovation, as members reveal their teaching practice. To facilitate this, however, engagement and communicating stories are essential as they encourage members to "act out these stories" (Wenger,

2007, p. 170) to improve practice. The key to engagement is “to learn what kind of community activities would allow them to engage their professional identities in the process of knowledge sharing and knowledge creation” (Kahan, 2004, p. 31).

The benefits of mentoring and teacher-led CoPs during the adoption of technology initiatives was researched by Kopcha (2010). The research found that they inspired teachers to investigate new uses of technology, whilst helping them to overcome obstacles and thus it was useful for answering research questions 1.1 and 1.4. Additionally, choices on adopting the new technologies were based on both their own beliefs about technology and on how their contemporaries received the new technology (Kopcha, 2010). Thus, it was useful in answering research question 1.3. CoP theory was appropriate for answering research question 1.2, as teachers instinctively work together during teacher gatherings and professional learning groups to debate issues and resolutions.

In summary, CoP theory was appropriate for this research as it provided the basis for the collaboration among participants as they sought to learn more about mobile TEL and its adoption.

Chapter 3: Literature Review

3.1 Overview

This chapter is comprised of three sections, including an introduction, literature review and summary. According to Galvan (2009) the goals of a literature review are to "provide a comprehensive and up-to-date review of the topic" (p.13) and to justify a rationale for the research study. Thus, this literature review focused on the background of technology adoption and how this integration has evolved from PC and laptop computers to mobile TEL. An understanding of the history and development of mobile TEL innovation is critical for HEI teachers as they face continuous innovations. Especially, what have been the adoption practices in the past, and what obstacles and outcomes have resulted? This literature review examined the background of mobile educational technology in today's global digital world, in addition to the outcomes and obstacles of mobile TEL initiatives and the adoption and implementation practices of HEI teachers. The specific areas which this literature review covers are:

- Background of Mobile TEL Innovation in Education
- Moving from Personal Computer and Laptop-Supported Learning to Mobile TEL
- Theories and Models for Learning with Mobile TEL Technologies
- Strategies and Models for Mobile TEL Technology Integration
- Mobile TEL Teacher Professional Development and Collaboration
- Mobile TEL Environments
- Obstacles and Challenges to Mobile Technology Adoption
- Effective Implementation of Mobile TEL

The selection of research, in the form of books, journal articles, reports, and Web sites, was based on their currency and relevance to technology adoption and mobile TEL. In addition, these research tools provided pertinent information germane to the teacher adoption of mobile TEL. The literature in this chapter is not HEI specific as it was important to include literature from other educational contexts that could be relevant to the adoption and implementation of mobile TEL in a HEI context.

3.2 Introduction

Crescente and Lee (2011) stated that “the push for m-learning and revamping education methodologies has come from the idea that the current and future generations will not know life without elaborate electronic technology” (p. 117). With the effective integration of mobile technologies, learners are prepared for a vast range of successful careers (Dettelis, 2010). A widely recognised benefit is ‘on-demand learning’, where the learner can access and engage with learning resources at anytime, anywhere (JISC, 2011). However, caution should be heeded in terms of viewing educational technology as a panacea solution to issues of engagement, critical thinking skills development and different levels of “digital literacy” and Internet access (JISC, 2015).

The purpose of this chapter is to review literature related to educational technology and its evolution from PC and laptop-based initiatives to mobile TEL. In addition to mobile learning theories and models, this review of literature will focus on teachers’ attitudes and perceptions during the adoption and implementation process of both PC, laptop and mobile TEL initiatives.

3.3 Related Literature

3.3.1 Background of Mobile TEL Innovation in Education

ICT and engineering teachers in HEIs have been given the task of teaching learners with the necessary skills available to them in today’s global digital world. For this reason, vast amounts of money are spent on teacher professional development, software and hardware technologies and associated technology infrastructures. Progressively, HEIs have begun implementing mobile technology enhanced learning to improve learner motivation and achievement (Johnson, Becker, Estrada, & Freeman, 2014; Laurillard, 2013; Keengwe & Onchwari, 2011). Many initiatives have been undertaken by higher education institutions to promote the use of mobile learning (Bachmann et al., 2015; Crow et al., 2010; Lopez et al., 2015; Ntinda et al., 2014). For example, mobile devices have been used as collaborative tools to increase motivation around examination preparation (Lopez et al., 2015). In a study undertaken by Dahlstrom and Bichsel (2014), it was established that 99% of undergraduate learners own a mobile Internet-enabled device, including 86% who

own a smartphone and 47% who own a tablet. Mobile TEL initiatives have the potential to significantly affect learner outcomes in higher education.

Concerns. Researchers have highlighted concerns held by both opponents and supporters of mobile TEL initiatives. Supporters have proclaimed that mobile TEL initiatives revolutionise teaching and learning. However, many opponents continue to deem the initiatives do not meet their expectations and are merely the most recent attempt of educators to positively impact educational outcomes (Kirkwood & Price, 2014; Lui & Han, 2010; Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014). Additionally, evidence indicated that some educators see mobile technology as an inappropriate distraction for learners, promoting disruption and cheating (Khaddage & Lattemann, 2013b; Kissko, 2010; Thomas & O'Bannon, 2013). Opponents also list issues with access, vision, attitudes, time and professional development (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). Particularly, teachers doubt the value of mobile technology due to time constraints and assessment demands (Gregory & Lodge, 2015; Liu, Han, & Li, 2010; Reed, 2014).

Furthermore, placing a mobile device in the hands of every HEI learner and teacher does not imply a radical change in didactics, teaching and learning. According to Yelland (2006), learning with technology needs more than making learning activities digital, it is also about creating 'contexts for authentic learning that use new technologies in integrated and meaningful ways to enhance the production of knowledge and the communication and dissemination of ideas'. Weak institutional support can hinder effective integration (Shraim, 2012). Effective mobile learning environments need "strong institutional support, including the design of relevant resources in mobile format … and technical support" (Sharples, Taylor & Vavoula, 2007, p. 8).

Although mobile learning is seen as having high potential and improving learning performance (Hwang & Chang, 2011), the cost for developing the dedicated software, along with network infrastructure failures, have been identified as issues. The management of the mobile technology itself can be challenging for learners and teachers (Sharples et al., 2014). Time constraints in the field may be restrictive (Meek et al., 2013), while continuous switching of attention between different representations and activities may be distracting (Rogers et al., 2010). Also, despite

the excitement or the interest that users might feel when using the mobile devices to learn, the content contributed by them may be of poor quality (Fitzgerald, 2012). In fact, learning in such environments can become too complex and learning achievements can be disappointing (Chu et al., 2010).

Questions. Although there is much literature supporting mobile TEL adoption by HEIs and its positives, it is not strong in several areas. We do not read about failures – this is a missed opportunity (Traxler & Wishart, 2011). There are too many generalisations (Traxler & Wishart, 2011) and the need for more literature specifically related to the disciplines of ICT and engineering. Although some researchers offer a framework for theorising about mobile learning with conversation theory and activity theory (Sharples, Taylor, & Vavoula, 2007; Uden, 2007; Zurita & Nussbaum, 2007), ICT and engineering instructional designers and teachers need a solid theoretical foundation for mobile learning in the context of mobile education. They also need more guidance about how to utilise emerging mobile technologies and integrate them into their teaching more effectively.

Teacher outcomes. With researchers voicing mixed results of positive learner outcomes relating to improved learning outcomes, many ICT and engineering teachers have become unsure about the benefits of adopting mobile TEL initiatives (Kirkwood & Price, 2014; Lui & Han, 2010; Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014). Unquestionably, teachers are crucial in the process of implementing successful mobile TEL initiatives. However, research shows that although most HEI teachers use mobile devices in their daily life, most lack experience and knowledge of integrating them into their teaching activities (Handal et al., 2013; Pegrum et al., 2013; Sad & Goktas, 2013; Yang, 2012). Teachers still do not understand the concept of mobile learning and the pedagogical and technological considerations of integrating mobile technology into their teaching. This indicates that teachers need to know when to use mobile technology, when mobile applications are suitable for integration into specific activities, and which content is most effectively presented to learners on small mobile screens. They must also understand the just-in-time nature of mobile learning. According to Stayton (2011), mobile solutions are appropriate in creating bite-sized chunks of information, which is especially critical when using devices with very small screens. Therefore, it is important to train teachers in how to

integrate these devices, in terms of both content and pedagogy (Mishra & Koehler, 2006).

A specific affordance of mobile devices is to help teachers to provide a dynamic visualisation of concepts to better communicate ideas to learners. Many mobile applications for analysing and visualising complex datasets are becoming more readily available. Educators see great potential for mobile TEL applications that allow science learners to manipulate data and process statistics, deepening their understanding of complex relationships and concepts (Johnson et al., 2010). For example, infographic apps are increasingly important, combining different types of video and audio to capture rich experiences. It is widely believed that visualisation gives a better representation of data that enables learners to better understand and interpret information than inputs in figures and words; this can improve both attention and comprehension.

Learner outcomes. Many positive benefits have emerged from mobile TEL initiatives. A study by Woodcock et al. (2012) highlighted that many learners were largely unaware of the potential for mobile devices to support learning, but that the majority were interested and receptive to the idea of integrating their devices within lectures. Similarly, Gikas, and Grant's (2013) study around learner perceptions of m-learning found that the apparent benefits were outweighed by the perceived drawbacks. Advantages included; rapid access to information; enhanced communications with fellow classmates and the lecturer; the use of online polls, video, voice memos and social media in teaching; and the delivery of course content within a real-world setting. One university has used a mobile learning system (m-LSEMC) within their mathematics department. It has been reported that 93% of learners who used the system to revise their subject gained improved results (Ntinda et al., 2014). Kenny et al. (2012) quantitatively assessed the self-efficacy of learners at a community college in western Canada related to their potential use of mobile technology. The median mobile self-efficacy score was 75%, indicating that learners were highly confident in their use of mobile technologies and prepared to engage in mobile learning. Walters (2011) suggests that portability and kinaesthetic interaction help learners to develop visual and spatial skills, boosting creativity. Educators see great potential for apps that allow science learners to manipulate data and process statistics, deepening their understanding of complex relationships and concepts

(Johnson et al., 2010). Mobile learning supports a social-constructivist pedagogy, with particular emphasis on learners' responsibility and ownership of learning. Mobile learners working in collaborative groups are more active learners and more accountable to the group for their learning (Pegrum et al., 2013).

Overall, mobile TEL initiatives have afforded opportunities for HEIs to meet the needs of today's digital world learners by providing them with authentic, interactive and learner-centred experiences (Kissinger, 2013; Tsai & Hwang, 2013).

3.3.2 Moving from Personal Computer and Laptop-Supported Learning to Mobile TEL

As life today becomes more mobile, the transition from PC and laptop to mobile devices is becoming more popular within HEI settings. Mobile telephones, smartphones, tablet computers, eBook readers, personal digital assistants (PDAs), and other similar devices can all be defined as mobile devices (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, & Vavoula, 2009). Mobile devices are personal, universal and closely linked to learner identity (Rothwell, 2016; Traxler, 2010). Wu et al. (2012) found in their literature review that mobile telephones are most commonly used for mobile learning (36.55%), followed by PDAs (30.96%), laptop computers (9.14%), iPods (4.06%), mp3/mp4 players (2.54%), podcasts (2.04%), and cameras (1.52%). Wu et al. (2012) also found that in formal education contexts, higher education institutions favoured mobile telephones (34 studies), followed by PDAs (30) and laptops (7). Hence, teaching and learning with mobile devices matches today's global digital world.

Mobile learning or m-learning has been defined by Crompton (2013) as "learning across multiple contexts, through social and content interactions, using personal electronic devices". The demand for new teaching strategies and pedagogies that focus on personalised instruction for learners (Milrad & Spikel, 2007) has resulted in the trend of education moving from PCs and laptops to "anytime, anywhere learning with mobile devices" (Kissinger, 2013; Munawar & Cukier, 2011; Traxler & Wishart, 2011). Mobile learning has unique technological attributes which provide positive pedagogical affordances (Park, 2011). Recent research findings on using mobile devices in different learning environments have exemplified their ability to effectively

enhance learners' knowledge and understanding in divergent subject areas such as science (Hwang, Wu, & Ke, 2011), mathematics (Huang et al., 2012; Mahamad et al., 2010) and engineering (Yang et al., 2013). This promising role in education is noticeable within the informal and formal learning context, such as facilitating knowledge acquisition in field trips (Menkhoff & Bengtsson, 2012), game-based learning (Young et al., 2012) and in-class collaboration learning (Echeverría et al., 2011). With mobile devices becoming more popular and affordable (Hintze, Hintze, Findling, & Mayrhofer, 2017) and demands for new teaching and instructional approaches, many HEIs have begun to implement mobile TEL initiatives as a strategy for addressing the diverse needs of ICT and engineering teachers and learners (Lin, 2015).

Rapidly advancing mobile technology means teachers are presented with even more challenges since "effective teaching depends on flexible access to rich, well-organised and integrated knowledge from different domains, including knowledge of learner thinking and learning, knowledge of subject matter, and increasingly, knowledge of technology" (Koehler & Mishra, 2009, p.61). Thus, mobile technology initiatives must be integrated into HEI education in an effort to keep up with the technological environment that society lives in outside of the educational setting. According to Handal et al. (2013), teaching in the future will most likely be conducted with mobile technology to facilitate anywhere-anytime learning, improving learners' communication beyond the university walls and enhancing autonomous learning.

3.3.3 Theories and Models for Learning with Mobile TEL Technologies

Advances in technology have resulted in changes in society and culture. Correspondingly, expectations of learners have progressed. With the advent of web 2.0 technology, learners can now interact with others through collaboration by making use of social networks, podcasts, wikis, and blogs (Maddin, 2011; Prensky, 2006). The Internet is now more than a tool for locating educational information. With these changes in learner expectations, key theories for technology innovation in education by teachers have emerged.

Constructivism. Educational research has proposed that instructional environments rich in digital technological tools greatly support active engagement, social learning, continuous feedback, and real-world application instructional approaches, and together represent constructivist pedagogy (Phillips, 2000). Kissinger (2013) claims that mobile technologies nurture constructivist teaching and learning. Mobile e-book readers for example allow for learner-centred and situated learning experiences (Kissinger, 2013). When instructional technology is used effectively, learners who are involved in technology-driven environments with real and active learning become autonomous thinkers who can transfer understanding to useful, real-life settings (Oblinger, 2008). Instruction by means of constructivist pedagogy has several unique features. Learning is centred on inquiry in an environment where knowledge is built rather than just shared (Roblyer & Doering, 2010). Learning is going from the inside out (Reiser & Dempsey, 2017) and happens where a learner constructs knowledge based on background, aptitude, experience, and interacts with others (Roblyer & Doering, 2013). Learning is learner-centred where learners generating their own knowledge can demonstrate proficiency in different ways (Mouza, 2008; Roblyer & Doering, 2010).

Learning by design. As well as constructivist learning aims, the use of technology advocates the importance of activating prior knowledge (Lee & Spires, 2009). Learners' learning experience has changed with the advent of always-available mobile computing. In response, teachers have the crucial task of enabling learner engagement and learning by means of mobile technology. Lee and Spires (2009) assert that learners should be "involved in the design of digital environments as active participants in a learning process" (p. 65). As learners become engaged with the mobile technology environments, they research, reflect and resolve issues in real situations. For example, the use of mobile devices as personal response systems, or "clickers" enables participation, which in turn makes learning more interactive (Foti & Mendez, 2014). In addition, learners begin to construct their own knowledge while at the same time building their own learning environments (Puntambaker & Kolodner, 2005).

Vygotskian psychology and activity theory. Highlighting the role of "social interaction in development and learning" (p.17), Verenikina (2010) proposed that Vygotskian psychology and Activity Theory are relevant for research about educational technologies. Notwithstanding Vygotsky's theoretical views emanating in the 1960s, Verenikina (2010) suggested that Vygotskian psychology and Activity Theory supported the idea that mobile computing devices are tools that are interconnected with a learner's real activities. Verenikina (2010) further emphasises that although these learner activities result in enhanced learner performance, technology should not take the place of strong pedagogical approaches. Rather, teachers must imbed technology into the content using advanced pedagogies. Young and Bush's (2004) principles which afford specific ways for teachers to implement technology efficiently and effectively support Verenikina's (2010) assertions. Young and Bush (2004) developed a framework for educators to think critically about the connection between technology and the development of critical thinking skills in literacy and writing. Their framework outlined a strategy for educators to "infuse technology in a way that does not interfere with the content pedagogy but supports it in a way that actively involves learners and prepares them with the technical and pedagogical skills" required for building learning environments where learner-centred instruction is the norm (p. 96).

Social development theory. Vygotsky's theory of social development, which was largely unknown until its publication in 1962, asserted that a fundamental part of the cognitive development process involves social interaction (Daniels, 2011**;** Delahunty**,** Jones & Verenikina, 2014; Miller, 2011). Accepting there to be a connection between people and the sociocultural context of human experiences, Vygotsky signified that human beings use tools that develop from a culture, such as speech and writing, to mediate their social environments (Phan, 2012). People who may initially develop these tools merely as a social function, later internalise these tools that then lead to higher-order thinking skills (Miller, 2011; Phan, 2012; Verenikina, 2010)

With Vygotsky's theory of social development, educators can promote learning contexts that actively engage learners who play an active role in constructing knowledge by collaborating with their teacher who facilitates meaningful construction. Here learning takes place both formally and informally as learners become autonomous, informal learners within social settings (Bell, 2011; Miller,

2011). Using web 2.0 services, ICT and engineering learners are able to share ideas and post their assignment work, read subject text based on their area of interest and construct knowledge through informal learning that takes place outside the classroom (Bell, 2011; Siemens, 2004).

Connectivism. Siemens (2004) suggested that learning is a "process of connecting specialised nodes or information process," and may lie in "non-human appliances" (Bell, 2011, p. 103). In addition, ICT and engineering learners learn through the practice of decision-making as they choose what subject specific areas to learn about and how changing views about what is right leads to greater learning and knowledge (Bell, 2011; Siemens, 2004).

According to Kop and Hill (2008), connectivism pedagogy signifies a move towards learner autonomy in learning, as the theory emphasises "distribution of learning across networks of people and things and the capacity of learners to be active" (Bell, 2011, p.103). However, many question the idea of connectivism as a theory and believe it is merely a pedagogical approach at course level (Bell, 2011; Clara & Barbera, 2013; Kop & Hill, 2008; Ravenscroft, 2011; Verhagen 2006). Having studied five scenarios regarding technology integration, Bell (2011) hypothesised that "connectivism alone is insufficient as a theory to inform learning and its technology-enabled support in an internetworked world" (p. 112), yet it can be an "influential phenomenon that inspires teachers and learners to make changes in their practice" of technology integration (p. 112).

Situated Learning. Situated Learning Theory developed by Lave in 1998 theorised that learning occurs in unintended ways and is "situated within authentic activity, context, and culture" (Brown, Collins, & Duguid, 1989). Hence, learning takes place wherever the learner might be and not only inside the confines of the classroom. Situated Learning focuses on the "context in which activities occur and their application to real-world use" (Kissinger, 2013, p.157) and is derived from constructivism and social cognitive theory. With the growth in mobile TEL opportunities, learners are able to create intellectual images of the world. These provide learner-centred and situational learning experiences (Kissinger, 2013).

Situated learning also includes social interaction and collaboration (Lave & Wenger, 1991). With mobile learning technologies and devices, learners are able to

constantly interact with others and their environment. Learning offered by mobile technology is “highly personal and situated within the individual’s own authentic contexts” (Kissinger, 2013, p.156).

3.3.4 Strategies and Models for Mobile TEL Technology Integration

Technology Pedagogical Content Knowledge

Comprehending educational technology theory is only one aspect of understanding the impact of technology integration and mobile TEL. Teachers must seek ways to comprehend learners’ habits, interests, and needs according to Prensky (2006). Mishra and Koehler (2006) introduced a specific form of knowledge called Technology Pedagogical Content Knowledge (TPCK or TPACK) in answer to the needs of digital generation learners. According to Mishra and Koehler (2006) and Koehler and Mishra (2009) this pedagogical approach is defined as knowledge about the “complex interplays between technology, pedagogy, and content and how they play out in different contexts”. The approach depicts the required procedures for teachers when integrating technology into their teaching of constructivist learning objectives (Lee & Spires, 2009).

SAMR. Another useful model for conceptualising technology integration into education is the Substitution, Augmentation, Modification, Redefinition (SAMR) model (Puentedura, 2014). The SAMR model assumes that technology is already being used in the classroom, so it is a logical next step after a mobile technology has been introduced to a HEI. The utility of this model comes from its ability to inform teachers and HEI administrators about how mobile TEL is influencing their faculty’s teaching and learner learning. By viewing their activities through the lens of SAMR, ICT and engineering teachers can gain insight into whether greater gains can be made from even more creative applications (Johnson, 2014). For example, at the redefinition level, where teachers use the technology for the creation of tasks previously inconceivable (such as to create a documentary video answering an essential question related to important concepts where teams of students take on different subtopics and collaborate to create one final product), the implication is that the technology will affect learner achievement.

Recent applications of this model include programme evaluations, specific intervention evaluations, and teachers' readiness research. The SAMR model was used to analyse activities implemented during a one-to-one iPad project (Chou, Block, & Jesness, 2012). Significantly, during this project the SAMR model was presented in professional development trainings in preparation for the programme. It gave the teachers a practical tool for evaluating their own lesson plans, and guided discussions during monthly professional development meetings. In Scotland the model was also used to evaluate an iPad programme (Fabian & MacLean, 2014).

Technology integration planning model (TIP). Teachers who are experienced with technology integration instinctively use the steps in the TIP model when planning to integrate mobile digital technologies. The TIP model is a problem-solving method to select best practice in applying mobile digital technologies (Roblyer & Doering, 2013). The model incorporates five steps as a guide to identifying what materials can benefit learning and any issues that may be present (Roblyer & Doering, 2013). TIP is also suitable for inexperienced teachers. Its steps include firstly determining the relative advantage of using technology, secondly deciding on objectives and assessments, thirdly designing integration strategies, fourthly preparing the instructional environment to support the technology integration and finally reflecting on the strategies and instruction through analysis and revisions (Roblyer & Doering, 2013).

3.3.5 Mobile TEL Teacher Professional Development and Collaboration

In the main, professional development for teachers has been delivered through scheduled, classroom-based sessions (Jones & Dexter, 2014; Jones & Dexter, 2017; Plair, 2008; Tytler, Symington, Malcolm, & Kirkwood, 2009). It is important to note that one-time workshops are not as effective as a system of on-going professional development, in regard to being most effective in supporting teachers' ability to develop the knowledge, skills, new teaching strategies, and technology integration change in classrooms (Cifuentes**,** Maxwell**,** & Bulu**,** 2011). Darling-Hammond, Hyler, and Gardner (2017) argued that seven elements should exist for teacher professional development to be effective: (a) content-focused, (b) incorporates active

learning, (c) supports collaboration, (d) uses models of effective practices, (e) provides coaching and expert support; (f) is of sustainable duration.

Professional development is not usually seen to be the most effective for teachers attempting to effectively implement mobile technologies, and typically does not meet the needs of today's teachers (Jones & Dexter, 2014; Ross, 2013). This is due to the inflexibility of time and place in addition to insufficient on-going support (Mackey & Evans, 2011). Teachers must receive effective professional development using appropriate delivery systems as they now face the additional pressures of integrating rapidly developing digital technologies. If not, attempts to prepare learners for careers that depend on a technology cognisant society will fail (Jones & Dexter, 2014; Kopcha, 2010).

Due to the insufficient and ineffective nature of formal professional development (Jones & Dexter, 2017) and the fast-paced evolvement of communication technologies, the need for alternatives to advance teachers' knowledge, skills and practice through collaboration has been researched. Dewey (1916) asserted that reflection upon and debate about a teacher's own practice is a social process and not a solitary activity. According to Dewey, reflection is the "product of practices embedded in community settings" (Hadar & Brody, 2017, p.158). However, due to seclusion, teachers have insufficient time or possibility to debate their concerns about mobile TEL integration. According to Triggs and John (2004), seclusion among teachers results from external and internal pressures of no time or opportunity to reflect on or discuss teaching with colleagues. Teachers enjoy little time to engage in dialogue with colleagues about research and teaching practice (Berry, 2009; Hadar & Brody, 2010). It is essential that CPD about technology integration is rooted in educational practices. Participation in a professional learning community (PLC), characterised by a focus on peer collaboration, stimulating discussions, reflective dialogue, and discourse about educational practice is crucial for teachers in their attempts to implement educational innovations (Darling-Hammond, 1997; Schlager & Fusco, 2004; Wenger, 1998). Cifuentes, Maxwell, and Bulu (2011) argue that effective technology integration must include social activity within a community of learners. Such a community including planned or unplanned outcomes, affords opportunities for educators to engage in collaborative activities and discussions,

build trusted relationships and learn from each other's practice (Wenger, McDermot, & Snyder, 2002).

Among the alternatives for enhancing teachers' mobile technology integration are formal and informal learning communities (Dufour, 2004; Jones & Dexter, 2017; Kopcha, 2010). Both formal and informal learning involve the development of teacher learning communities and can include the development of PLCs (Dufour, 2004), CoPs (Fitzsimmons, 2007; Jones & Dexter, 2014; Wenger, 2007) and personal learning networks (PLNs) (Richardson & Mancabelli, 2011). Literature suggests that formal PLCs can facilitate improved communication among teachers, and between teachers and others, by providing structured time for sharing and collaboration (DuFour, 2004; Duran, Brunvard, & Fossum, 2009; Gerard, Bowyer, & Linn, 2010; Loving, Schroeder, Kang, Shimek, & Herbert, 2007).

Learning Communities. Teacher communication and collaboration is greatly improved by means of professional development within learning communities (Jones & Dexter, 2017). In addition, such professional development delivers timely support and enables teachers to choose the time and content (Dufour, 2004; Jones & Dexter, 2017; Wenger, 2007). Cano (2006) asserted that professional development is most effective when it takes place in vibrant learning communities which can take various forms, but all value ongoing learning by both teachers and learners. They cultivate collegiality and problem solving and they emphasise continuous improvement in learning environments.

Recent research illustrates many benefits to learning communities. Learning communities provide opportunities for improvement in teacher practice by assisting and learning from other teachers and increases in problem-solving to improve practice. Also, they afford opportunities for collaborative planning and mentorship (Martin, 2011; Stoll, 2011).

CoPs and Informal Learning. CoPs not organised by HEIs but formed by teachers who share common issues are considered informal learning communities (Jones & Dexter, 2014; Jones & Dexter, 2017). CoPs which are formed by teachers who communicate daily provide many benefits to teachers adopting and implementing mobile TEL technologies. Teachers can decide on the time, content and means for learning, and additionally the support for the mobile TEL technologies and devices

improves as the response time for the support improves (Plair, 2008). Although CoPs are voluntary, to be effective they depend on teachers' skills and knowledge relating to mobile TEL technology integration, their interaction and engagement as CoP members and a personal passion from those involved (Abigail, 2016; Drouin**,** Vartanian, & Birk**,** 2014; Jones & Dexter, 2014; Jones & Dexter, 2017).

With the advancement of mobile tools and technologies, CoPs for ICT and engineering teachers are also being developed through online or virtual communities (Jones & Dexter, 2014; Jones & Dexter, 2017; Mackey & Evans, 2011; Pimmel, McKenna, Fortenberry, Yoder, & Chavela Guerra, 2013). Many researchers believe that creating and maintaining virtual communities that are not inhibited by space and time (Wenger et al., 2002, p.5) will provide a meaningful solution to the challenge of pursuing traditional professional development and expand its scope (Kirschner & Lai, 2007; Locke, 2006; Williams & Olaniran, 2012). Murray-Johnson (2014) found that virtual CoPs offer a clearer sense of professional identity, increased reflective practice and diversified skills. Research also indicates that virtual CoPs for professional academic development are transformative, sustainable and scalable (Donnelly, 2008).

PLCs and Informal Learning. Suggesting to enable change and develop the practice of teachers and HEIs, PLCs help to initiate an institute-wide culture and enhance institute-wide advancement (Hadar & Brody, 2010). PLCs represent an increasingly utilised learning strategy with potential to give rise to praxis between practice-based learning and pedagogy (Watson, 2014) by addressing participant-identified needs, collaborative problem solving, continuity, and support (Parker, Patton, & Tannehill, 2012). PLCs have proven successful in breaking personal and professional isolation through interdisciplinary collaboration, the encouragement of risk taking, and the promotion of mutual support (Hadar & Brody, 2010). Bellanca and Brandt (2010) assert that PLCs are a crucial factor in helping teachers as they acquire the necessary skills.

Researchers have reported a number of benefits of the official establishment of PLCs. Besides improving communication capability for teachers, PLCs provide a formal time to build a collaborative culture so that they can develop real, research-based teaching strategies (Dufour, 2004; Stoll, Bolam, McMahon, Wallace, &

Thomas, 2006). However, Jones, and Dexter (2017) note that official and formal PLCs developed by department heads do not always coincide with the professional development needs of teachers. PLCs are effective in promoting the competence and confidence, as well as the learning of the teachers involved (Stoll et al., 2006). Participation in PLCs does seem to support teacher learning and professional development that is primarily influenced by the needs of teachers as they work toward their individual, department and school-wide goals (Vescio et al., 2008). Overall, teachers' professional learning taking place in PLCs is "widely believed to be more effective when it is based on self-development and work based learning" (Stoll et al., 2006, p. 232).

The evolution of mobile tools and technologies provides alternative ways for ICT and engineering teachers to debate and reflect on their teaching practice and to collaboratively resolve issues regarding mobile technology integration and learner achievement (Jones & Dexter, 2014; Jones & Dexter, 2017).

PLNs and Informal Learning. It is now easier for teachers to inspire, inform, and challenge each other by sharing paths of learning via online personal learning networks designed to provide them with current resources. Teachers build such online PLNs by subscribing to professional learning sites, blogs, twitter, wikis, podcasts, social bookmarking sites, and online videos to source and share ideas and resources (Baker-Doyle, 2011; Richardson & Mancabelli, 2011). This type of community learning differentiates itself from previously mentioned models such as informal COPs and formal PLCs in that the platforms used have no connection to a member's organisation, and not only is the member's activity voluntary, it is frequently anonymous because of the use of alternate logins or user names. PLNs can provide speedier access to information on emerging technologies, as there is no waiting time for learning activities to be developed. Teachers globally utilise social media to report, in real time, their successes and failures with new tools. PLNs possess many of the same offerings as PLCs and informal COPs, but generally utilise a greater network of resources, have more up-to-date information on technology integration, and allow for anonymous participation (Alderton, Brunsell, & Bariexca, 2011). Anonymous participation in PLNs has been reported by teachers as allowing them the ability to discuss issues felt inappropriate for HEI sponsored platforms and allows them to seek support without feeling intimidated (Jones &

Dexter, 2014). However, PLNs also require teachers to possess somewhat advanced knowledge of technology in order to utilise and navigate among several different platforms (Flanigan, 2011).

3.3.6 Mobile TEL Environments

Mobile learning technologies have been used in HE settings and offer many benefits. Research indicates portability, ease of use, size, learning in real-world learning contexts, personalised learning and increased teacher and learner communication and engagement as reasons to integrate mobile devices into learning environments (Khaddage, Lattemann, & Bray, 2011; Munawar & Cukier, 2011).

As the majority of learners already own a mobile device (Wagner, 2008), today's digital world learners are already proficient in using such technology. As mobile devices and technologies are widely used and enable global connectivity, their application in higher education affords opportunities for authentic learning activities where learners can work with problems from the real world (Tsai & Hwang, 2013). In this new learning environment, learners are able to access wide-ranging digital resources and interact with learning systems via handheld devices and wireless networks when they are situated in real-world contexts (Wu et al., 2012; Yin et al., 2013). Such a learning scenario happens without being limited at a fixed location or time (Abhyankar & Ganapathy, 2014; Kissinger, 2013; Munawar & Cukier, 2011; Traxler & Wishart, 2011).

Solverg and Rismark (2012) in a study on learning spaces in higher education mobile learning environments discovered that learners like the flexibility of being able to watch lectures at a convenient time for them, and that learning did not have to occur at a fixed time or place. Learners can watch video lectures in real time off campus using their own wireless connections (Solverg & Rismark, 2012). In addition, mobile technologies offer better access and possibilities for task-based, personalised learning for the learner-driven element of their digital lifestyles (Khaddage, Lattemann, & Bray, 2011; Kopcha, 2010; Munawar & Cukier, 2011).

Due to the benefits mobile technologies offer learners as they become competent in the skills necessary for success in today's digital world, the use of mobile devices in ICT and engineering education has become as important as the need for teaching ICT and engineering principles themselves. Research into the use of mobile TEL

initiatives for learning indicate that TEL technologies are a valuable asset in overcoming difficulties in learning concepts within ICT and engineering by situating these learners in real-world learning contexts, anytime, anywhere and providing a learning environment that enables such learners to access appropriate digital learning resources (Abhyankar & Ganapathy, 2014; Handal et al., 2013). Adopting mobile TEL technologies provides teachers and learners with unique ways to express and communicate ICT and engineering concepts in real situations using TEL initiatives such as smartphones, tablets, Google Docs, blogs, twitter, wikis, synchronous and asynchronous discussion forums (De Wever, Hämäläinen, Voet, & Gielen, 2015; Menkhoff, Chay, Bengtsson, Woodard, & Gan, 2014; Minocha, 2009; Wheeler, 2010). According to Keengwe, Pearson, and Smart (2009), learners are engaged and motivated when using mobile devices, and see the devices as helpful in understanding difficult concepts.

Within higher education settings, mobile TEL environments help teachers to personalise learning activities and differentiate their lessons to address learners' diverse learning styles. Teaching materials can be customised to learners' learning style, location, time and activity (Isabwe, 2014). From a learner perspective, mobile TEL environments empower learners by shifting the control from the learner as a recipient of teacher knowledge to a learner as an active learner (Crompton, 2013). In this context, learning becomes informal, situated and authentic, resources and knowledge being available whenever the learner needs it (Land & Zimmerman, 2015; Pimmer & Pachler, 2014).

Khaddage and Lattemann (2013a) studied the use of three mobile apps (e-Lecture Producer, Dropbox and QR Code) by 26 second-year learners on an e-commerce course. They found that mobile devices and apps can be used in HE as a form of ubiquitous learning, allowing teachers and learners to collaborate, communicate and learn together, bridging formal and informal learning. Overall, using mobile TEL technologies not only provides learners with unique opportunities to write and communicate in real situations, but also keeps them active and supports ICT and engineering teachers in creating more engaging experiences (Pegrum et al., 2013). Mobile TEL technologies also provide learners with support from their fellow learners and teachers when completing assignments (Dohn, 2009; Farley et al., 2015), creating a more meaningful learning experience because learners take more

responsibility for their learning and feel as though they are contributing in unique ways.

3.3.7 Obstacles and Challenges to Mobile TEL Technology Adoption

Although mobile learning is engaging and affords learners opportunities for collaboration, obstacles do exist and must be overcome before mobile TEL can be applied at its best. Previous research into the obstacles for technology integration with mobile devices indicates such obstacles include access, vision, attitudes, time and professional development (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). Many teachers doubt the value of mobile technology due to time constraints and assessment demands (Gregory & Lodge, 2015; Liu, Han, & Li, 2010; Reed, 2014). Due to smaller screen sizes, reduced resolution, and lack of data input impeding the use of mobile devices, many teachers doubt the potential of mobile learning because the perceived task value is low (Liu, Han, & Li, 2010). This perceived lack of potential then impacts adoption of mobile technologies.

Additionally, insufficient preparation, lack of time and inadequate professional development hinder mobile TEL adoption. Research indicates that teachers feel unprepared to best implement mobile technologies into their instruction (Albirini, 2006; Butler & Sellbom, 2002; Pelgrum, 2001). Time remains an issue for teachers since there are so many responsibilities they already have to include in their planning (Gregory & Lodge, 2015; Liu, Han, & Li, 2010; Reed, 2014; Tsai & Chai, 2012). CPD frequently focuses more on the technology skills and less on the pedagogical skills needed to integrate technology effectively (Ertmer et al., 2012; Kopcha, 2010). Studies to date show that professional development programmes are not of sufficient duration to sustain change and do not focus on concise and relevant information (Desimone, 2009; Opfer & Pedder, 2011; Timperley & Alton-Lee, 2008). Such programmes are not of sufficient duration to facilitate change and that they do not provide sufficient content-specific information (Desimone, 2009; Opfer & Pedder, 2011; Timperley & Alton-Lee, 2008). Therefore, teaching experience, computer competency, availability of technology, institutional support, time and adequate professional development play a critical influential role in whether ICT and engineering teachers feel ready to adopt TEL in their teaching (Dougherty, 2015).

In general, teachers who are at the centre of any initiative, are still unconvinced as to the benefits of mobile TEL technologies in learner learning (Chen et al., 2009; Ertmer et al., 2012; Hwang & Wu, 2014; Kopcha, 2010; Kopcha, 2012; Roblyer & Doering, 2013; Sharples, Arnedillo-Sanchez, Milrad, & Vavoula, 2009; Shih et al., 2011; Wagner, 2008). Although professional development continues to be an external obstacle for adoption and implementation of mobile TEL initiatives, attitudes and beliefs of other teachers obstruct the use of technology more so than a teacher's own attitudes and beliefs (Ertmer et al., 2012).

3.3.8 Effective Implementation of Mobile TEL

Ross (2013) advocates that obstacles encountered in mobile learning can be alleviated through effective implementation. Bielefeldt (2012) and Ting (2012) reported certain factors and conditions that must be in place for effective implementation of mobile TEL. These factors include an adequate support system, CPD, and prospects for teacher collaboration (Bielefeldt, 2012; Liaw, Hatala, & Huang, 2010; Ross, 2013; Ting, 2012). In addition, teacher perceptions of mobile technologies significantly influence its effective implementation (Crompton, 2013).

Handal et al. (2013) found that additional training and experience implementing instructional technology in pedagogical processes is necessary for teachers to become comfortable with instructional technology and to use it effectively. Teachers therefore need training into how to incorporate these devices into content and to explore truly innovative uses (Melhuish & Falloon, 2010). In their qualitative study focusing on technology adoption and implications on training, Keengwe, Kidd, and Kyei-Blankson (2009) concluded that teacher support and training were the foundation of teacher adoption of instructional technology.

Somekh (2008) reviewed research that focused on the factors affecting instructional technology adoption and found a key for the successful adoption of instructional technology was for professional development opportunities to focus on both technical skills and pedagogical changes. This focus on skills and pedagogy led to instructors embedding technology in the learning processes. Somekh (2008) also found that another factor to the successful adoption of instructional technology was for development to focus on the teachers. With this focus on the educators, training

and pedagogical support catered to individual differences and took into account individual teacher personality types.

If teachers are to enhance teaching and learning practice effectively by integrating emerging mobile technologies, they must understand their particular attributes, perceive self-efficacy in using them, have positive attitudes towards their pedagogical affordances and recognise challenges to implementing them in education (Handal et al., 2013; MacCallum & Jeffrey, 2009).

3.4 Summary

This chapter offered an analysis of the evolution of technology integration for HEI education with PCs, laptops and mobile devices. Background evidence was charted, together with present findings of technology integration experiences and results, and obstacles to technology adoption and implementation. Prolific changes in technology devices and tools result in significant challenges for HEI teachers who continue to voice their lack of confidence in using this technology for teaching (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012; Mishra & Koehler, 2006). Also, insufficient mobile TEL-specific CPD remains an obstacle in the adoption and integration process (AlMutlaq, Dimitriadi, McCrindle, 2017).

Many aspects of the research design as outlined in the next chapter ‘Chapter 4: Methodology’, build on particular issues outlined in this literature review. As there are too many generalisations regarding the successful adoption of mobile TEL (Traxler & Wishart, 2011), this research builds on current literature specifically related to the disciplines of ICT and engineering adopting mobile TEL. Looking at the interactions with the wider surrounding social system and the perceptions of benefits and obstacles builds on the current literature detailing issues of engagement, critical thinking skills development and different levels of “digital literacy” and Internet access (JISC, 2015). This phenomenological research also explores ICT and engineering teachers’ specific perceptions of failures in mobile TEL adoption which to date has been a missed opportunity (Traxler & Wishart, 2011). Examining how the innovation becomes integrated into the time and space of practice helps fill the void of a solid theoretical foundation for mobile learning in the context of mobile education. It also provides guidance about how to utilise emerging mobile

technologies and integrate them into ICT and engineering teaching more effectively (Sharples, Taylor, & Vavoula, 2007; Uden, 2007; Zurita & Nussbaum, 2007). Examining perceptions of the innovation itself, generates insights into the unique technological attributes of mobile TEL applied specifically within ICT and engineering which provide positive pedagogical affordances (Park, 2011). Also, by exploring the teaching practices and pedagogies used by ICT and engineering teachers, greater insights are gained into the assertion that most theories of pedagogy fail to capture the distinctiveness of mobile learning (Taylor, Sharples, O'Malley, Vavoula, & Waycott, 2006).

Chapter 4: Methodology

4.1 Overview

The purpose of this chapter is to present the research design, procedures, and analysis for this research study. Descriptions of the research questions, setting, participants (population and sampling), as well as procedures, role of the researcher, and measures for data collection (instrumentation) and analysis are outlined and debated throughout. Trustworthiness and ethical considerations are also addressed.

The purpose of this qualitative phenomenological study was to seek and understand the experiences and perceptions of ICT and engineering teachers with the adoption and integration process as teachers at HEIs in Ireland and the UK transition from PC and laptop-based initiatives to institution wide adoption and implementation of mobile TEL. Mobile TEL environments were generally defined as classrooms both physical and virtual, where teachers and learners use a variety of TEL technologies and devices across multiple platforms to enhance their learning. Additionally, the adoption process was defined as the manner through which an individual or group sought and processed information about an innovation, then formed an attitude and decided whether to adopt or reject the innovation (Rogers, 2003).

4.2 Research Design

This qualitative research investigated and sought to understand the perceptions and lived experiences of ICT and engineering teachers within HEIs adopting and implementing mobile TEL initiatives. Qualitative research was deemed appropriate for the following reasons. Firstly, qualitative research is favourable for researchers who seek to understand concepts that have not been well-defined in the literature (Creswell, 2013). Mobile TEL is a relatively new phenomenon, particularly in ICT and engineering higher education literature. Also, qualitative studies are valuable because the researcher can be included in the lived experiences of the participants. Qualitative research examines “things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them” (Denzin & Lincoln, 2000, p. 3). Throughout my research, I sought to highlight the significance of and unearth meaning from the perceptions and lived experiences of ICT and engineering teachers as they adopted and implemented mobile TEL

initiatives; thus, I conducted semi-structured interviews, observations, and focus groups in the normal context of the phenomenon.

Creswell (2013) asserts that a phenomenological design is appropriate for describing lived experiences of a concept or phenomenon. Phenomenology is defined as research "concerned with wholeness, with examining entities from many sides, angles, and perspectives until a unified vision of the essences of a phenomenon or experience is achieved" (Moustakas, 1994, p. 58). Thus, in this phenomenological study, I focus on the shared experiences of the participants so that I ascertain the meaning of the experience and then comprehensively describe it (Moustakas, 1994). Notably, as the purpose of phenomenology is to "reduce individual experiences with a phenomenon to a description of the universal essence" (p. 76), perceptions and experiences about the individual experiences of teachers during their adoption and implementation of mobile TEL initiatives are also revealed.

Phenomenological research also studies the *lifeworld* (Lebenswelt), which is defined as "what we know best, what is always taken for granted in all human life, always familiar to use in its typology through experience" (Husserl, 1970, p. 123-124). As mobile tools and technologies are widely used and embedded in teacher and learner lifeworld today, an examination of mobile TEL teachers' experiences is consistent with the choice of a phenomenological design (Cilesiz, 2011). In attempting to appreciate the affect mobile TEL tools and technologies have on teaching and learning practices and pedagogies, it is critical to examine and comprehend teacher perceptions and experiences during the adoption and implementation process. As teaching and learning with mobile TEL tools and technologies is fundamentally different to that with traditional methods, Cilesiz (2011) argues that a phenomenological approach is necessary because it "provides a suitable framework for research on experiences in educational technology and can advance the field by complementing and unifying existing research" (p. 488).

As a methodological tradition, phenomenology has many points of origin and takes different approaches and traditions. Two phenomenological approaches exist: descriptive and interpretive. Descriptive phenomenology is primarily derived from the work of Husserl (1970) with his primary question being "What do we know as persons?" and focused on describing human experience as "understood and

described from the perspective of those who have had the lived experiences and are able to describe it" (Polit & Beck, 2008, p. 228). Interpretive phenomenology derives from the philosophies of Heidegger and Gadamer and strives to understand the meaning of being in the world. The primary question in this research is "What is Being?" and stresses interpreting and understanding the possibility of living such an experience over merely describing human experience (Polit & Beck, 2008, p. 228). As I required to describe the experiences of teachers as opposed to interpret and understand the possibility of living such a teaching experience, descriptive phenomenology was appropriate for this research.

Moustakas (1994) seeks to articulate what he terms a transcendental phenomenological tradition, while Giorgi (2000) presents an empirical-psychological tradition. Both traditions derive from Husserl's descriptive approach and have alternative interpretations of phenomenological concepts such as epoche and reduction. Giorgi (2000) describes the empirical-psychological tradition as one where "only the objects of the experience are reduced, not the acts" (Giorgi, 2000, p.65). Using the psychological reduction, the facticity of the empirical objects described by the participant is bracketed, but not the facticity of the psychological subject. That is to say, "the acts are considered to be correlated with an existing, world subjectivity" (p. 65). The tradition remains a psychological one because the participant's empirical ego, the individual psyche, is regarded as a fact rather than bracketed and regarded as an instance of transcendental subjectivity. For Moustakas (1994), transcendental subjectivity represents an achievement of the empirical ego. As a result, Moustakas collapses the transcendental into the empirical. Moustakas asserts that the researcher remains present as the person that he or she is, and that he or she has or adds a "transcendental consciousness" to their personal presence by setting aside biases. Hence, he claims that once a researcher has "achieved" transcendental consciousness, then "the perceiving self is an authentic self… the self is actually present" (p. 61). Here the participant's empirical ego, the individual psyche, is not regarded as a fact and is bracketed. In this way the use of transcendental phenomenology hereafter referred to as phenomenology, includes a process for acknowledging the researcher's own opinions and suppositions about the phenomenon being examined. Moustakas (1994) referred to this process as *epoche*.

This was important because I had experienced the adoption and implementation of mobile TEL initiatives in one of my own HEIs.

As I required to describe the experiences of teachers as they adopted mobile TEL technologies, eliminating any preconceptions and personal bias, the transcendental tradition of phenomenology described by Moustakas (1994) was deemed most suitable for this research. The transcendental phenomenology method involves the following steps for each research participant. Firstly, in the epoche, the researcher "looks inside to become aware of personal bias, to eliminate, or at least gain clarity about preconceptions" (Patton, 2002, p. 485). Researchers need to be aware of prejudices, viewpoints or assumptions regarding the phenomenon under investigation (Katz**,** 1987). Secondly, moving from the epoche in a process called transcendental-phenomenological reduction to describe what the participants experienced, the researcher approaches the phenomenon with a clear and open mind, and from different perspectives, eliminating any preconceptions (Katz, 1987). This is significant to the robustness of my research. Here units of meaning or invariant horizons are identified. These units of meaning are then given equal value which is referred to as horizonalisation. Subsequently researchers describe what was seen using textural descriptions. Such descriptions involve the "internal act of consciousness, the experience as such, the rhythm and relationship between phenomenon and self" (Moustakas, 1994, p. 90). Thirdly, in the process called imaginative variation, from the textural description the researcher constructs the structural epitome of the experience using imaginations and intuition to reflect the relationship (themes) pertinent to the experience. Fourthly, in a process called synthesis, the textural and structural descriptions are combined to form a textural-structural description of the experience, with emphasise on the space and time when the phenomenon is observed (Moustakas, 1994). Finally, once these four steps are completed for all participants, the textural-structural descriptions are combined into a composite description representing the essence of experience of all participants.

4.3 Research Setting

This research was conducted across three HEIs (including my workplace) in Ireland and also four HEIs in the UK. HEIs included four universities, two institutes of technology, and one HEI of another type, spread throughout Ireland and the UK.

Taken together, these broad range of HEIs are ideally representative of the ICT and engineering HEI population as a whole. The ICT and engineering school's populations ranged from the lower end of the scale with approximately 700 learners and 70 full-time and 15 part-time teachers, to middle scale with approximately 3,000 learners and 310 full-time and 40 part-time teachers, and finally to large scale with approximately 40,000 learners and 147 full-time and 1,600 part-time teachers. Based on 2017-18 learner enrolment, learner average age was as follows: 23 years of age for undergraduate learners and 35 years of age for postgraduate learners. At the time of this research, the ICT and engineering schools were in the early stages of adopting mobile TEL. Teachers and learners had not been issued mobile devices and did not have 24/7 access to school-owned mobile technologies. However, they were part of the adoption and integration of mobile TEL initiatives at their HEI where each teacher had their courses delivered via a VLE, and teachers and learners used their own mobile devices in mobile learning environments to enhance learning.

4.4 Participants

Participants for this study were twelve ICT and engineering teachers aged between 25 years of age and 60 years of age of various socio-cultural backgrounds, ethnicities, educational attainment levels, gender identities and roles, at HEIs in Ireland and the UK. This sample ensured all perspectives and diversity of teachers was included. This number allowed me to reach saturation, but I remained open to recruiting more if necessary. This sample size was appropriate as Creswell (1998) advised that phenomenological study should be conducted with a group of at a minimum 5 to a maximum of 25 individuals. Morse (1994) asserted at least six. According to Patton (2002), small sample sizes are appropriate for qualitative studies as the sample provides "information-rich cases" about the phenomenon (p. 230).

At the time of this research I was employed in the same institution as one of the participants and was a fellow learner at another educational institution. Therefore, my insider position, background and perspectives influenced the rationale, operationalisation and interpretation of this research. However, insider mitigation techniques proposed by others (Mercer, 2007) were employed. Specifically, the epistemological assumptions undergirding the methodological approach are made clear, my biases are disclosed, I situated myself and acknowledged this role (Lincoln

& Guba, 1985). I also worked to challenge my subjective tendencies through the process of researcher reflexivity (Glesne & Peshkin, 1992) and peer debriefing where I had a colleague review the research before and after the data collection. In addition, open-ended questions were used.

Participants were selected using purposive sampling. Patton (2002) asserts that this sampling method solicits participants who have experienced the phenomenon being studied and meets the inclusion criteria being researched. Having sourced the potential participants, I asked them to partake in the study. Using this qualitative method yielded rich descriptions about aspects of the mobile TEL initiatives and their impact on teaching and learning (Gall, Gall, & Borg, 2007). This method was appropriate in my phenomenological research as all participants must experience the same phenomenon (Creswell, 2013). The criterion for participation in the study was that all participants be involved in the adoption and integration of mobile TEL initiatives.

4.5 Research Procedures

Research procedures for conducting the study included applying for Institutional Ethics Committee approval from Lancaster University (Appendix One). This approval was obtained before seeking participants. After obtaining this permission I sought potential participants by reading their staff profiles on a random sample of HEIs within Ireland and the UK. Once sourced, I sought permission from the department head of each HEI to approach the potential participants (Appendix Two). When obtained, I emailed potential participants to explain the purpose of the research and invited them to participate (Appendix Three) and asking if they knew of other potential participants (Appendix Four). At this point, I gave each potential participant a Participant Information Sheet (Appendix Five) that explained the research purpose. Once participants were selected, informed consent (Appendix Six) was obtained from each participant. Throughout the next eight weeks, in-depth, semi-structured interviews (Appendix Seven) and teacher observations (Appendix Eight) were conducted. At the end of eight weeks, I conducted an online focus group (Appendix Nine) to collect shared understandings about the mobile TEL adoption and implementation process. Focus groups are advantageous when researchers are attempting to increase confidence in the patterns that emerge from individual

interviews (Patton, 2002). Furthermore, as participants considered each other's responses and reviewed each other's views, I obtained richer descriptions of the phenomenon (Patton, 2002). Following the online focus group, I used phenomenological reduction methods to analyse the data from all three methods.

4.6 Role of the Researcher

At the time of the research, I was a doctoral candidate pursuing a PhD at the Centre for Technology Enhanced Learning in Lancaster University's Department of Educational Research. Additionally, I was a non-participant interviewer and observer as I investigated the experiences of teachers in the mobile TEL initiatives. Throughout the data collection exercise, I was the human instrument of data collection (Creswell, 2013) for all interviews, observations, and an online focus group. As I was a mentor teacher-facilitator in the same HEIs where some of the research took place, I was a teacher at these schools implementing the mobile TEL initiatives. In 2010, I began using basic technologies to augment the learning in my classes, and in 2013 I started to introduce mobile TEL technologies. The implementation of these provided opportunities for professional and personal growth. As a mentor teacher-facilitator for third level undergraduate and postgraduate learners, I provided assistance and resources to teachers as they attempted to integrate technology and mobile TEL initiatives into their teaching. Having been a teacher and participant in non-mobile TEL environments, I was also able to offer in-depth analysis of these programmes as they compared to the mobile TEL initiatives. Because of my participation in the mobile TEL adoption initiatives in my own HEIs and also being the human instrument in my data collection, I participated in the epoche process as described by Moustakas (1994). Accordingly, I documented my reflections of and experiences with mobile TEL. Researchers often describe their experiences in this manner so that they can bracket out their views before investigating the experience of others (Creswell, 2013).

4.7 Data Collection

Data for this research were collected from three sources: semi-structured interviews, observations and an online focus group. These methods were apt for collecting thick,

rich data about the lived experiences of the phenomenon (Creswell, 2013). In addition, the credibility of my research was validated using three different methods as my data were triangulated (Creswell, 2013; Patton, 2002). Collecting my data in the order of interviews followed by observations and subsequently an online focus group allowed me to gather rich descriptions of the participant perceptions and experiences.

Interviews were conducted firstly so that I built up a trusted relationship between the participants and myself. While interviewing, I gained knowledge as to participants' experiences with mobile TEL adoption. As the interviews proceeded, I became well-known to the participants and this helped them to understand my role as a researcher into their perceptions and experiences. Following each interview, I conducted 60-minute observation sessions where participants choose the date and time most suited to their teaching. This increased significantly participants control and confidence in the observations. Undertaking observations subsequent to the interviews, I was able to relate the data collected from the interviews to data collected from my observations and at the same time verify participants' reports of their perceptions and experiences with mobile TEL adoption and implementation. I also documented disparities and parallels in data collected through the first two methods. During the collection of interview and observation data, I repeatedly compared the data which helped me form patterns so that I identified areas where further information was required and data were lacking. Subsequently conducting the online focus group enabled me to investigate these areas more.

4.7.1 Semi-Structured Interviews

Semi-structured interviews were conducted at each participant's HEI during lesson planning times or after teaching. The interviews, lasting 50-60 minutes, were conducted at a time chosen by the participants so that it was convenient for them. Each participant was asked the same set of questions during their interview using an interview protocol (Appendix Seven) which contained both open- and close-ended questions. However, I asked more probing questions where I needed further clarification or a deeper understanding. Using semi-structured interviews containing open-ended questions on mobile TEL initiatives allowed me to discuss particular

areas in greater detail (Patton, 2002). Semi-structured interviews were appropriate for my research as I asked all participants the same questions, but I also asked further questions as required in order to obtain further insight into participant experiences. Whilst closed-ended questions gave me information regarding each participant's positioning with regard to the subject, open-ended questions allowed participants to tell their own 'story' and this enabled me to collect an abundance of data about the lived experiences (Creswell, 2013). To increase validity, I evaluated and refined the questions. Having anchored each question in the literature, I asked two teachers who had integrated mobile TEL initiatives in their teaching to evaluate the questions for correctness, clarify and to ensure they would elicit the required participant information. All interviews were digitally recorded to ensure correct information was recorded as per the interview protocol (Creswell, 2013). They were subsequently transcribed to ensure accuracy.

The aim of Interview Question One (IQ1) was to confirm that each participant had recent experience of using mobile TEL initiatives to enhance learning. Creswell (2013) asserts that a prerequisite of phenomenological research is all participants having a shared experience with the phenomenon.

Question Two addressed the obstacles to and the benefits for its adoption by teachers as they met numerous, changing and advancing technologies in the mobile TEL environment. Research into obstacles for technology implementation and mobile devices indicates such obstacles include access, vision, time, distraction, cost and professional development as all being impediments (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012; Tsai & Chai, 2012; Wood, De Pasquale, & Cruikshank, 2012). In addition, teachers doubt the value of mobile technology due to time constraints and assessment demands (Gregory & Lodge, 2015; Liu, Han, & Li, 2010; Reed, 2014). Due to smaller screen sizes, reduced resolution, and lack of data input impeding the use of mobile devices, teachers doubt the potential of mobile TEL as the perceived task value is low (Liu, Han, & Li, 2010). Although familiarity with mobile devices exists, teachers often question their usefulness for teaching and learning (Ertmer & Ottenbreit-Leftwich, 2010; Kirkwood & Price, 2014; Liu, Han, & Li, 2010). Such perceived usefulness subsequently impacts the adoption and implementation of mobile TEL.

However, mobile learning transforms the learning process and changes the ways of teaching, creating new opportunities beyond the traditional classroom, offering flexibility and mobility in learning, expanding the learning experience in terms of time and place (Lam, Yau, & Cheung, 2010). Mobile learning has enabled contingent mobile learning, situated learning, learning in dead-time and small bursts and addressed issues with physiological or cognitive differences (Traxler & Wishart, 2011). Research indicates portability, ease of use, and size as benefits for teachers (Khaddage, Lattemann, & Bray, 2011; Munawar & Cukier, 2011). Also, mobile technologies allow better access and possibilities for task-based, personalised learning (Khaddage, Lattemann, & Bray, 2011; Kopcha, 2010; Munawar & Cukier, 2011).

Questions Three to Nine aimed to allow teachers to express how the use of mobile TEL initiatives affected their teaching and the associated learner learning. Previous research regarding the impact of integrating technology on teacher pedagogy indicates teachers do not always change their teaching practice to a more learner-focused approach. In essence, teachers continue to apply a teacher-centred didactic instructional approach although reporting the use of technology to allow learner engagement and learning (Montrieux**,** Vanderlinde**,** Schellens, & De Marez, 2015; Ottenbriet-Leftwich, Glazewski, Newby, & Ertmer, 2010; Sung, 2016). However, through convenient information gathering and sharing, mobile TEL can also promote innovative teaching methods such as cooperative learning (Lan, Sung, & Chang, 2007; Roschelle et al., 2010), exploratory learning outside the classroom (Liu, Lin, Tsai, & Paas, 2012), and game-based learning (Klopfer, Sheldon, Perry, & Chen, 2012). Therefore, mobile TEL technologies have great potential for facilitating more innovative educational methods in HEIs.

Question Ten aimed to elicit the benefits, if any, that mobile TEL initiatives had brought to learner engagement, motivation and achievement. Previous research indicates a number of benefits for teaching ICT and engineering learners in mobile TEL environments. Gikas and Grant's (2013) study around learner perceptions of mobile computing devices in higher education learning found that the apparent benefits were outweighed by the perceived drawbacks. Generally, adopting mobile TEL technologies provided teachers and learners with unique ways to express and communicate ICT and engineering concepts in real situations with TEL initiatives

such as smartphones, tablets, Google Docs, blogs, twitter, wikis, synchronous and asynchronous discussion forums (De Wever, Hämäläinen, Voet, & Gielen, 2015; Menkhoff, Chay, Bengtsson, Woodard, & Gan, 2014; Minocha, 2009; Wheeler, 2010). Adopting mobile TEL technologies also gave learners support from their teachers and peers when undertaking assignments (Dohn, 2009), provided a more rewarding learning experience, continuous and situated learning support and improved levels of literacy, numeracy and participation (Crescente & Lee, 2011; Elias, 2011). In addition, mobile TEL can be used as a 'hook' to re-engage disaffected learners (Savill-Smith, Attewell, & Stead, 2006).

Questions Eleven and Twelve were used to understand how professional development and communication channels impacted teachers' perceptions of the mobile TEL adoption and implementation process. Research indicates that professional development programmes are not of sufficient duration to facilitate change and that they do not provide sufficient content-specific information (Desimone, 2009; Opfer & Pedder, 2011; Timperley & Alton-Lee, 2008). Hence, professional development, technical support from administration, availability of resources, and teacher beliefs play an influential role in whether HEI teachers feel ready to use technology in practice and consequently, whether they actually do (Cviko, McKenney, & Voogt, 2012; Kopcha, 2012; Liu, 2011).

As well as professional development, the use of communication channels is a vital part of mobile TEL adoption and implementation. Cifuentes, Maxwell, and Bulu (2011) contend that effective integration of technology must include social activity within a community of learners. This community, which may include incidental or intentional outcomes, affords opportunities for teachers to engage in collaborative activities and discussions, develop relationships and learn from each other's practice (Wenger, McDermot, & Snyder, 2002). Learning occurs in the communities of practice (Lave & Wenger, 1991). However, because of educator seclusion, teachers have modest time or opportunity to review their concerns about technology adoption and implementation. Gourlay (2011) and Miller (2015) stress that seclusion among educators is significant and stems in the main from external and internal pressures, of no time or opportunity to reflect on or discuss teaching with peers. To overcome this seclusion, professional learning must be rooted in educational practices and social context.

Question Thirteen sought to understand what teachers wished HEI executives who deal with policy knew about teaching and learning as it corresponds to the adoption and integration of mobile TEL initiatives. In order for mobile TEL devices and technologies to be best integrated into ICT and engineering teaching within HEIs, HEI executives must fully comprehend the obstacles faced by teachers in the adoption process (Abrahams, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012; Serin, 2012). It is not enough for teachers to possess the knowledge and ability to teach with mobile TEL but HEI executives must comprehend the obstacles teachers face. Such comprehension may lead to solutions that will assist in the adoption and implementation processes.

Question Fourteen afforded participants the opportunity to express their thoughts on any mobile TEL adoption and implementation topic which they felt had not been covered in the interview questions. Responses to the question generated insights that require further exploration in future research.

4.7.2 Observations

Creswell (2013, p. 213) defined observation as the "process of gathering open-ended, first-hand information by [the] observation [of] people and places" in the participants' natural setting. Observations in this research were a highly important part of the data collection as semi-structured interviews only provided a rich description from the participants' perspective. In qualitative research, "observation allows the researcher to formulate their own version of what is occurring and then check it with the participants" (Gall et al., 2007, p. 276).

Following each interview, the participant chose the date and time for their subsequent observations. The observations were used to gain a visual picture of the participant's integration of mobile TEL. Data gathered from my observations provided a more complete description of the adoption and implementation process of the mobile TEL initiatives. Conducting one scheduled observation with each participant, I observed how they used mobile technologies when teaching for 60 minutes. After each observation, I transcribed the data to ensure accuracy and coded them to compare themes found in the interviews. In order to record field notes detailing the

behaviours, activities and all patterns observed in the natural teaching setting (Creswell, 2013), I used an observation protocol (Appendix Eight).

Following the transcription of the interviews and observations, I sent the transcripts to each participant for respondent validation and asked them to check the transcription for accuracy and advise me of necessary changes. Respondent validation is a technique for exploring the credibility of results (Creswell, 2009; Silverman, 2006). Silverman (2006) argues that where respondent validation is applied, where participants verify the findings of the research, it generates more confidence in the findings. The only corrections were spelling and grammatical changes. Subsequent to these corrections, I coded all transcripts and noted memos in the margins (Appendix Ten).

4.7.3 Online Focus Group

Following the interviews and observations, I held an online focus group with all participants. According to Creswell (2013), this third data source involves "collecting data through interviews with a group of people" (p. 218). This method allowed me to collect shared understandings about mobile TEL adoption and implementation. Focus group questions were composed from information gained from participant interviews and observations (Creswell, 2013). After the transcription and coding of the observations, I compared codes to the interview data. I subsequently reviewed the focus group questions, so I could adjust them based on areas needing clarification. These areas included teachers' beliefs about the enhanced ability of mobile TEL to convey ICT and engineering concepts; teachers' previous experiences and challenges with changing teaching practices, technology integration and technology issues in general; unplanned results or the failure of mobile TEL adoption and implementation. A colleague with extensive experience in technology integration viewed the questions for reliability. Designing these questions at this later stage allowed for reflexive iteration as qualitative research is iterative in nature. As Srivastava and Hopwood (2009) state, reflexive iteration is "at the heart of visiting and revisiting the data and connecting them with emerging insights, progressively leading to refined focus and understandings" (p.77). These were then assessed by three ICT and engineering teachers who had previously adopted mobile TEL

initiatives, recommending minor points of clarification. The focus group was held using a Google Group asynchronous discussion forum. The discussion forum was open for 15 days during January 2018, which allowed participants to view posts and add more information about their experiences of mobile TEL adoption. In addition, the forum provided a convenient method for participants to share ideas and respond to other's answers. Following the online focus group protocol (Appendix Nine), I posed the questions. Within the Google Group asynchronous discussion forum, participants read the questions and added responses when it suited them. The discussion board remained open for 15 days. This gave sufficient time for participants to respond to the questions and to each other's contributions. Patton (2002) states that focus groups are very beneficial when researchers want to validate and strengthen the patterns that arose from participants' interviews. As teachers reviewed discussion posts and considered each other's responses, I obtained rich descriptions of the phenomenon (Patton, 2002). At the end of the 15 days, I generated transcripts of the Google Group discussions to validate and ensure accuracy of the online focus group (Creswell, 2013).

The information from the discussion forum focus group provided rich descriptions about participants' mobile TEL adoption experiences. It also provided verification of the themes gathered from the semi-structured interviews and teaching observations. Subsequently, I emailed all transcripts to participants to ensure the participants agreed with them. This allowed respondent validation from each participant as their check for accuracy and resonance with their experiences helped improve the validity of the data. During the respondent validation process no changes were made to the transcripts other than minor spelling and grammatical errors.

4.8 Data Analysis

Whilst reading and rereading the data during my data analysis, I concurrently noted memos on transcripts, reflected on the analysis and coded data using highlighters. I also ensured a peer reviewed my data analysis regularly to ensure the accuracy of my coding. Noting memos served as a script of the mental framework I undertook in the process of analysing the data which was reviewed for possible coding and emergent themes providing analytical insight in reference to my research questions

(Saldaña, 2009). Additionally, these memos assisted with my interpretation of the data and helped form the foundation for my conclusions and recommendations (Bloomberg & Volpe, 2012).

A “modification of the Stevick-Colaizzi-Keen method” outlined by Moustakas (1994, p. 121) was used when analysing my data. The steps in the process included *epoche*, phenomenological reduction, imaginative variation, and synthesis of composite textural and composite structural descriptions (Moustakas, 1994).

4.8.1 Epoche

In order to avoid bias when analysing the data, I epoched my opinion and experience with technology adoption and implementation. Epoche is defined as the “systematic effort to set aside prejudgements regarding the phenomenon being investigated” (Moustakas, 1994, p.22). As I was a mentor facilitator during the adoption and implementation of TEL in my HEI, I had substantial experience with the adoption and implementation process. According to Moustakas (1994), it is important for the researcher to be “open, receptive and naïve in listening to and hearing research participants describe their experiences of the phenomenon being investigated” (p. 22). Thus, I kept a reflective journal in an effort to set aside my own opinions regarding the phenomenon being explored.

4.8.2 Phenomenological Reduction

When analysing the data, I used phenomenological reduction which enabled me to bracket my personal experiences about the phenomenon (Moustakas, 1994). This required examining the data repeatedly so that “I look and describe, look again and describe, look again and describe” (Moustakas, 1994, p. 90). I was able to remove personal bias on the phenomenon by eliminating any suppositions about the adoption and integration of mobile TEL initiatives. I maintained a reflective journal throughout the study, in an effort to bracket my preconceptions related to the phenomenon.

The next step performed was Horizonalisation. This process involved listing statements and considering them with equal value (Moustakas, 1994). My

experiences were described from the “vantage point of self-awareness, self-reflection, and self-knowledge” (p. 95). While considering each participant’s experiences, I recorded all relevant statements as significant to their lived experience. I recorded any significant statements that did not change, having considered each from several sources. Having identified the significant statements, the next step was to identify meaningful units (Creswell, 2013) about the phenomenon that were revealed during the process. I subsequently deleted all statements that were considered to be extraneous to the research questions, repetitive, or overlying. Using NVivo I clustered significant statements into meaningful units or themes. I read transcripts numerous times to determine patterns of information or themes. Combining the analysis of data from all three data sources provided clarification about the experience of teachers participating in mobile TEL initiatives. The horizons or “the textural meanings and invariant constituents of the phenomenon” were only left (Moustakas, p. 97). The invariant horizons were listed and coded in order to cluster meanings and themes within the data (Appendix Eleven). I subsequently emailed the themes and subthemes to the participants to ascertain their feelings about their accuracy. Participant feedback indicated that they agreed with the information; thus, no changes were made. Subsequently, colleagues familiar with mobile TEL provided feedback on the themes and subthemes by reading the analysis of the transcripts and connecting them to identified themes and subthemes. This peer debriefing resulted in no changes.

Using these meanings and themes, I then composed individual textural descriptions and a composite textural description. Individual textural descriptions are a compilation of “invariant textural constituents and themes of each research participant”, while composite textural descriptions are individual descriptions that have been integrated into a “group or universal textural description” (Moustakas, 1994, p. 180). The textural descriptions included what the participants experienced as they adopted and integrated mobile TEL into their teaching. The descriptions described how the participants experienced the phenomenon in relation to their setting or context (Creswell, 2013). In analysing the data, I described in “textural language just what one sees, not only in terms of the external object but also the internal act of consciousness, the experience as such, the rhythm and relationship between phenomenon and self” (p. 90). When analysing the significant statements

and themes, I composed a narrative description of how participants' experiences were influenced by the context or setting (Creswell, 2013).

4.8.3 Imaginative Variation

According to Moustakas (1994, p. 98), the task of imaginative variation is using "imagination, varying the frames of reference, employing polarities and reversals, and approaching the phenomenon from divergent perspectives, different positions, roles or functions" in order to understand the essential, universal structure of how each participant experienced the phenomenon. I was able to include the most crucial aspects of the phenomenon in a description by using imaginative variation. In doing so, the phenomenon was viewed from several perspectives and explored from all imagined possibilities. I listed structural qualities and then clustered them into themes. According to Moustakas (1994), six universal structural themes should be considered, including "time, space, relationship to self, to others, bodily concerns, and causal or intentional structures" (p. 181). Structural qualities and themes were subsequently integrated into individual structural descriptions of how each participant experienced the phenomenon as well as a composite structural description, integrating all of the individual structural descriptions.

4.8.4 Synthesis of Meanings and Essences

The last step in my data analysis was illuminating the core of the phenomenon by instinctively and reflectively composing a synthesis of the universal themes in the lived experiences of the participants (Moustakas, 1994). This synthesis combined the composite structural and the composite textural descriptions to create a composite textural-structural description and provides the reader with knowledge about what the participants experienced and how they experienced it (Creswell, 2013).

4.9 Trustworthiness

Schwandt, Lincoln, and Guba (2007) identify four criteria for achieving trustworthiness in a study: credibility, confirmability and dependability, and transferability.

Credibility

Credibility, or the fit between the participants' experiences and my interpretation (Schwandt, 2007), was achieved with respondent validation (Creswell, 2009; Silverman, 2006), peer debriefing (Schwandt et al., 2007) and triangulation of data.

Respondent Validation is the requesting of participant feedback on the findings of the study (Creswell, 2009; Schwandt, 2007; Silverman, 2006). Creswell and Miller (2000) assert that respondent validations are a crucial part of the validity procedure as it "shifts from the researchers to participants in the study" (p. 127). This allowed the participants in this research to examine the findings and establish the accuracy of the description and interpretation of the phenomenon. Opportunities to give written feedback or give feedback via email or focus group were then provided to participants. Participants believed the transcripts, findings, and description of the phenomenon to be accurate other than a few minor grammatical corrections.

Peer debriefing is the "review of the data and research process by someone who is familiar with the research or the phenomenon being explored" (Creswell & Miller, 2000, p. 129). A peer mobile TEL teacher familiar with the mobile TEL initiative in my HEI was asked to review the procedures and content described in the reports for all participants to establish the accuracy of the content, methodology, and interpretation. This peer was a valuable asset, providing written feedback during the research process and acting as a referee for ideas and obstacles encountered (Creswell & Miller, 2000). During the research and data analysis phases of my research, this peer read the relevant chapters to evaluate content, methodology, and interpretation. Where more details and clarity were needed, required changes were made.

Triangulation of data, or the methods used to examine the accuracy and reliability of teachers' findings and interpretations (Schwandt, 2007), provided credibility as the data were collected from three different sources to allow comparisons and matches

between experiences (Creswell, 2013; Schwandt et al., 2007). The three sources of data used in this study were interviews, observations, and an online focus group.

Confirmability and Dependability

Confirmability is the criteria that ensured the interpretations and findings were not fabricated by me the researcher (Schwandt, 2007). Dependability assured that the research process was conducted in a traceable and logical manner (Schwandt, 2007). By means of an audit trail, confirmability and dependability were achieved which assured that documents that supported the findings of the study were kept (Schwandt et al., 2007). An audit trail was established as I kept "clear documentation of all research decisions and activities" (Creswell & Miller, 2000, p.128). I applied three suggested activities for establishing a clear audit trail: firstly, recording all research activities, secondly recording all data analysis procedures, and thirdly developing a data collection chronology (Creswell & Miller, 2000).

Transferability

Using the purposeful sampling method, this study is based entirely within the context of ICT and engineering teachers in HEIs in Ireland and the UK. It is not my intention to generalise the findings to all HE faculty members. The results are most pertinent only to ICT and engineering teachers in other HEIs. Transferability, or generalisation of the study to other settings and participants (Schwandt, 2007) is aided by the writing of thick, rich descriptions. Denzin (1989), asserts that "thick descriptions are deep, dense, detailed accounts" (p. 83). Creswell stated that thick, rich descriptions create "verisimilitude", which are "statements that produce for the readers the feeling that they have experienced, or could experience, the events being described in a study" (Creswell & Miller, 2000, p. 129). By providing thick, rich descriptions which contribute to case-to-case reasoning (Firestone, 1993), I enable readers of the research to establish if the study's results can be generalised to other populations (Schwandt et al., 2007).

4.10 Ethical Considerations

Ethical issues of anonymity, informed consent (Appendix Six), and data security (Creswell, 2013) were considered and addressed in the research proposal. Ethical

approval (Appendix One) was obtained from the research ethics committee at Lancaster University prior to data collection. I then identified participants and provided them with informed consent forms, which informed them about the study and let them know about their rights as participants (Creswell, 2013). Using pseudonyms, anonymity protected the privacy of everyone involved, both for the participants and the HEIs. Additionally, the data were stored in password-protected documents on Lancaster University secure servers.

4.11 Summary

This chapter presented the research procedures, design, and analysis for this research study. Details of the procedures, design, as well as methodology, population, sampling method, instrumentation, and measures for data collection and analysis were outlined. Data gathered from participant semi-structured interviews, observations and an online focus group helped answer the overarching research question which guided this research, 'How do ICT and engineering HEI teachers perceive mobile TEL?'. Subsequently, I transcribed, organised, coded and analysed my data, finding significant statements and revealing themes and subthemes.

The following chapter details the findings from the interviews, observations, and online focus group as the purpose of the findings chapter is to present the results of the data analysis. The themes and subthemes are documented together with both the composite textural and structural descriptions and subsequently the textural-structural synthesis. The core of the lived experiences of the twelve participants in this research is outlined. Analysing the data uncovers 12 themes relating to teachers' experiences and perceptions with the move from a PC and laptop-based environment to adopting mobile TEL initiatives where ICT and engineering teachers were able to use mobile devices to enhance learning: (1) frustration at inability to make progress; (2) HEI executives need to consult teachers on related policy; (3) sharp and significant learning curve; (4) improved attrition rates; (5) continuing professional development (CPD) required; (6) mobile TEL adoption is necessary to better convey ICT and engineering concepts; (7) many benefits; (8) obstacles with access and sustainability; (9) informal discussions; (10) learning is personal; (11)

professional learning communities of practice; and (12) additional collaboration and networked learning essential.

In chapter 6, I present a summary of the findings, followed by a discussion of these findings related to the relevant literature and theoretical framework. Bloomberg and Volpe (2012) assert the purpose of a research discussion chapter as the synthesis of themes outlined in the research findings so that a more complete understanding of the phenomenon and the research findings is presented. As such, the themes outlined in chapter five are synthesised into 6 significant analytical statements. The statements are as follows: (1) Feelings of frustration, anxiety, and uncertainty prevail; (2) Continuing professional development anchored in teaching practice is required for effective adoption and implementation; (3) Pervasive adoption and implementation will take significant time; (4) Greater teacher collaboration, networked learning and less seclusion when learning about mobile TEL are essential; (5) Mobile TEL devices, tools and wireless networking technology access and availability are crucial for successful mobile TEL initiatives; and (6) Enhanced ability to convey ICT and engineering concepts and improved attrition rates are key benefits. These statements completely exhibit an understanding of the research questions and theoretical framework for this research.

Chapter 5: Findings

5.1 Overview

The purpose of this transcendental phenomenological research was to investigate the perceptions and experiences of ICT and engineering teachers at HEIs in Ireland and the UK with the mobile TEL adoption and implementation process as they transitioned from PC and laptop-based technology to an institution-wide adoption of a mobile TEL initiative. Moustakas (1994) defined phenomenology as research "concerned with wholeness, with examining entities from many sides, angles and perspectives until a unified vision of the essences of a phenomena or experience is achieved" (p.58).

The transcendental phenomenological method was used to investigate all the ICT and engineering teachers who experienced the transition from PC and laptop-based technology to a mobile TEL environment. Voicing the essence of how HEI teachers viewed their adoption and integration of mobile TEL was the phenomenon being researched.

This chapter will discuss my findings from the interviews, observations, and online focus group, as the purpose of this chapter is to present the results of the data analysis. Interview data are particularly emphasised as interviews are the main source of data collected. In addition, interviews are the source of any emerging patterns. Observations resulted in much less data but allowed me to verify participants' self-reported experiences and were an advantage to me when attempting to increase confidence in the patterns that emerged from the individual interviews. Focus group data also resulted in much less data than the interviews, but helped me to delve deeper into these patterns and collect a shared understanding about the mobile TEL adoption and implementation experience.

5.2 Participant Summary

Twelve participants with a wide range of ICT and engineering teaching experience agreed to participate in this study. Each participant was involved in a mobile TEL initiative at their HEI and all were experiencing the transition to a mobile TEL environment.

After obtaining permission from Lancaster University for my research study I also obtained permission from the Head of Department at each potential participant's HEI to approach them. I subsequently discussed the research with all ICT and engineering teachers recruited in my sample and gave consent forms to each teacher who indicated they were interested in participating in the research. After meeting with interested participants, all twelve of them agreed to participate in the research and signed the consent form. All of them worked at HEIs in Ireland and the UK. Of the teachers participating, four were experienced ICT-only teachers, five were experienced engineering-only teachers, one was a recently qualified ICT-only teacher, and two others were both experienced ICT and engineering teachers. One ICT teacher was also acting as director of the discipline learning centre and one participant was both an experienced ICT and engineering teacher and a mentor teacher for mobile TEL.

5.3 Participant Profiles

Participant 1, Adam, held a degree in mathematics and computing, an MSc in Computing and an MBA in Technology Management. Adam had been teaching both undergraduate and postgraduate ICT and engineering learners for over ten years. At the time of this study, Adam taught approximately 110 learners annually. Eighty percent of these were adult learners and 20% traditional learners. Adam had adopted mobile TEL initiatives in the last five years. When he started teaching in 2006, he had only one laptop computer in the classroom and modules were delivered face-to-face with no online modules. As teacher and learner access to technology increased, his adoption and implementation of technology increased as well. Adam taught online 90% of the time.

Participant 2, Ben, held a master's degree in Engineering Management and was a chartered engineer and chartered manager and had been teaching for over six years. Ben had been teaching approximately two cohorts catering for approximately 26 undergraduate engineering learners and 16 postgraduate engineering learners per year who were mid-twenties years of age professional engineers, that is 100% adult learners. Ben had adopted mobile TEL initiatives within the last two years. At the time of this research significant amounts of his PC and laptop-based technology

had been superseded by the adoption of mobile TEL initiatives. Ben taught 50% of the time face-to-face and 50% of the time online.

Participant 3, Colin, held a Bachelor of Science Degree and was further qualified to PhD level, and taught ICT undergraduates with varying ages (both traditional and adult learners) for approximately twenty-one years. Colin had adopted mobile TEL initiatives in the last six to eight years. Colin practiced significantly as a teacher of distance learning prior to the adoption of mobile learning and thus much of his prior teaching experience was not classroom-based. At the time of this research approximately 40% of his teaching was online.

Participant 4, Diane, held a Bachelor of Science degree in Computer Systems, Master of Arts Degree in E-Learning Design and Development, a Diploma in Project Management and taught for over fourteen years. Diane was a programme manager but previously taught approximately 40 ICT learners annually, both undergraduate and postgraduate, 40% traditional learners and 60% adult learners, 50% face-to-face and 50% online until two years prior to the time of this research. Diane had adopted mobile TEL initiatives gradually in the last nine years.

Participant 5, Eric, held a degree in Mechanical Engineering, a certificate in Aircraft Navigation Systems and was a qualified electrician. Eric had been teaching for two and a half years. At the time of this study Eric taught approximately 30 postgraduate adult learners and 25 undergraduate traditional learners. Eric taught 50% of his time face-to-face and 50% of his time online. Eric had adopted mobile TEL initiatives in the last year.

Participant 6, Fiona, was qualified to PhD level. Fiona also held a certificate in Technical Writing and a postgraduate certificate in Teaching and Learning. Fiona had over eleven years' experience as a lecturer in chemical engineering of undergraduate and postgraduate learners and also worked as a project supervisor and project coordinator for adult learners. Fiona taught 60% traditional learners and 40% adult learners. Fiona adopted mobile TEL initiatives in the last six years and at the time of this study taught face-to-face 70% of the time and online 30% of the time.

Participant 7, Gwen, who held a degree in Computer Science and Information Systems, a Master of Arts in Teaching as a Foreign Language and a Master of Arts in Educational Leadership had eight years' teaching experience as a full-time

lecturer and computer aided language learning director. Gwen taught face-to-face 40% of the time and online 60% of the time. Approximately half of Gwen's learners were traditional ICT undergraduates and the other half were ICT teacher adult learners. Gwen also worked as an educational technology consultant. Gwen had adopted mobile TEL initiatives in the last two years.

Participant 8, Heather, was an ICT lecturer and held a Bachelor of Science in Applied Computer Science and a master's degree in Computing and Enterprise Applications Development. She taught traditional undergraduate learners only. Heather had been teaching for approximately three years. At the time of this research she taught face-to-face 80% of the time and online 20% of the time. Heather had adopted mobile TEL initiatives in the last two years.

Participant 9, Ian, was qualified to degree level and was a lecturer in mathematics and engineering. Ian had over two years' teaching experience and had adopted mobile TEL initiatives since he started teaching. Ben taught undergraduate traditional learners face-to-face 60% of the time and online 40% of the time.

Participant 10, Jeremy, was qualified to master's degree level and was a lecturer in Engineering Design of traditional undergraduate learners for almost eight years. Jeremy taught approximately 80 learners face-to-face 80% of the time. Jeremy had adopted TEL initiatives in the last three years.

Participant 11, Kate, was a university Professor of Learning Technologies, qualified to post doctorate level. Kate taught both undergraduate and post graduate learners during her almost twenty years career, mostly traditional but some adult learners. Kate had adopted mobile TEL initiatives gradually in the last ten years and taught substantially both face-to-face and online.

Participant 12, Laurence, was qualified to master's degree level and was undertaking a PhD in a TEL-related area. Laurence had over fifteen years' teaching experience in ICT and engineering fields and taught mostly traditional, both undergraduate and postgraduate learners. At the time of this research he taught online 50% of the time. Laurence adopted mobile TEL initiatives in the last six years.

5.4 Research Themes

The following is a discussion of the themes I discovered through my analysis of the data from the interviews, observations and focus group data collection methods. A representative sample of responses was used to support selected themes.

5.4.1 Research Question One

Research question one was designed to obtain information about ICT and engineering teachers' experiences with and perceptions of mobile TEL adoption and implementation. Two meaningful themes were revealed after a comprehensive analysis: (1) Frustration at the ability to make progress; and (2) HEI executives need to consult teachers on related policy.

(1) Frustration at the ability to make progress

Teachers unanimously expressed the frustration they felt when adopting and implementing the mobile TEL initiatives. Subthemes related to this theme were inadequate and obsolete mobile TEL tools, unreliable technical infrastructure, wireless networking connectivity issues, and time consumption. This theme was evident in the interviews, observations and online focus group.

Inadequate and obsolete mobile TEL tools. All except one participant reported issues due to inadequate and obsolete mobile TEL tools. The majority of teachers felt that HEIs should either provide a suitable mobile device with data access or insist that the learner have their own as a pre-requisite for registration. Jeremy said:

> When learners and teachers use their own mobile devices, there is no consistency in the teaching and learning process. Learners have different screen sizes, different cameras, different Wi-Fi access speeds and different data plans so they may not all have access when required (Interview with Jeremy, November, 2017).

Ben highlighted that "Some material has been designed to work on mobile devices other than smartphones such as tablets. Most learners only have a smartphone at best" (Interview with Ben, October, 2017).

Many participants reported that lack of access for learners was annoying as it was difficult to plan collaborative learning and they often had to plan an alternative for those with access issues. In the online focus group discussion, Heather asked, "With

everything hosted on a Blackboard, what do I do when learners have an obsolete device or cannot access the Internet?" (Online focus group discussion with Heather, January, 2018). Eric said:

> I know most of my learners have a tablet or access to one, but I cannot be certain. Thus, as a teacher, I am reluctant to insist that the class undertake a particular activity when not on campus, in case they do not have the mobile technology. I am happy to integrate mobile TEL into my labs on campus, as I can use the mobile devices available to us and can act on any issues (Interview with Eric, November, 2017).

Ian stated, however, that his main frustration is that the mobile devices provided to teachers do not function correctly. He said:

> Teachers get annoyed when they do not work as expected. This is also time consuming… as when I have a class scheduled the devices do not work or the mobile applications are running an old software version whereby I cannot use a function as expected to explain something (Interview with Ian, November, 2017).

Adam explained the issues that occur with versions of software where learners use their own nonstandard mobile devices when he said:

> I have learners with smartphones running the Windows operating system, Android operating system and the Apple operating System. These learners get different results when they try to log into the mobile VLE, try to use a Reusable Learning Object (RLO) I have developed or participate in a group task that requires collaboration in the form of recording events in video and uploading them to the VLE (Interview with Adam, October, 2017).

When discussing inadequate and obsolete mobile TEL tools in the online focus group discussion, participants discussed the advantages of having a standard device owned by the learners as a pre-requisite to enrolment. Several teachers felt this was much less annoying. Gwen reported that learners generally preferred to have their own device as they can add their own software when required without having to go through technical support in the HEI. In addition, learners looked after them better when they owned them. Additionally, Fiona said that "If the college provide the

mobile devices, I have no doubt that valuable teaching time will be lost in retrieving and preparing the devices for a class, and then putting them away again afterwards" (Interview with Fiona, December, 2017). Diane agreed and added, "When the HEI provides the device, there are potential issues with support and costs involved" (Interview with Diane, November, 2017).

In summary, standardised devices owned by learners themselves are key to successful adoption of mobile TEL and to alleviate teacher frustration. These findings concur with current perspectives by Kopcha (2010) who reported that inoperable devices exacerbated teachers' lack of confidence with mobile TEL adoption. Findings are also aligned with Gu et al. (2013) and Hammonds et al. (2013) who asserted that when mobile devices did not work, mobile technology integration failed. The data show that inadequate and obsolete mobile TEL tools lead to inconsistency in teaching and learning.

Unreliable technical infrastructure. All participants noted issues with servers, mobile devices and hardware. Adam felt frustration in his lecture due to "issues with mobile telephones, tablets and PDAs," and noted the example:

> Three times we had an offsite lecture planned and when the time came, learners could not join the lecture as both the server and mobile device had issues. Initially no one could join, the following days myself and guest lecturers has similar issues (Interview with Adam, October 2017).

Ian added that "newer, faster and more reliable severs are required because major problems occur with VLE and portal access on the in-house servers" (Interview with Ian, November, 2017). Jeremy said "VLEs accessible by mobile devices should be supported by cloud-based servers rather than on premise where technical support is not available between 7pm and 8am the following day" (Interview with Jeremy, November, 2017).

Ben agreed with the others who reported technical infrastructure issues. Ben said:

> I have had issues with mobile devices during group activities. Recently, I was running a Kahoot with iPads provided by the college. Two iPads had battery issues. Chargers go missing when you need them and the few I can get are insufficient to charge all the iPads quickly. Another had a keyboard issue. This

> required a replacement iPad and there was none available (Interview with Ben, October, 2017).

These server, mobile device and hardware issues were evident during observations. For example, Heather had issues with Adobe Connect running on a server when holding a group tutorial one evening. During a collaborative activity, Heather had her learners separated into pods when the application stopped working. Chaos ensued. Heather reverted to email and telephone in order to contact the learners. To resolve the issue, she had to log a helpdesk for technical support, so she abandoned the tutorial and re did it another day. During the online focus group discussion, Heather said “Mobile TEL cannot be implemented successfully unless 24/7 high priority support is available” (Online focus group discussion with Heather, January, 2018).

Similarly, Diane and Laurence shared their frustration with mobile TEL implementation in the online focus group. Diane said, “When the mobile technology works, it is fantastic. However, when it does not, I and the learners have to change the whole activity. This kills engagement and the learners lose motivation” (Online focus group with Diane, January, 2018). Laurence agreed and said:

> This results in teachers having to come up with an alternative teaching and assessment strategy as you cannot be certain that the mobile TEL technology will work. As a teacher I have to be prepared for disturbance, change and a lot of additional work (Online focus group discussion, January, 2018).

In summary, participants all felt that reliable servers with associated technical support are essential to avoid chaos and loss of learner motivation and engagement. This supports current perspectives of Howard and Mozejko (2015) who asserted that frustration and anxiety prevail for teachers when they cannot resolve technical infrastructure issues.

Wireless networking connectivity issues. These issues were outlined several times during the interviews and the focus group discussions. The HEIs in which the participants teach used various cloud computing software applications with the adoption of mobile learning. These included Moodle Mobile, Blackboard Mobile, Google Docs, Google Hangouts, Google Voice and Skype. All of these applications required wireless connectivity to the server. I sensed severe frustration as Eric recounted the issues he faced with the Internet connection in his tutorials. He said:

> I have to stop the tutorial and contact IT Support, which means lots of interruptions because I do not have a replacement device. I have to reschedule the session. Often, I would like to be able to change settings for applications on my tablet as they adversely affect the Internet connections, however I do not have access to do it because it's restricted to IT support. Other issues are similar to the final year assessment . . . I had four learners who could not access the examination and this takes up my time and adds more days for correcting. It is because of such connectivity issues that my time for end of year assessment was severely affected, providing technical support, while feeling annoyed that I needed to be correcting. Instead, I was trying to deal with the stress of learners who could not complete their examination (Interview with Eric, November, 2017).

I experienced evidence of teachers' frustration in my observations. In Adam's class, learners were partaking in a virtual class on software engineering using Adobe Connect. Learners were attempting to view and listen to Adam and at the same time contribute in sub-groups to the lesson by means of collaborative tasks in various laboratories on campus. In the latter half of the class, many learners were having difficulty connecting to the Internet. As Adam travelled to the laboratories in an attempt to assist some learners, others were contacting IT Support. Here only those learners who had access to their own devices with mobile Internet access were able to proceed. Adam was clearly very stressed and annoyed as the effort and time put into preparing the session particularly designed for mobile learning became pointless due to wireless connectivity issues.

Teacher perceptions here such as numerous unwanted wireless connectivity-related interruptions to their teaching, the need for rescheduling lessons, failure to complete collaborative tasks, and loss of valuable teaching time clearly support current research perspectives that reliable Internet connectivity is crucial for successful mobile TEL initiatives (Alqahtani & Mohammad, 2015; Ertmer & Ottenbreit-Leftwich, 2010; Harrison, Flood, & Duce, 2013; Kopcha, 2012; Montrieux**,** Vanderlinde**,** Schellens, & De Marez, 2015). The evidence indicates that participants' experiences led to beliefs which negatively influenced their adopting mobile TEL initiatives.

Time consuming process. All participants spoke about the amount of time, mainly on their own, necessary to implement the mobile TEL initiatives. When interviewing Adam, he recounted his attempts to develop a Reusable Learning Object to explain an ICT programming concept. He outlined how the task was "extremely time consuming when attempting to create an RLO with all involved" (Interview with Adam, October, 2017). The majority of participants reported feelings of there being too much to learn and implement in a short time. The number of tools and technologies has increased substantially since adopting the mobile TEL initiatives. These tools and technologies include VLEs, e-assessment software, e-portfolio software, lecture capturing systems, mobile collaboration tools, podcasts, and cloud storage systems. Gwen noted, "It is the speed at which changes happen . . . affecting teachers and their sense of confidence…perhaps not the actual speed of it but perhaps the number of tasks . . . that have to be done at once" (Interview with Gwen, October, 2017).

Ian added "I have never been shown how to use the mobile version of the module VLE…I need to spend a lot of time learning on my own" (Interview with Ian, November, 2017). Jeremy spoke about the time involved in planning classes. He noted that holding lectures using mobile TEL technologies is "time consuming…as we plan a suitable class and subsequently the mobile device does not work or we lose wireless Internet connectivity . . . it is really annoying" (Interview with Jeremy, November, 2017). Similarly, Laurence, when debating the range and number of skills teachers had to learn stated:

> I do not have enough time to learn everything so I end up outlining to colleagues who are more technology minded what I want to do and ask them to try and work out how to do it. Then I ask them to show me how to do it (Interview with Laurence, November, 2017).

Eric also noted frustration about the amount of time required to "know all this technology" and highlighted "I have no additional time to learn on my own" (Interview with Eric, November, 2017). Ben agreed when he said, "Teachers are pressurised with numerous and wide-ranging TEL tools the institute has adopted. Eventually we get annoyed due to all the tasks we must adopt and learn to use . . ." (Interview with Ben, October, 2017).

In summary, all participants exhibited frustration with the amount of time, mostly personal, required for mobile TEL adoption. Vast volumes of information to consume in short timescales and using numerous mobile technologies were extremely problematic. This concurs with recent literature where 'time' has consistently been cited as the biggest barrier to TEL development (Walker et al., 2016), leading teachers to question their ability to adopt mobile TEL (Liu, Han, & Li, 2010; Reed, 2014).

(2) HEI executives need to consult teachers on related policy

An analysis of data revealed that teachers need to be consulted by HEI executives on related policy for successful adoption of mobile TEL initiatives. Participants in the research reported the need for HEI executives to realise that the transition to mobile TEL is not simple. Two subthemes were revealed: (a) HEI executives require an appreciation of teachers' needs to successfully adopt mobile TEL; and (b) HEI executives must involve teachers when designing and implementing a mobile TEL strategy.

Appreciation of teachers' needs required. All participants reported a significant lack of appreciation by HEI executives of the needs of teachers where they are adopting mobile TEL. Adam said:

> Teaching with mobile TEL technologies is a totally different way of teaching compared to face to face teaching or using a desktop computer in a lab. It requires extensive training in both how to integrate mobile technologies to teaching and also how to apply an appropriate mobile TEL pedagogy (Interview with Adam, October, 2017).

Ian agreed and said:

> In my institute, adopting mobile TEL by lecturers meant starting a new academic year using a VLE with mobile access. Lecturers were asked to move their teaching material to the VLE making it accessible by learners and host online tutorials instead of face to face ones (Interview with Ian, November, 2017).

Jeremy said:

> There was little training given. We did get some training on using Blackboard Collaborate, but there was no training on how to approach developing teaching material to deliver with mobile TEL, how to deal with learners in a mobile TEL environment and what pedagogy would be appropriate (Interview with Jeremy, November, 2017).

Additionally, Heather explained that “There appeared to be no plan as to how lecturers could best transition to the new mobile TEL environment. There was no incremental adoption and associated training. It was a sink or swim situation” (Interview with Heather, November, 2017). Ben also reported a significant lack of understanding by HEI executives in his institute as to the learning curve for teachers in adopting mobile TEL initiatives. He shared that:

> Any change in teaching practice requires time to adjust, appropriate training and ongoing professional development. I have seen little of this. In order to do my job as best I can, I have undertaken substantial training in my own time and at my own cost (Interview with Ben, October, 2017).

Most participants agreed that a huge amount of time is essential when adopting mobile TEL initiatives. Kate said:

> The time constraint is the biggest factor. It’s not that people are lacking the skills or initiative. What I found is that usually one or two people are very creative. Then everyone starts looking up to them. But no one evaluates whether it made a difference (Interview with Kate, October, 2017).

In the focus group discussion, Eric shared that teachers have “concerns about time constraints” and added, “it’s a big issue” as these “lecturers feel quite negative about the adoption process” (Online focus group with Eric, January, 2018). Gwen concurred and added, “... teachers have little time as it is, and being forced to integrate mobile TEL into our teaching without any reasonable allowance for the time it takes is totally impractical” (Online focus group with Gwen, January, 2018).

In summary, participants clearly felt the huge change and associated time to transition to mobile TEL was under-appreciated by HEI executives. This concurs with current research that policy makers, heads of department and HEI executives must

appreciate the obstacles and benefits teachers face and how mobile TEL can best be diffused and adopted (Abrahams, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012).

Teachers' involvement with mobile TEL strategy. In discussing the adoption process of mobile TEL, some participants mentioned the role they felt teachers should have in the adoption process. Participants expressed concern about the lack of teacher input to the strategy for the mobile TEL initiatives. Ian said, "In terms of mobile TEL initiatives, there is disconnect between us on the ground and the people making the decisions" (Interview with Ian, November, 2017). Laurence agreed and shared:

> Those that are involved in the decisions about what technologies should be implemented, when and how, have no understanding of what is involved in day to day teaching. As a result, they cannot plan properly for how teachers can best adopt the initiatives. They do not understand the time and effort involved (Interview with Laurence, November, 2017).

In the online focus group, Adam expressed his frustration about the unfair expectations placed upon teachers. He asked the other participants:

> Are you all concerned by the huge expectation put on us as teachers to adopt mobile TEL initiatives without any consideration for the impact on our time and ability to teach in this completely different environment? How do you feel the HEI executives could deal with the adoption process better, so that it is less onerous on teachers and ultimately more successful? (Online focus group with Adam, January, 2018).

Heather answered, "There needs to be a strategy in place by the institution to provide training, time to train and access to TEL technologies and expertise" (Online focus group with Heather, January, 2018). Diane added:

> I feel that HEI executives must involve teachers in the whole strategy and process for adopting mobile TEL initiatives. My recommendation would be that a working group made up of HEI executives, heads of department, administration staff, teachers both new and experienced together with ICT

> experts from the HEI and external consultants be involved in strategy formation and execution (Online focus group with Diane, January, 2018).

During participant interviews, several others offered suggestions. Gwen said, “I would recommend a TEL expert in each department who is in close contact with those in charge of university policy” (Interview with Gwen, October, 2017). Ben said:

> I am convinced that involving teachers directly in the adoption process will lead to its success. I am also convinced that the adoption process can be vastly improved by a few simple changes. The main changes I see are: allocating sufficient time to acquire the minimum skills required initially and for ongoing professional development; providing appropriate training with regard to both practice and pedagogy; having a mentor available to each teacher; ensuring adequate technical infrastructure is in place; and insisting teachers and learners adopt a set standard for mobile devices and data plans (Interview with Ben, October, 2017).

A successful technology integration strategy, as proposed by Schneckenberg (2010, p. 981), is based on the assumption that “a successful implementation of technology-driven innovation in universities depends on the capabilities of the leadership management to actively involve teachers in organisational change”. Findings from this study clearly concur with this current perspective. HEI executives must include teachers in the formation and execution of any mobile TEL strategy and process (Abrahams, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). HEI executives must also engage with TEL teachers when formulating policy around mobile TEL adoption (Dougherty, 2015). This will enable HEI executives to better know what is needed before an intervention is put in place. The practical implications for this are that any mobile TEL strategy should be focused on the precise needs of the teachers.

There are clear pedagogical consequences discussed by teachers in response to research question one. Teaching and learning becomes disjointed and lacks consistency from constant interruptions due to technology issues. Teachers are not suitably proficient with mobile TEL due to a lack of time. Consequently, confidence as a teacher is lost. As the working relationship with their HEI executives worsens due to the lack of close involvement on mobile TEL strategy, education as whole can

only suffer with lower achievement for learners. These findings show it is crucial that HEI executives support teachers more in their teaching role and especially when adopting and implementing mobile TEL initiatives.

5.4.2 Research Question Two

Research question two was designed to gather information about how values, beliefs, professional needs and past experiences with technology impact the adoption and integration process of mobile TEL. A priori codes from RQ2 were firstly used to code the data. These codes included the following: values/beliefs, CPD needs, and past experiences. Data from these codes were subsequently analysed for significant statements and research themes. The following themes emerged: (1) sharp and significant learning curve; (2) improved attrition rates; (3) continuing professional development (CPD) required; and (4) enhanced ability to convey ICT and engineering concepts.

(1) Sharp and significant learning curve

In recent years, participant HEIs had begun implementing mobile TEL initiatives. Teachers shared that much teaching and learning time was lost as a result of technology issues due to a lack of teacher understanding. Unanimously, participants shared that both they and the learners had little experience with using mobile technologies, particularly tablets and PDAs.

In interviews with Diane and Adam, both explained how getting to grips with the mobile TEL tools and technologies is hugely challenging. Diane said “Teachers in my department feel they are not prepared enough to design, develop and deliver modules that make use of mobile technology. It is a huge change from more traditional teaching for both the learners and ourselves” (Interview with Diane, November, 2017). Diane added that “It is both a change in bringing in the use of mobile technology to enhance the learning and the approach you take.” Similarly, Adam said “The whole thing now requires me to develop more collaborative, learner centred material, so I not only have to get to grips with the technology itself, but the way I have to teach” (Interview with Adam, October, 2017).

Likewise, Ben said:

> Learning how to effectively teach with mobile technology is not a quick process. It requires adequate training, practice and this takes a lot of time. From what I have read we should be learning how to use a totally new pedagogy specifically aligned to teaching and learning with mobile devices (Interview with Ben, October, 2017).

Colin noted that:

> In face-to-face teaching you can see the body language of learners which can show whether what I am teaching is getting across well or not. With the implementation of the Mobile TEL initiatives I cannot see the learners' body language so I have to change my approach by asking online whether the learners are understanding what I am teaching…learners can use emoticons to express their feelings, but they need to be shown how to do this (Interview with Colin, November, 2017).

Preparing learners to use mobile devices effectively is a large part of ensuring that mobile TEL adoption does actually result in the learning being enhanced and this requires significant time. Eric outlined the importance of preparing learners to be able to work with the new form of course delivery. He emphasised, however, that this is another task that falls on the already-overwhelmed teacher. Eric said, "I cannot expect my learners to use the VLE without at least a quick demonstration" (Interview with Eric, November, 2017). Adam said:

> Last week as part of a weekly assignment I asked learners to access the details of the assignment using their mobile device while on a site visit and to subsequently interview an engineer, record a short video and upload it to the mobile version of our VLE using their mobile device. I ended up getting so many calls from learners and answering so many questions as regards the operation of the VLE. This ate into my other teaching time and the learners' assignment time (Interview with Adam, October, 2017).

Diane detailed all the essential elements her learners must be accustomed to before she can successfully implement mobile TEL in her classes. In addition to ensuring her learners can use the mobile devices and the VLE software the HEI uses, she must ensure they understand the objectives, expectations, rules and roles associated with partaking in an online class using mobile technology. She said:

> Hosting an online tutorial using Adobe Connect, I need to take time to show learners how to navigate the VLE, post assignments, set alerts, join online discussions, attach videos and use various other cloud applications . . . which all takes considerable time (Interview with Diane, November, 2017).

Clearly mobile TEL is a huge departure for all participants in this study in terms of new technologies and pedagogies. These findings are consistent with current perspectives which contend that teachers must also ensure learners are prepared for mobile TEL environments (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012; Mishra & Koehler, 2006). With such a significant learning curve and the ever-apparent 'time' constraint, the data show that it will take years not months before teachers will fully change their practice to a more learner-focused approach. In essence, I see some teachers continuing to apply a teacher-centred didactic instructional approach in the short term, although reporting the use of technology to allow learner engagement and learning (Montrieux**,** Vanderlinde**,** Schellens, & De Marez, 2015; Ottenbriet-Leftwich, Glazewski, Newby, & Ertmer, 2010; Sung, 2016).

(2) Improved attrition rates

All but three participants believed that the adoption of mobile TEL initiatives led to an improvement in attrition rates. Colin, Fiona and Kate did not notice any significant difference, but it is worth noting that these participants were mainly teaching undergraduates who tend to have less difficulty with technology adoption and have the time to attend campus-based programmes.

Adam shared how his cohorts had expressed great satisfaction with the flexibility the HEI's move to mobile TEL had brought. Adam said:

> One of my Software Engineering learners, who works abroad every second week stated in no uncertain terms that had he not been able to undertake years three and four of his degree using mobile technology, anywhere and anytime that suited him, he would most definitely have had to drop out of the course (Interview with Adam, October, 2017).

These views were echoed by Ben and Diane who highlighted the number of dropouts in their courses had dropped considerably since adopting mobile TEL. Ben shared that:

> Before our qualifications were available remotely using mobile devices, learners had to travel back to the UK to undertake their studies on campus when they were on leave from work. Now they can undertake all aspects of the programme while on site abroad. The modules are available anytime anywhere. They do not have to be on leave either (Interview with Ben, October, 2017).

Diane who recently worked in both teaching and administrative roles was able to confirm that enrolment numbers had increased significantly and withdrawal numbers had reduced significantly since her HEI had adopted mobile TEL initiatives. Diane said, “I have no doubt that moving our postgraduate qualifications online and being accessible with mobile devices, particularly those related to working professionals and targeted at many alumni that work overseas has provided a huge growth in our learner numbers” (Interview with Diane, November, 2017).

Notably, other participants who recognised improved attrition rates shared that as well as anytime anywhere access resulting in better attrition rates, other significant causes were the features or benefits which mobile TEL bought to learner learning. For example, Gwen highlighted how feedback from learners indicated that learner information portals were a key to increasing learner satisfaction and consequently improved attrition rates. She said, “Today my learners are more technology aware than before and they rather get progress reports by logging onto their learner portal where they can see their grades and check their progress relating to their degree requirements” (Interview with Gwen, November 2017).

Eric added that “Videoconferencing enriches online mobile classroom offerings and also provides opportunities for increased collaboration. I would definitely say that this has led to improved attrition rates” (Interview with Eric, November, 2017). Adam shared that learning analytic tools bring together data points from various sources to facilitate an early warning system for learner learning issues. Adam said “I have seen first-hand where these systems help teachers reach out to learners and provide

resources early enough that the intervention is very effective. It has prevented many learners from falling by the side" (Intervention with Adam, October, 2017).

Jeremy raised a crucial point when he said that:

> In our institute, where mobile TEL has been implemented, modules are designed to create a high level of engagement and this leads to course completion. Also, the mobile learning offering is tailored to fit the mobile device habits of our learners and the result is higher rates of retention (Interview with Jeremy, November, 2017).

Interestingly, Adam, Ben, Gwen and Ian all shared how they have experienced learners' high levels of motivation, engagement, satisfaction and course completion where mobile apps have been used. Specifically, Adam said:

> I used a mobile app to prompt learners to test whether their level of knowledge of course concepts met with the learning outcomes. The app delivered quizzes on key course content to the learners' mobile devices at key times during the module term. Incidentally, not only did their grade performance improve, but I had less dropouts during the term (Interview with Adam, October, 2017).

Ian outlined how at his HEI "My learners would rather do things on their mobile device. I try to take advantage of their preference and how they want to communicate with me" (Interview with Ian, November, 2017).

Both Laurence and Gwen described how the content developed for mobile learning in the modules they taught online was very modular and concise. Laurence said "The flexibility provided by this modularly designed content is huge. It leads to a seamless mobile learning experience" (Interview with Laurence, November, 2017). Gwen added:

> The mobile apps we provide enable self-paced and personalised learning that is much easier when you do not have to be at a desk or in a lecture room. I have taken existing e-learning modules and packaged them into mobile apps using Adobe Captivate. These apps have been able to take advantage of cameras on the mobile devices and this cannot be done using a PC (Interview with Gwen, November, 2017).

In summary, participants believed that mobile TEL enhanced the ability to convey ICT and engineering concepts and consequently improved attrition rates. This aligns with current research that endorses the move from didactic teaching practices which are classroom-based to learner-centred practices (Abhyankar & Ganapathy, 2014). Numerous participants perceived their HEI's use of mobile TEL helped learners to overcome physiological and cognitive differences such as dyslexia or impaired hearing when using mobile applications. This is consistent with research conducted by Traxler and Wishart (2011) who found that mobile TEL enabled contingent learning, situated learning, learning in dead-time and small bursts which addressed such issues.

(3) Continuing professional development (CPD) required

All participants strongly believe that there is a lack of sufficient professional development and training and that this has hindered the adoption of mobile TEL. Generally, they receive training as part of their monthly staff meetings or after normal working hours. Overall participants reported that PD was technically focused and not pedagogically focused. Adam stated:

> That comes from the fact that you know it is not on the radar of the executives in the HEIs from either a budgetary point of view or they themselves are so far removed from the actual teaching experience today that they just are not aware of the benefits of TEL and thus you know insisting on three or four weeks professional development and putting in place a TEL strategy in the institute just does not exist (Interview with Adam, October, 2017).

Disillusioned with the lack of TEL PD in his HEI, Eric shared how "the people who lack the most understanding of mobile TEL are those that decide on institute policy for our mobile TEL adoption" (Interview with Eric, November, 2017). He emphasised that this is typical of most institute technology adoption.

Colin described PD in his HEI as brief with "Adobe Connect courses…but no formal or informal training on mobile TEL initiatives" (Interview with Colin, November, 2017). Diane agreed and added:

> We assume that it is not a big leap but it can be. I think the style of writing for example that is required is really important and training around that. I think this is something that is overlooked . . . I cannot think of a lot of training that has come my way (Interview with Diane, November, 2017).

Gwen added:

> There is a department called Centre for Learning and Teaching and they offer such training. However, I attended these workshops and I can say that they are only just certificates and very basic. I do not find the professional development courses provided by the university beneficial at all. They are didactic, they are passive (Interview with Gwen, November, 2017).

Similarly, Ian indicated that ICT and engineering teachers at his HEI have been slow to adopt mobile TEL, do not have a consistent set of TEL skills and an associated TEL PD strategy when he stated:

> There is a big variety in how people teach with TEL in this institution. Most have not received any training and are very set in the traditional way. I was just shown where the mobile TEL devices were and left to learn how to use them myself (Interview with Ian, November, 2017).

Ian also noted that due to the variances in teachers' skills and experience, PD should be personalised.

Heather, who is in her second year of teaching with mobile TEL, expressed the need to practice and learn these mobile TEL technologies in a group setting prior to implementing them to her actual teaching. She said:

> I think teachers in HEIs like myself need professional training and development in using mobile TEL. In addition, we could do with getting access to trial technologies. It would be good also to have some sort of working group for like-minded people to share ideas and experiences and perhaps even demonstrate how they use the technologies to enhance the learning. Ideally, we would need a mentor who is an expert (Interview with Heather, November, 2017).

Jeremy added:

> What I find most difficult about the adoption process is that the training we get includes too much to take in all at once and more importantly, we lack adequate time to practice what has been presented my means of limited training on mobile TEL. I feel overwhelmed with the adoption process (Interview with Jeremy, November, 2017).

He also described how monthly staff meetings are not an appropriate time to receive PD for such a massive change in teaching as the adoption of mobile TEL. Adding to Jeremy's comment, Laurence expressed how his PD on mobile TEL was "always scheduled for after normal working hours and this is not compatible with teachers' personal and family lives" (Interview with Laurence, November, 2017).

Significantly, Ben noted that he is not "applying specific mobile TEL pedagogies…but using the pedagogy that I use every day and including or building in the use of mobile technologies or fitting them in around the pedagogy" (Interview with Ben, October, 2017). However, Ben recognised that "we should actually be developing mobile TEL pedagogy or specific learning pedagogy, you know that will enable us to I suppose maximise the potential of mobile technologies rather than fitting the mobile technologies around the existing pedagogy". All other participants voiced similar opinion. Notably, Adam stated that he believed "the adoption itself has affected the way I teach, that is the pedagogy and teaching practice I use. In a way I have adopted my own mobile TEL pedagogy" (Interview with Adam, November, 2017). Jeremy's comment typified participants' feelings when he stated, "Our Professional development needs to include mobile TEL specific pedagogy" (Interview with Jeremy, November, 2017).

In summary, participants believed that PD did not meet their requirements as it was very irregular and too high level. This aligns with current research on HEI mobile TEL initiatives that shows PD has not met the requirements of HEI teachers in today's global digital world (Chen & McCray, 2012; Gonzalez-Sanmamed, Munoz-Carril, & Sangra, 2014; Jones & Dexter, 2014; Opfer & Pedder, 2011; Ross, 2013; Simon, 2012). Participants also felt that PD was not focused on the practical issues which mobile TEL teachers face. This is consistent with current literature that highlights the lack of practice-based mentoring support with relevant assessment and feedback (Mackey & Evans, 2011; Ross, 2013). In addition, participants believed that PD was

too technologically focused and not pedagogically focused. Current research supports this finding asserting that PD concentrates on the practical skills for mobile TEL to the detriment of the required pedagogical skills (Baran, 2011; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2010).

(4) Enhanced ability to convey ICT and engineering concepts

Throughout the interviews and online focus group, participants shared their belief that adopting mobile TEL initiatives leads to greater ability to convey ICT and engineering concepts. Adam said:

> Well when using mobile technologies with learners on field assignments and in commercial environments I feel that I can better explain concepts and the learners can better understand the issue or point much better . . . the level of depth I can go into in explaining a particular concept or example has changed as with mobile TEL I can better explain or demonstrate the concept or example (Interview with Adam, October, 2017).

Adam also added “And in addition I can definitely say that they understand certain key concepts much better when explained in situ to them in a real-life setting” (Interview with Adam, October, 2017).

Colin explained:

> I think that the learners can better understand particular ICT and engineering concepts with the advent of mobile TEL initiatives . . . I can use a web cam in the field to illustrate an actual example rather than a picture/drawing representation of a concept . . . For example, there is one particular concept in relation to configuration of Point of Sale (POS) laptops and wireless transmission of data from POS to a central server. This is best explained to learners by seeing the actual configuration in the field in real-time whereby the teacher uses a smartphone to demonstrate to the learners who view the action on their own mobile devices such as their smartphone or tablet. The teacher also records this by video and it can be reviewed by the learners anytime anywhere when they access their learner portal (Interview with Colin, November, 2017).

Ian shared an innovative example:

> Well even demonstrating calculator use beneath the document camera with YouTube clips, working through an engineering solution, you have a screenshot of the examination paper question, talking through that, and then I start working through the solution exactly as a learner might in an examination situation and then I am demonstrating the exact way to use the calculator. Whereas if you are up at the whiteboard in front of forty people, you cannot be walking around showing each person how to use the calculator. I also have libraries of these type of recordings that the learners can watch repetitively (Interview with Ian, November, 2017).

Another highly innovative example was detailed by Eric who shared that:

> The measurement instruments I use in Mechanics experiments require much precision and versatility. For example, the precision of angle slope measurements using classical instrumentation is very low. However, the mobile telephone offers a methodical alternative for improving such measurements. With an app on my smartphone, I can measure and display in real time an angle value of a slope (Interview with Eric, November, 2017).

Adam also added that:

> I use an application based on the acceleration sensor called Accelerometer Monitor, which can display both graphically and numerically in real time the projection value of the acceleration of gravity on all three axes of the Cartesian coordinate system. These values can then be recorded in a word document and sent using Bluetooth or email to another to be processed using a spreadsheet (Interview with Adam, October, 2017).

Gwen said “Technology is widening our reach to different topics and extending the classroom. I use several TEL technologies to do exactly that like WhatsApp for example or Google slides. It allows us to add to the knowledge of other learners” (Interview with Gwen, November, 2017).

In summary, participants believed that mobile TEL helped them to overcome some difficulties in learning concepts. These findings were consistent with recent research which shows that situating learners in real-world learning scenarios, anytime, anywhere and providing a learning environment that enables such learners to access

digital learning resources helps teachers overcome difficulties in learning concepts (Abhyankar & Ganapathy, 2014; Handal et al., 2013). Findings were also consistent with research that outlined greater integration of mobile TEL in ICT and engineering disciplines, is widening the reach to different topics and extending the classroom (Beatty, 2013; Teresevičienė et al., 2015).

5.4.3 Research Question Three

Research question three was designed to gather information about the collaborative and networked learning sources (guidance) used by participants in an effort to develop, distribute, source and learn about mobile TEL as the innovation becomes integrated into the time and space of practice. Participants indicated that they used Facebook Groups, Google Hangouts and Skype to collaborate and network as they shared resources. An analysis of the data identified the following themes: (1) informal discussions; (2) learning is personal; (3) professional learning communities of practice; and (4) additional collaboration and networked learning required.

(1) Informal discussions

Much of the collaborative resources used by the participants included informal discussions. The discussions occurred mostly between department colleagues within the HEI during breaks or while exchanging lecture theatres, but also with contacts made at conferences and within special interest groups from networked learning. Adam said:

> We have teachers that are known to be experienced mobile TEL users and are always enthusiastic to pass on their ideas and show interested colleagues how mobile technology can be applied. They will often hold an informal ‘brown bag’ session in a corner of the staff canteen with their tablet or smartphone or move it to a lab to use other specialised mobile technology. At lunchtime, one of our Engineering teachers ran a Kahoot to show how assessment using a quiz can be so much fun and so motivational for learners (Interview with Adam, October, 2017).

Ben explained that:

> With cloud-based applications accessible from a mobile device such as Lync instant messaging and SharePoint, it is really easy to have a quick conversation and share material with colleagues when you have an issue or require a learning resource in a hurry. An informal quick message and resource link can provide a wealth of information (Interview with Ben, October, 2017).

Likewise, Gwen said:

> Often, I meet colleagues at conferences, face to face or virtual and when we discuss possibilities for enhancing learning in our modules with mobile TEL, we can quickly share thoughts and demonstrate what we have done by accessing our VLEs on our mobile devices. In essence, when in the moment, socialising over a coffee break, a spontaneous discussion becomes so enlightening (Interview with Gwen, November, 2017).

Ian added:

> Often in informal conversations with a colleague from Veterinary College, she will point me to certain people within her department that would be useful to speak to as regards mobile devices used in teaching concepts applicable in general practice…like see how someone is using a smartphone to capture live treatment of animals and then incorporating these into their recorded lectures with Articulate Storyline before making them available on the VLE, also accessible on learners mobile devices (Interview with Ian, November, 2017).

Diane also described how much of the collaboration in her HEI was facilitated by informal discussions. She said:

> We have a sort of virtual community of mobile technology users in college as we have a Facebook Group set up where we all post queries and answers and share ideas on what we have come across. There is no set day or time to join in, it is very informal. The Facebook notifications on our smartphones do keep us informed though of activity within the group (Interview with Diane, November, 2017).

Laurence concurred with the other participants regarding the usefulness of informal discussions with experienced mobile TEL teachers facilitating more collaboration

about mobile TEL adoption. When debating the benefits of informal discussions for implementing mobile TEL initiatives, Eric outlined that teachers in his HEI gained more knowledge and learned more practical skills when they worked together. He said “When deciding on the appropriate approach, pedagogy, course material and mobile tools to blend together for lessons, discussing with others how they did it makes the whole process so much better. We benefit from their ideas and experience” (Interview with Eric, November, 2017).

In summary, findings revealed that collaboration occurred mainly through informal conversations with other teachers where not secluded. This is aligned with current research perspectives which assert interactions occur informally during breaks at work, at conferences or virtually through social networking, blogs, and discussion forums (Kahan, 2004; Pyrko**,** Dorfler, & Eden, 2017; Wenger, 2007) or indeed via mobile interactions when members communicate via mobile technology such as smartphones (Kietzmann et al., 2013).

(2) Learning is personal

Most of the participants reported that any skills and experience gained about mobile TEL initiatives were sourced in their own time and at their own expense. When sourcing information, participants mainly used Google, YouTube, blogs, Google Search and online academic libraries. Gwen described how:

> Online resources such as YouTube videos are really useful for understanding how other teachers have applied mobile TEL tools and technologies in practice for specific tasks. The overriding benefit of these is that I can watch them anytime, anywhere to suit myself (Interview with Gwen, November, 2017).

Similar to Gwen’s idea of personal learning, Ben added:

> I started subscribing to blogs on the use of technology in higher education and where I could find any, blogs on mobile TEL. I get notifications of bloggers posts and I can then go and read them in detail in my own time (Interview with Ben, October, 2017).

Ian said, “Anything I have learned has been as a result of my own initiative, mainly using Google” (Interview with Ian, November, 2017). Jeremy agreed and said:

> I have not been provided with any professional development to help me adopt and implement mobile TEL. What knowledge and skills I have, I got from my own research and practice with the technology. I mainly use Google to search for mobile technologies I can use in my teaching for specific tasks and when I find an idea I like, I try out the technology myself (Interview with Jeremy, November, 2017).

Adam agreed and said:

> I find going online the best. When considering general approaches and pedagogical practices for using mobile technology, I tend to use online academic libraries as I have easy access to them using the university portal. Where I want to see how a specific tool or application has been used for a task, I tend to use Google (Interview with Adam, October, 2018).

These findings were aligned with the literature on how teachers learn about adopting and implementing mobile TEL initiatives. Jones and Dexter (2014) assert that forms of personal learning such as blogs, wikis and discussion forums afford teachers access to learning resources anytime, anywhere. In this study, this facilitated participants' learning at a time and place that suited them. Without doubt, personal learning afforded teachers in this study a means to overcome issues which scheduled professional development had not addressed.

(3) Professional learning communities of practice

Participants also reported that they collaborated and networked through professional learning communities of practice. When discussing how ICT and engineering teachers learned about mobile TEL, Adam said:

> Our department is very large and as I work primarily online and remotely, it is difficult to meet with everyone. There is no regular meeting and no specific agenda on mobile TEL. Although I am on campus once a month, others work entirely online and are based outside the country. So, we need as many ways to communicate as we can (Interview with Adam, October, 2017).

Ian outlined how informal PLCs worked well in his department as he reported "great benefits of having knowledgeable colleagues available to help when needed" (Interview with Ian, November, 2017). Ian also outlined how meeting teachers from

other departments and industry professionals working as professional trainers outside his HEI led to informal PLCs. During the discussion, Ian described how professionals he and his colleagues met at a technical training centre showed them how to use Articulate Storyline, as they were using it for providing CPD internally to their company staff.

Gwen, however, reported that in her department she did not believe PLCs were operating effectively as a means of collaboration on mobile TEL. When questioned on this, she said:

> We meet informally at lunch break times every Friday. We chat about things in general. However, people do not discuss what they are trying to do with mobile TEL. There is no great collaboration or working together as a community on generating ideas on implementing mobile TEL, showcasing what others have done or reviewing what the HE community is doing in general with mobile TEL (Interview with Gwen, November, 2017).

Laurence raised the value of Virtual PLCs. He said, “In my University, we are considering the introduction of a Virtual PLC as several teachers had become aware of their effectiveness for online teachers” (Interview with Laurence, November, 2018). Laurence explained that for teachers who worked substantially online it would be a valuable source of support and learning. Adam and Diane agreed. Adam reported that in his role as online facilitator on a fully online master’s degree in ICT, all teachers are both academics and experienced industry professionals. Adam said:

> I find that Virtual PLCs are an innovative way to meet the professional development needs of teachers working in online and mobile learning environments. I find it gives me a sense of belonging as a remotely based teacher who practices mobile TEL. I collaborate a lot with my colleagues who also work remotely. We share resources on mobile TEL. It is a great form of professional development for us (Interview with Adam, October, 2017).

Diane added “In our community of online facilitators, we try to brainstorm and test instructional approaches suited to teaching with mobile technologies and devices. You could say we provide peer coaching” (Interview with Diane, November, 2017). When I asked Diane to elaborate on why she felt the Virtual PLC was so successful she said:

> It is so much better than the conventional approach to professional development. Within our Virtual PLC the learning and development is led by peers. As a result, it is more meaningful and lasting. We are all industry and academic professionals and who better to help us to learn and develop professionally than ourselves when we work collaboratively (Interview with Diane, November, 2017).

In summary, PLCs and particularly Virtual PLCs worked very well for participants in this study as a means of collaboration and learning about mobile TEL. Of exceptional value was the collaboration which occurred through shared experiences with other ICT and engineering teachers on the Internet. These findings are supported by current research which advocates that teachers use networked learning to learn about mobile TEL as it gives access to leading edge information on technology (Jones & Dexter, 2014; Jones & Dexter, 2017; Meijs, Prinsen, & de Laat, 2016).

(4) Additional collaboration and networked learning required

All twelve participants stated that additional collaboration and networked learning were needed as most of what they learned about mobile TEL adoption was done in isolation. Adam said “I do not collaborate with others when developing modules that include mobile technologies. We do discuss what we need to do, but we do not work together when implementing the technology. Everyone tends to do their own thing” (Interview with Adam, October, 2017).

Diane agreed with Adam when she said:

> Deciding what mobile TEL initiatives to implement is a personal thing in my institute. Yes, we collaborate on the curriculum and assessment, but as regards say how we can best bring in mobile technologies to deliver a particular module, this is not done collaboratively. I implement mobile technology where I see fit when I am teaching, for example I have used a mobile app to set a quiz for learners. I developed this myself (Interview with Diane, November, 2017).

Ian noted “It would also help considerably if we were to collaborate or network with colleagues from other HEIs . . . we could see what way others approach

implementing mobile TEL and they could offer us advice" Interview with Ian, November, 2017). Jeremy elaborated and said:

> As we are a relatively small college based in the north west of Ireland, it's difficult to collaborate with many ICT and engineering teachers. There is little collaboration with any similar lecturers outside the college. We do meet colleagues from other ITs, but it is infrequent, and relations are not such that I could contact them when I have an issue with my use of mobile technologies and expect to get their time and assistance there and then (Interview with Jeremy, November, 2017).

Continuing the discussion on collaboration and networked learning, Heather was questioned on the tools her HEI had provided for collaboration among its ICT and engineering teachers. During our conversation, Heather outlined the mobile TEL tools her department provided, and she noted the absence of networking and collaboration among department teachers with regard to effectively adopting mobile TEL initiatives. Ian shared a solution that seemed to work within his department when he reported:

> We set up a virtual community of practice within our department using a Facebook group. Here we all post queries and offer advice on what mobile learning initiatives worked well for us. We find that it really caught on. People get excited about contributing, enjoy showing what they have done and also see it as very supportive. It builds confidence. This in turn leads to further collaboration. Some of us are also members of other special interest groups on educational technology and we share useful elements of practice we come across (Interview with Ian, November, 2017).

In a conversation about networking with Laurence and Ben, both participants highlighted the importance of HEI policy in driving the importance of networking and facilitating better collaboration. Laurence explained that he felt the lack of collaboration may be due to the lack of HEI policy promoting it. Laurence strongly stated:

> We need our heads of department and policy makers in the institute to promote networking and collaboration among teaching and technical staff in all areas within the institute. They need to highlight its importance, make it

> easier for us all to communicate and allow us the time to do so. For example, we need interdepartmental working groups on using mobile technology (Interview with Laurence, November, 2017).

Ben agreed and said:

> Departments here work very much in isolation. There is no formal way to discuss teaching approaches let alone technologies such as mobile devices and applications that other departments use. As adopting mobile TEL is such as big change, I think we need a change management policy across the institute (Interview with Ben, October, 2017).

Interestingly, several participants indicated that the lack of collaboration and networking was a contributing factor to the poor mobile TEL adoption and practice at their HEIs. Heather said:

> I only realised this year that lecturers in the Faculty of Design had been using mobile TEL devices and applications for the last three years. And I now see that I have not been using mobile learning as best I could (Interview with Heather, November, 2017).

Adam noted “I am aware of several cases of failed adoption of mobile TEL which could have been prevented had those HEIs been in contact with other institutes who have very successfully adopted mobile TEL” (Interview with Adam, October, 2017).

Although all participants expressed the clear need for greater collaboration, and the benefit of sharing different ways of implementing mobile TEL initiatives, I feel Adam’s point carries huge significance. Clearly if we have more collaboration between HEIs, poor mobile TEL adoption and adoption failures can be avoided. Recent research concurs with these perspectives as Bielefeldt (2012) and Ting (2012) both reported teacher collaboration must be in place for effective implementation of mobile TEL.

5.4.4 Research Question Four

Research question four sought to identify participants’ perceived obstacles and benefits for mobile TEL adoption. A priori codes were initially used to sort the data from interviews, observations and online focus group. The codes included obstacles

and benefits. Data from these codes were subsequently analysed for significant statements and meaningful themes.

(1) Obstacles

Themes identified for obstacles included: access; and sustainability. Challenges with mobile TEL tools, technical infrastructure and wireless network connectivity, already discussed in RQ1 as a frustration to ICT and engineering teachers, also proved to be an obstacle to participants as they adopted mobile TEL initiatives. Largely the computer and server issues led to the two themes below revealed as obstacles.

Access. All participants reported Internet access as a major obstacle to mobile TEL adoption. This was particularly so when working collaboratively. The issue was exacerbated when teachers scheduled activities to be done off campus in the learners' own time and place. Ben outlined that "Not all my learners have smartphones with the latest Wi-Fi capability. They are not all guaranteed access" (Interview with Ben, October, 2017). Laurence stated "For mobile TEL to be successfully implemented, it must be a pre-requisite that they have the required mobile device. This could be provided for as part of their course registration if learners do not have their own" (Interview with Laurence, November 2017).

Eric said:

> Most of my learners are using different providers and service contracts for Internet access on their smartphones. Some have limited data download capabilities. Many learners do not have Internet access on other devices such as tablets with larger screens. So, how can I develop a one-fits-all RLO or exercise. I cannot assume mobile learning will suit all my cohort. Clearly those with the technology are at an advantage (Interview with Eric. November, 2017).

During the online focus group, participants shared that the inconsistency in access resulted in teachers having to allow for additional unscheduled time for those with access issues. Adam reported "I frequently have to provide extensions on assignments and additional online or face to face tutorials" (Online focus group with Adam, January, 2018).

Ben highlighted that it was the responsibility of the HEI to ensure that access issues were eliminated if mobile TEL adoption was to be a success. Ben said “HEI executives need to drive policy that ensures technical infrastructure and Internet access are available 24/7 in addition to all users having appropriate mobile devices” (Interview with Ben, November, 2017).

For all participants, access to suitable mobile devices, data plans and Internet access were crucial elements in influencing their successful adoption of mobile TEL initiatives. These findings are exactly aligned with current research perspectives which assert that lack of these crucial elements inhibit participants’ ability to enhance lessons and best convey ICT and engineering concepts as well as negatively influencing their beliefs of how useful mobile TEL can be (Alqahtani & Mohammad, 2015; Ertmer & Ottenbreit-Leftwich, 2010; Harrison, Flood, & Duce, 2013; Kopcha, 2012; Montrieux**,** Vanderlinde**,** Schellens, & De Marez, 2015).

Sustainability. Many participants shared concerns about the sustainability of the mobile TEL initiatives. During the online focus group, Colin said, “You always need an alternative plan when reliant on mobile technology” (Online focus group with Colin, January, 2018). Gwen agreed and added, “Problems do happen, like I lose connectivity. I have to reschedule a synchronous tutorial or group activity. That’s why I always have an alternative plan” (Online focus group with Gwen, January, 2018).

Ian said, “Whether I use technology in the lab such as smart scopes or mobile technology such as smartphones or tablets, I always need an alternative plan to deal with potential access issues” (Interview with Ian, November 2017). Jeremy stated, “Often implementing alternative plans involves moving back to old practices and pedagogies which is confusing for both lecturers and learners”. Jeremy added “To be honest, reliability concerns lead to a lack of confidence and slow the adoption process” (Interview with Jeremy, November, 2017). Diane said:

> One of my MSc programmes is fully online and allows for mobile access, having a mobile version of the VLE. How can I be expected to encourage learners to progress to further modules when the first and pre-requisite module has frequent issues with downtime due to technical infrastructure problems? Also, learners enrolled on the programme find their own mobile devices are inadequate or obsolete and their Internet and access plans are

> unsuitable to support a mobile VLE. This raises serious questions around sustainability of the mobile TEL initiatives (Interview with Diane, November, 2017).

All participants reported how much they relied on their own mobile devices for teaching. Ian, Jeremy and Heather highlighted strongly the cost of sustainability and the lack of investment to support the mobile TEL initiatives. Heather said “We are encouraged to adopt mobile TEL. Yet, we have to purchase our own devices and learn how to design, develop and deliver our subject in our own time and at our own cost. How is this sustainable?” (Interview with Heather, November, 2017).

Always having to have an alternative plan and reverting to old pedagogies and practices resulted in frustration for teachers who acknowledged designing lessons using mobile TEL tools was already a significant strain on their time. This supports Howard and Mozejko (2015) who asserted that such frustration is a major obstacle to mobile TEL adoption.

(2) Benefits

The following themes were discovered as benefits: increased learner collaboration and global communication; increased learner motivation, engagement and achievement; larger number of teaching resources; and improved teaching.

Increased learner collaboration and global communication. All participants reported significant increases in the levels of learner collaboration as a result of mobile TEL adoption. This was confirmed in participant observations.

Adam described a software engineering assignment his learners completed using ShareSpace cloud platform. As part of module assignments, learners were required to share their Class diagrams with all groups of learners who as a group collaborated and provided group feedback to the learner that shared their diagram. Learners shared their class diagrams and feedback by uploading to the ShareSpace web site using their mobile devices. Adam said, “Using an application such as ShareSpace which is accessible anytime, anywhere from a mobile device, learners on this software engineering module experienced hugely greater collaboration” (Interview with Adam, October, 2017). Additionally, Adam emphasised that his learners gained so much more than content knowledge. He said, “My learners are becoming mobile

global intercultural collaborators and fully prepared to learn in today's digital world" (Interview with Adam, October 2017).

Using online discussion forums with her learners, Diane shared how her learners participated in weekly discussions "collaborating at anytime and anywhere they wished as the discussion was hosted online and accessible via learners' mobile devices" (Interview with Diane, November, 2017). Interestingly Diane shared how in her online discussions, learners are set a discussion question to research, report their findings to the group and subsequently debate the question. Diane said, "In essence, mobile TEL integration in my module allows for peer learning where the learners learn from each other when it suits them" (Interview with Diane, November, 2017). Diane also highlighted how working in groups collaboratively became a natural process for her learners but noted the importance of:

> Teachers must provide clear direction and expectation for collaborative activities. Facilitating and monitoring a technology enhanced collaborative exercise requires teachers to have appropriate pedagogical and practical skills. It is not the same as organising a group exercise in the classroom (Interview with Diane, November, 2017).

While discussing the advantages of mobile TEL tools such as Moodle Mobile, Google Docs, Google Hangouts, Google Voice and Skype, Gwen reported how her learners used these cloud-based platforms to collaborate on module assignments anytime, anywhere. Gwen said, "My learners can collaborate on course work using any mobile device as long as they have a mobile connection" (Interview with Gwen, November, 2017). Colin added, "Another huge benefit of the type of collaboration mobile TEL provides is the instant feedback learners receive from each other" (Interview with Colin, November, 2017).

Heather shared an interesting angle on how her IT learners collaborate. She said, "In my programming modules, learners can work collaboratively to build up the logical design for a program and develop the actual code together, debugging it as a joint exercise" (Interview with Heather, November, 2017). Similarly, Eric shared how in his engineering modules:

> Learners collaborate on design exercises by using their mobile devices to record demonstrations of their prototype machines in real-life field contexts

> and then post the recordings online. Subsequently a collaborative discussion follows and feedback streamed to their mobile devices enables follow up demonstrations of their prototype machines having made adjustments based on the collaborative feedback (Interview with Eric, November, 2017).

Ian added “Mobile TEL has facilitated this type of real time collaborative prototyping in engineering” (Interview with Ian, November, 2017).

Summarising the above findings, greater collaboration resulted in learners gaining much more than content knowledge. They gained intercultural competence, practiced peer learning and gained instant feedback. Real-time prototyping was of particular benefit to engineers. Clearly the pedagogical need of learning through learner collaboration was better met (Peng et al., 2009). However, appropriate pedagogical and practical skills required by mobile TEL teachers is key to ensuring greater collaboration.

Increased learner motivation, engagement and achievement. Participants described learners as more motivated when completing assignments and more engaged when using mobile devices and tools to complete tasks. This was confirmed during the observations. Additionally, learners’ grades improved significantly.

Interviews revealed the combination of anytime, anywhere access combined with greater collaboration with peers and teachers, wide-ranging resources, more active learner-centred learning and the ability for context learning in the field as contributing factors. Gwen shared that her learners were “able to learn when it suits them and so are specifically focused at these times” (Interview with Gwen, October, 2017). Ben agreed and added that “The increased collaboration between the learners, both each other and I, helps them to remain more engaged” (Interview with Ben, October, 2017). Laurence noted “The wide-ranging resources available keep learners fascinated with the subject at hand, having the freedom to work with what material suits them” (Interview with Laurence, November, 2017). Diane stated that “The essence of mobile learning which is facilitated rather than didactically delivered enables more active learner-centred learning. This empowerment of the learners increases their motivation, engagement and ultimately their learning and grades” (Interview with Diane, November, 2017). Adam said, “My learners were motivated

and engaged when they interacted with the material in the field, using mobile apps to access relevant material, stream video and collaborate with their peers and tutor in real world contexts" (Interview with Adam, October, 2017).

Ben agreed and said, "Mobile learning is so much more authentic for learners, they are much more motivated and engaged" (Interview with Ben, October, 2017). Both Colin and Kate made reference to the ease of learning with technology when mobile as opposed to carrying around textbooks and notepads. Colin stated, "Mobile devices lighten the load, giving learners the ability to access material remotely, start something in dead-time and complete when free again" (interview with Colin, November, 2017). Kate added "The ability to learn when it suits the learner rather than the teacher is hugely motivating" (Interview with Kate, November, 2017).

When observing Ian on a Friday afternoon, his learners were losing motivation and hardly engaged. However, when Ian announced he was going to show a YouTube video he had made and would follow up with a Kahoot, his learners jumped to attention. Similar findings were found in Jeremy and Eric's observations. Their learners were very motivated and engaged when using technology to collaboratively create a Prezi and present and review it using Skype and Adobe Connect on their mobile devices.

Heather remarked how "Integrating mobile devices and technology into teaching is not all drudgery. I enjoy technology and find it fun" (Interview with Heather, November, 2017). Fiona agreed and said:

> My learners really enjoy working with technology, especially devices like tablets and smartphones. Sharing a video, they have made or a cleaver Wordle, attending a group Skype call when on vacation all add to the 'fun' element, engaging learners more (Interview with Fiona, December, 2017).

When observing Ian's group in an engineering laboratory, I experienced the high levels of motivation and engagement that technology brings with it. Ian's learners were tasked with working in groups and completing their experiments so that they could be shared on Blackboard with Ian and the other learners. Learners were accessing resources on their mobile devices, uploading them to the PCs in the laboratory, then screen casting their design experiments and finally uploading them to Blackboard. Learners were eager to "show off" their level of subject knowledge

and “technical knowhow” (Interview with Ian, November, 2017). During our online focus group, Jeremy said:

> Learners to a large extent feel more like professionals when they are working with leading edge technology, particularly when working with mobile technology. They see great value and comfort in the fact that knowing how to apply this technology to their learning is a transferable skill to the work place. They see accessing information with Google Drive, online collaboration with Google Docs, creating an online presence with portals and YouTube channels as chances to work as professional designers would in the commercial world. Altogether, learners are more motivated and engaged when assigned an authentic task that integrates mobile TEL (Online focus group with Jeremy, January, 2018).

Ian’s comments summarised well the overall perception of participants when he said “It is no coincidence that learners are achieving higher grades where mobile TEL initiatives have been adopted. Clearly, the increased motivation and engagement leads to greater levels of achievement” (Interview with Ian, November, 2017).

In this study, the combination of anytime, anywhere access enabling greater collaboration with peers and teachers, wide-ranging resources, more active learner-centred learning and the ability for context learning in the field, led to increased learner motivation, engagement and achievement. These findings align with Keengwe, Pearson and Smart (2009) who assert that learners are engaged and motivated when using mobile devices and see the devices as helpful in understanding difficult concepts. The findings also affirm current research perspectives that where HEIs implement mobile TEL, motivation and achievement will increase (Johnson, Becker, Estrada, & Freeman, 2014; Laurillard, 2013; Keengwe & Onchwari, 2011).

Larger number of resources. All participants reported high levels of satisfaction at the larger number of resources made available to them with mobile TEL. Resources ranged from wide-ranging content knowledge to varied software applications such as Kahoot, Prezi and SlidedShare, cloud platforms and mobile apps including Google Docs, Google Voice, Mobile Moodle, ShareSpace, Wordpress, Blackboard Instructor and Skype. Interviews with Heather, Ian and Jeremy revealed that often there are

too many resources to choose from. Ian said, “Mentoring by an experienced mobile TEL user would help to identify those tools most appropriate as some are clearly better than others” (Interview with Ian, November, 2017).

Discussing the resources, the participants were excited as they described the benefits of implementing the different tools and technologies. Adam said “Blackboard Instructor is a great app to help me. I can manage modules anytime, anywhere, host content and assessments, moderate discussions, manage announcements and host Blackboard Collaborate sessions” (Interview with Adam, October, 2017).

Similarly, Diane said “Desire to Learn is a great tool to help me track my learner progress and ultimately grades. I can set quizzes, mark assignments and leave video feedback for learners” (Interview with Diane, November, 2017). Ian, Eric, Adam and Colin agreed and shared that Blackboard offered similar benefits. Ian said, “Blackboard allows me to identify early in the module where learners are having difficulty and provide appropriate intervention” (Interview with Ian, November, 2017).

Eric shared how there is a vast amount of RLOs available on the Internet that he can embed in his modules to enhance the learning. He described how “YouTube videos are particularly useful for explaining particular engineering concepts. There are many available videos of a really high quality that I can integrate to my modules with ease” (Interview with Eric, November, 2017). All participants reported that they were able to find resources other than what they had prior to adopting mobile TEL. Adam summarised the benefits of the numerous available resources when he said, “The Internet has provided teachers with unlimited mobile TEL resources” (Interview with Adam, October, 2017). Colin added, “I can source resources anytime, anywhere . . . I have access to all University resources on my tablet and to subject wide TEL resources on the Internet” (Interview with Colin, November, 2017).

In summary, participants were highly satisfied with the larger number of resources made available to them with mobile TEL. Providing a learning environment that enables such learners to access appropriate digital learning resources has been shown to be a valuable asset in overcoming difficulties in learning concepts within ICT and engineering (Abhyankar & Ganapathy, 2014; Handal et al., 2013). The data show that such resources improve the quality of informal, situated and authentic

learning which current research asserts mobile TEL enables (Jisc, 2011; Land & Zimmerman, 2015; Pimmer & Pachler, 2014).

Improved teaching. Ten of the participants stated that the mobile TEL initiatives had led to teaching gains. Ben said “I always aim to incorporate TEL technologies and tools into my teaching now. I am a more productive teacher as a result. My learners prefer it and their grades are a testament to the clear gains for all” (Interview with Ben, October, 2017).

Adam added:

> Mobile TEL initiatives enable me to include wide-ranging resources such as synchronous discussions, interactive quizzes and personalised video feedback. This enhances the teaching and learning so much more than when I used printed lecture notes and whiteboards in a classroom (Interview with Adam, October, 2017).

Participants compared teaching methods and pedagogical practices before mobile TEL initiatives were adopted. Predominantly, participants described using face-to-face lectures supported by textbooks, handouts and whiteboards and sometimes projectors linked to desktop computers. Gwen said:

> Much of the course books I used were out of date. It was difficult to get hold of material related to current computing topics. Now there is abundant subject matter available on the Internet and matching teaching material in the form of RLOs (Interview with Gwen, October, 2017).

Diane added:

> Now that my teaching role has moved from a didactic figurehead to an online facilitator of learning, both the learners and I can search, share and collaborate on nearly any subject anytime, anywhere and be assured of having the most current material. Digital media accessible from a mobile device has enabled this (Interview with Diane, November, 2017).

Jeremy added “Mobile devices combined with appropriate teaching and learning techniques enable us to teach in a completely different way. I am now more of a guide on the side with the learner at the centre of the learning” (Interview with

Jeremy, November, 2017). Laurence added, “Teaching is now a more collaborative exercise where the learners are equally involved in the learning along with the teacher. I can definitely say this has improved the teaching per se” (Interview with Laurence, November, 2017).

Heather, who taught ICT agreed that having instant access to current subject matter improved teaching. Heather said:

> Since implementing mobile TEL initiatives, I can practice flipped learning, where I send links to what areas I will cover in my online session and learners can review the material beforehand with their mobile devices. Then during the online session, we can cover a lot more of the subject area (Interview with Heather, November, 2017).

Additionally, participants highlighted the instruction and learning available to learners in dead-time and small bursts, logging onto VLEs such as Moodle, Blackboard, Desire To Learn and ShareSpace with their mobile devices anytime, anywhere as a huge step forward in offering personal instruction. Ben said, “I would not have the capacity to provide personalised instruction like this in the time I have each week” (Interview with Ben, October, 2017).

Adam reported that mobile TEL had brought a better sense of reality to his teaching when he said:

> I can record the practice of an ICT concept in the field and both stream this live to my learners on their mobile devices and upload it so that it is available on the learner portal. Likewise, learners can record their own field experiments for their peers and me (Interview with Adam, October, 2017).

Ben noted that “It affords more authentic learning” (Interview with Ben, October, 2017). Similarly, Ian stated:

> When I use a YouTube video to explain Mathematical expressions, rather than trying to write or talk though my notes on a projector, the learners are more engaged. These videos are typically of high quality and incorporate a lot of visuals (Interview with Ian, November, 2017).

Kate agreed and said, “An added benefit is that RLOs such as YouTube videos can be viewed anytime anywhere by learners” (Interview with Kate, October, 2017).

In summary, according to evidence collected during interviews and observations, the majority of participants perceived mobile TEL improved their teaching and improved learner grades. Findings were consistent with research that outlined greater integration of mobile TEL in ICT and engineering disciplines, is widening the reach to different topics and extending the classroom (Beatty, 2013; Teresevičienė et al., 2015). Findings also align with research by Johnson et al. (2010) who found that mobile TEL applications allow science learners to manipulate data and process statistics, deepening their understanding of complex relationships and concepts. Pedagogical practices moved from being didactic to more learner-centred and collaborative. Anytime anywhere instruction enabled flipped learning and more personal and authentic instruction. This is consistent with research conducted by Traxler and Wishart (2011) who found that mobile TEL enabled contingent learning, situated learning, learning in dead-time and small bursts.

5.5 Composite Textural Description

The composite textural description centred on the group’s description of the adoption and implementation process. The themes for each research question discussed above served as a basis for composing the composite textural description.

As regards teachers’ perceptions of mobile TEL adoption and implementation, all participants were enthused by the larger number of resources available for enhancing their teaching. However, they were annoyed due to the issues with unreliable technical infrastructure. With the exception of one participant, the lack of wireless networking connectivity and adequate mobile TEL tools affected their teaching significantly. Also, participants reported spending vast amounts of time, much of it in isolation, upskilling on how best to implement the mobile TEL initiatives. All participants revealed that HEI executives need to consult teachers on mobile TEL policy for effective implementation. In particular an appreciation of teachers’ needs and their involvement with related strategy is required.

As regards teachers’ values, beliefs, professional needs, and past experiences with technology and how it impacted the adoption of mobile TEL, all participants reported

a sharp and significant learning curve. Participants spent a significant amount of time educating learners on using the mobile TEL tools and technologies. In addition, participants felt there was a severe impact on both work and personal time.

Eleven of the participants reported their belief that mobile TEL afforded teachers enhanced ability to convey ICT and engineering concepts to learners resulting in improved attrition rates. According to participants, learners understand certain key concepts much better when demonstrated and explained in situ to them in a real-life setting using mobile TEL.

All participants required greater practice-based CPD. Participants also reported a lack of focus on a mobile TEL specific pedagogy. Additionally, participants reported too much knowledge was imparted in short periods without sufficient follow up. Thus, the implementation was void of mentoring, assessment and feedback as required for effective adoption.

Regarding the obstacles to adopting and implementing mobile TEL initiatives, all participants noted that unreliable technical infrastructure and wireless networking connectivity issues, required them to always have an alternative plan. Also, participants doubted the sustainability of the mobile TEL initiatives due to inadequate and obsolete mobile TEL tools. Lack of reliable learner access was a significant impediment.

Notwithstanding the challenges faced when adopting and implementing mobile TEL initiatives, all the teachers perceived benefits. They reported that learner collaboration and global communication increased, and that learner motivation, engagement and achievement improved due to the increase in collaborative and team-based learning. Additionally, participants reported that the larger number of resources and the ability to provide real-life practical tasks and instruction in dead-time and small bursts with mobile TEL had improved their teaching.

Finally, although teachers used many collaborative sources to create and distribute information about mobile TEL, most learning was personal. Thus, they unanimously favoured greater collaboration and networked learning with other ICT and engineering teaching professionals and HEIs. Most collaboration was through informal discussions with peers, particularly those nearby. All participants noted PLCs were a source of collaboration.

5.6 Composite Structural Description

The composure of the composite structural description necessitated the exploration of how ICT and engineering teachers perceived the adoption and implementation of mobile TEL initiatives in the setting and context (Creswell, 2013). The structural description concentrated on how teachers developed their perceptions of the mobile TEL adoption and implementation process. Participants' convictions about the ease of mobile TEL adoption and implementation were affected by their prior experiences with PC and laptop initiatives. At the time of this study, the length of time participants had been using mobile TEL ranged from less than one to ten years, with the majority using mobile TEL for less than two years. The actions of these teachers in the main demonstrates characteristics of early adopters of this technology to enhance learning. However, three teachers were categorised as early majority and four as late majority.

Most participants recounted use of inadequate and obsolete mobile devices, issues with unreliable technical infrastructure and wireless networking connectivity issues which resulted in the loss of anytime anywhere access for learners. Frustration existed as many participants highlighted the need for standardised mobile devices and data plans as a prerequisite for mobile TEL initiatives.

Planning with the feeling of uncertainty adversely affected teachers' confidence and decision making in designing, developing and delivering learning using mobile technology. Participants unquestionably felt the lack of reliable anytime anywhere learner access by mobile devices and Wi-Fi disallowed the development of collaborative learning.

Prior experiences with PC and laptop initiatives also affected participants' views about mobile TEL adoption being necessary to better convey ICT and engineering concepts. Participants strongly believed that learners understand certain key concepts much better when explained in situ to them in a real-life setting using innovative mobile TEL. Participants consequently reported improved attrition rates.

In addition, participants reported that additional collaboration and networked learning was required. However due to the nature of the HEI infrastructure being dispersed, teachers felt secluded when learning about implementing mobile TEL in their practice. Thus, learning how to use mobile TEL became personalised and in

teachers' own time. Limited collaboration occurred with colleagues nearby. In addition to receiving little professional development, teachers felt too much material was provided and this was not supported by relevant mentoring, assessment and feedback. As a result, participants felt they had no choice but to learn and develop their mobile TEL skills in their own time in a solitary way.

Notwithstanding participants' previous experiences with technology, the majority reported positive feelings as regards the larger number of resources afforded by the mobile TEL initiatives. Teachers believed the material afforded by mobile TEL enhanced their pedagogical approach and teaching practice.

5.7 Textural-Structural Synthesis

Every participant detailed several accounts of their positive and negative experiences with the adoption and implementation of mobile TEL initiatives. Issues with unreliable technical infrastructure and wireless networking connectivity in addition to inadequate and obsolete mobile TEL tools reinforced participants' feelings of frustration. Moreover, the significant amount of time required to learn about the many mobile TEL practices and pedagogies added to participants' feelings of being overcome.

Although participants supported the institutional adoption and implementation of mobile TEL, strong feelings for HEI executives to consult teachers on related policy were prevalent. As much time was spent learning how best to apply the mobile technologies and tools and upskilling learners on their use, participants were overcome by the burdens of adopting the initiative along with their everyday role. Participants felt HEI executives had a lack of appreciation of teachers' needs required for successful mobile TEL adoption and recommended HEI executives involve them with the mobile TEL strategy formation and execution. Frustration, anxiety and uncertainty were increased as participants did not feel the professional development offered by their HEI was sufficient to assist them best adopt and implement mobile TEL. Teachers recommended CPD that is practice-based with adequate mentoring and relevant assessment and feedback.

Largely, all participants conveyed benefits of the mobile TEL initiatives. However, they also highlighted obstacles including, lack of teacher and learner access to

wireless networking technology, and inadequate or obsolete mobile TEL devices which led to concerns regarding the sustainability of mobile TEL initiatives. Such issues resulted in significant disruption when teaching and caused loss of valuable time when attempting to teach more challenging ICT and engineering concepts.

5.8 Summary

All twelve participants in this research shared many accounts of their experiences and perceptions with the move from PC and laptop-based environments to adopting and implementing mobile TEL initiatives, through semi-structured interviews, observations and online focus group discussions. An analysis of the data uncovered several themes: (1) frustration at the inability to make progress; (2) HEI executives need to consult teachers on related policy; (3) sharp and significant learning curve; (4) improved attrition rates; (5) continuing professional development (CPD) required; (6) mobile TEL adoption is necessary to better convey ICT and engineering concepts; (7) many benefits; (8) obstacles with access and sustainability; (9) informal discussions; (10) learning is personal; (11) professional learning communities of practice; and (12) additional collaboration and networked learning required. Peer debriefing and respondent validation were used to ensure the themes were accurate. The methods employed to attain trustworthiness did not result in any changes. I acknowledge that some of the above twelve themes are related in that, for example, theme (5) continuing professional development (CPD) required, should be helped by theme (11) professional learning communities of practice. However, for the point of the research questions, my aim was to analyse them individually rather than address commonalities between them.

The length of time participants had been using mobile TEL ranged from less than one to ten years, with the majority using mobile TEL for less than two years. As regards the first research question, RQ1, the theme of frustration at the inability to make progress arose from participants' accounts of inadequate and obsolete mobile TEL tools when moving from PC and laptop-based initiatives to a mobile TEL environment using non-standard mobile devices and data plans. Also, participants were annoyed by the numerous issues with unreliable technical infrastructure and wireless networking connectivity. Finally, all teachers stated their frustration at the

substantial amounts of their own time necessary for the adoption and implementation of mobile TEL initiatives. However, eight of the twelve participants believed that providing training, time to train and access to TEL technologies and expertise was preferable to teaching without adopting the mobile TEL initiatives.

In conjunction with the theme of frustration, the theme of HEI executives needing to consult teachers on mobile TEL policy emerged. HEI executives must appreciate teachers' needs when adopting mobile TEL. As teaching with mobile TEL is totally different to teaching face-to-face without technology, the need for extensive training is essential. Yet it was apparent that HEI executives lacked such appreciation, as inadequate training and time was provided. Regarding this need, participants debated how their involvement with mobile TEL strategy improves its adoption. Specifically, participants felt involving teachers in the whole adoption and implementation process was crucial to its success. It was felt that if HEI executives listened to the needs and concerns of teachers, planning for meeting the goals of mobile TEL adoption and implementation would be significantly improved. Providing a TEL expert in each department who is in close contact with those in charge of university policy was described as beneficial.

Four themes emerged when analysing data for RQ2. This question investigated how teachers' values, beliefs, professional needs, and past experiences with technology, that is their attempts to communicate the innovation to others, impacted the adoption and implementation of mobile TEL. Firstly, the theme of sharp and significant learning curve emerged as participants highlighted the limited experience they had with using mobile TEL tools to enhance their teaching and learner learning. Participants outlined how much time it took to prepare lessons and upskill learners in a mobile TEL environment, together with the plethora of tools and technologies they are faced with. A second theme for RQ2 was participants' belief that the flexibility of access, enrichment of content and analytic tools afforded by mobile TEL resulted in improved attrition rates. A third theme was teachers' need for CPD. Rather than having short professional development sessions, teachers recommended that HEIs should provide ongoing practice-based training that is supported by mentors and includes assessment and feedback. Finally, the fourth theme for RQ2 was the perception that mobile TEL adoption is necessary to better convey ICT and engineering concepts.

Regarding what guidance (collaboration and networked learning sources) teachers use to develop, distribute, source and learn about mobile TEL initiatives, that is how does the innovation become integrated into the time and space of practice, RQ3, teachers noted they use Facebook Groups, Google Hangouts, Skype, Lync, SharePoint and blogs to collaborate and network as they distributed resources and experience. Analysing the data revealed the following themes for collaborative and networking sources: (a) informal discussions; (b) learning is personal; (c) professional learning communities of practice; and (d) additional collaboration and networked learning required. Findings revealed quite a diverse range of knowledge and experience amongst teachers in different HEIs. This indicated that HEIs in certain regions were more advanced in their use of mobile TEL than others. However, as collaboration was limited to participants' own HEIs, teachers reported the need for greater collaboration among different HEIs in Ireland and the UK. The majority of collaboration occurred through informal discussions and PLCs of practice. However, learning about mobile TEL and developing resources for it was mainly done in isolation.

For RQ4, an analysis of the data revealed teachers perceived many benefits but also obstacles with mobile TEL adoption and implementation. Perceived benefits included increased learner collaboration, global communication, motivation, engagement and achievement as well as a larger number of teaching resources and improved teaching. Notwithstanding participants' frustration outlined in RQ1, all of the participants perceived the potential for much improved teaching and learning, as they were including more learner-centred, collaborative, concept-based tasks and material aligned to real-life, due to the capabilities and resources which mobile TEL provides.

Perceived obstacles included the themes of teacher and learner access in addition to sustainability concerns. Eleven of the participants revealed their reservations about the sustainability of the mobile TEL initiatives. Participants noted the requirement to have an alternative lesson plan which caused them to be indecisive when planning classes with mobile TEL. Participants also outlined that often the mobile TEL devices were obsolete and no longer fit for purpose. Consequently, sustainability of mobile TEL initiatives affects HEI budgets significantly. Teacher and learner access to mobile or wireless networking technology was perceived as a significant obstacle.

However, only one participant believed that PC and laptop-based initiatives were more successful as they ensured that teachers and learners are technically proficient and have guaranteed access.

The following chapter presents a detailed discussion of the above themes regarding the theoretical framework of this research, in addition to research implications and recommendations, limitations and delimitations, and further research. The themes are synthesised into significant analytical statements which completely exhibit an understanding of the research questions and theoretical framework for this research. These statements are subsequently discussed in light of Rogers's DOI and Wenger's CoP theories. It is revealed that the innovation of mobile TEL initiatives was substantially made at HEI executive level for the HEIs in this research. It is also revealed that some of the apprehensions, weaknesses and concerns faced by participants with regard to issues with pedagogies and practices for mobile TEL were eased by the CoP support. Implications and recommendations are many, including the need for strong institutional support and involvement of teachers in change for successful mobile TEL adoption. Research limitations of this study are detailed, such as, this research focuses on teachers' perceptions of the adoption and implementation of mobile TEL initiatives, as opposed to students, heads of department and those of IT Support people who are also key stakeholders in the adoption and implementation process. Finally, much future research is considered, including the need to investigate the effect which teacher seclusion has on their adoption and implementation of technological innovations.

Chapter 6: Discussion

6.1 Overview

Mobile TEL is being speedily introduced and applied in many aspects of teaching globally. From professional to educational use, mobile technologies are being used to enable anytime, anywhere access to a multitude of information. Taleb and Sohrab (2012) state that for learners in HE, “Mobile technology is now an integral part of their everyday life” (p.1). As these innovations rapidly advance and influence life today, teachers are tasked with educating learners in today’s global digital society in such a way that they develop global communication and network learning skills. As the speedy development of mobile TEL technologies continues, the adoption and implementation of these innovations in HEIs rapidly increases. Teachers often feel overcome as they must continually embrace change. However, like the queen on a chessboard, the teacher with the most moves has the most options and the greatest degree of influence (Garmston & Wellman, 1998). Confidence of teachers is often the deciding factor when adopting new innovations (Ertmer et al., 2012; Howard & Mozejko, 2015; King & Boyatt, 2015; Kopcha, 2010; Kopcha, 2012; Mac Callum, Jeffrey, & Kinshuk, 2014; Wagner, 2008).

Irrefutably, teachers are essential to the successful adoption and implementation of any mobile TEL initiative. However, they remain dubious about the benefits of mobile technologies for learner learning (Chen et al., 2009; Ertmer et al., 2012; Hwang & Wu, 2014; Kopcha, 2012; Roblyer & Doering, 2013; Sharples, Arnedillo-Sanchez, Milrad, & Vavoula, 2009; Shih et al., 2011). According to Howard and Mozejko (2015), the speedy advances in mobile TEL tools have given rise to challenges for teachers, many who lack confidence in using these TEL tools for teaching. While some ICT and engineering teachers do use TEL technologies, there remains a void in the effective adoption and implementation of TEL initiatives (Ertmer & Ottenbreit-Leftwich, 2010; Koehler & Mishra, 2009; Reid, 2014). To identify how we can best help ICT and engineering teachers in their adoption and implementation of mobile TEL initiatives, HEI executives must strive to comprehend what these teachers perceive and experience during the adoption process.

The aim of this research was to investigate the perceptions and lived experiences of ICT and engineering teachers in higher education institutions who adopt and

implement mobile TEL initiatives. Insight gained from hearing the collective views of teachers during the adoption and implementation can benefit HEI executives as they support teachers adopting and implementing mobile TEL initiatives.

The overarching research question which guided this research, ‘How do ICT and engineering HEI teachers perceive mobile TEL?’ was answered with data gathered from participant semi-structured interviews, observations and an online focus group. Subsequently I transcribed, organised, coded and analysed my data, finding significant statements and revealing themes and subthemes. In chapter five, these themes and subthemes are documented together with both the composite textural and structural descriptions and subsequently the textural-structural synthesis. The core of the lived experiences of the twelve participants in this research is outlined in my findings in chapter five.

In this chapter, I present a brief summary of the findings, followed by a discussion of these findings related to the relevant literature and theoretical framework. Subsequently, the limitations of the research, research implications and recommendations for future research are outlined.

6.2 Summary of Findings

Analysing the data uncovered several themes relating to teachers’ experiences and perceptions with the move from a PC and laptop-based environment to adopting mobile TEL initiatives where ICT and engineering teachers were able to use mobile devices to enhance learning: (1) frustration at inability to make progress; (2) HEI executives need to consult teachers on related policy; (3) sharp and significant learning curve; (4) improved attrition rates; (5) continuing professional development (CPD) required; (6) mobile TEL adoption is necessary to better convey ICT and engineering concepts; (7) many benefits; (8) obstacles with access and sustainability; (9) informal discussions; (10) learning is personal; (11) professional learning communities of practice, and (12) additional collaboration and networked learning essential.

Bloomberg and Volpe (2012) assert the purpose of a research discussion chapter as the synthesis of themes outlined in the research findings so that a more complete understanding of the phenomenon and the research findings is presented. As such,

the themes outlined in chapter five were synthesised into 6 significant analytical statements. These statements completely exhibit an understanding of the research questions and theoretical framework for this research. The statements are as follows:

1. Feelings of frustration, anxiety, and uncertainty prevail.
2. Continuing professional development anchored in teaching practice is required for effective adoption and implementation.
3. Pervasive adoption and implementation will take significant time[8].
4. Greater teacher collaboration, networked learning and less seclusion when learning about mobile TEL are essential.
5. Mobile TEL devices, tools and wireless networking technology access and availability are crucial for successful mobile TEL initiatives.
6. Enhanced ability to convey ICT and engineering concepts and improved attrition rates are key benefits

6.3 Discussion and Implications in light of the Theoretical Framework

Two theories framed this research. Firstly, Rogers's Diffusion of Innovations (DOI) theory. Secondly, Wenger's Communities of Practice (CoP) theory provided the foundation for the collaboration among participants as they strived to learn about mobile TEL and its implementation.

6.3.1 Rogers's DOI Theory

The process of adopting innovations over time was described by Rogers's DOI theory (Rogers, 1995). The theory included four main elements: innovation or adopters, communication channels, time, and social system (Sahin, 2006). The innovation-decision process encompassed five stages that are achieved in a linear order. These stages comprised knowledge, persuasion, decision, implementation and confirmation. In addition, five characteristics were crucial for the adoption process: relative advantage, compatibility, complexity, trialability and observability

[8] Several academic terms.

(Rogers, 1995; Sahin, 2006, Schauer-Crabb, 2002). The innovation of mobile TEL initiatives was substantially made at HEI executive level for the HEIs in this research. This was as a result of HEI strategic policy to move from PC and laptop-based initiatives to mobile TEL being decided by the HEI boards. However, the transfer of pedagogical and practical knowledge of the innovation necessary in the diffusion and adoption (Rogers, 1995) of mobile TEL initiatives was enabled by social interactions. By means of communication channels, ICT and engineering teachers in this research acquired knowledge and developed perceptions and beliefs about the relative advantage, compatibility and complexity of implementing mobile TEL tools to enhance their teaching. As they met mobile technology and wireless networking technology problems, they developed opinions regarding the benefits of the mobile TEL initiatives. These opinions were apparent in the interviews and online focus group. Only one teacher perceived that the PC and laptop-based approach was more advantageous to teachers due to the constant connectivity and screen size.

This research adhered to the adopter categories in a social system as described by Rogers (1995). Evidenced by the interviews, observations and the online focus group, particular ICT and engineering teachers were early adopters (Rogers, 1995). Nearly all participants outlined learning about mobile TEL practices from a colleague when questioned about professional development. Ben outlined how one of the ICT and engineering teachers in his HEI was extremely knowledgeable and experienced with mobile TEL and was always called upon when help was needed. Adam, Colin, Diane, Kate, Laurence, were categorised as early adopters as they were fully proficient in specific mobile TEL tools and technologies. These teachers had mentored other teachers on how to integrate mobile TEL tools to aid teachers and learners access resources and collaborate on task-based assignments. In the findings, it was clear that Adam was an example for other teachers as they observed him and inquired about how to apply the mobile TEL innovation across their teaching. Ben, Fiona and Jeremy can be categorised as an early majority. These teachers were enthusiastic to integrate mobile TEL and communicated with their peers frequently. They reported how they pursued knowledge in their own time and at their own cost.

Eric, Gwen, Heather and Ian can be categorised as late majority adopters. Late majority adopters are unlikely to feel safe to adopt until they have removed

uncertainty about the innovation (Rogers, 2003). The pressure of peers is necessary to motivate their adoption of an innovation (Rogers, 2003). They do not adopt until most others in their social system have done so (Rogers, 2003). Although Eric, Gwen, Heather and Ian used mobile TEL tools in their teaching, they questioned the relative benefit of them for enhancing their teaching and learner learning. This uncertainty stemmed mainly from the issues experienced with the technical infrastructure and Wi-Fi. However, significant uncertainty also came from their perception that learners were ill-prepared and had great difficulties with the mobile tools and technologies. According to Rogers (1995), the best way to lessen uncertainty in possible adopters is to source knowledge through others in the social system. Teachers in this research, however, interacted less with others due to issues with location on campus and working online and remotely. Although they had been teaching for between two and eight years and had been using mobile TEL for between one and two years, they were too far removed from the more experienced early adopters. They were not subject to the pressure of early majority peers. They were not aware of how many of their fellow late majority teachers had already adopted mobile TEL. Thus, it is my interpretation that what we learn from this study that we did not know before is that being more secluded as adopters, ICT and engineering mobile TEL teachers need persuasion about the benefits of mobile TEL.

During the teacher interviews and observations, frustration was clear as they faced issues. When technical infrastructure and Wi-Fi problems occurred in these classes, these teachers were annoyed by the subsequent disturbances as they had to abandon sessions to seek technical support from the helpdesk. Frustration of adopters can negatively affect the adoption rate (Rogers, 1995). Clearly, if greater communication had occurred with other stakeholders, managing the difficulties of mobile TEL integration may have been easier. Although relative advantage and compatibility for adopting innovations have been considered more important (Rogers, 1995), the perceived complexity of an innovation may become an impossible hurdle in the adoption process. Although mobile tools and technologies were familiar to both teachers and learners, the adoption of these to enhance learning was perceived a very complex task. Teachers were overwhelmed with the extent of the adoption process and had great difficulty gaining sufficient knowledge about them to effectively implement them in their teaching. Problems with obsolete

and inadequate devices together with Wi-Fi issues resulted in teachers being indecisive about lesson plans and always needing alternative plans. Such uncertainty caused frustration and anxiety.

Change is recognised as being crucial for the innovation diffusion process (Sahin, 2006) according to Rogers's DOI theory (1995). Correspondingly, adopting and implementing a new innovation as described in this research takes time. Rogers (2003) contended that when adopting and implementing a new innovation, previous perceptions and innovations must be dropped. If not, the adoption rate is slower (Rogers, 2003). In this research, one teacher was disinclined to see the benefits of the mobile TEL initiative when planning collaborative assignments and believed the PC and laptop-based approach was more suitable. Consequently, Rogers's (1995) suggestion of time being a vital element of the diffusion process was highlighted. It is my interpretation, that possibly with more time and support, doubting participants in this research may develop a deeper understanding of how to effectively apply mobile TEL.

Time was also required for teachers to traverse the innovation-decision process. It is evident from this study that greater time is crucial for teachers to implement mobile TEL initiatives and address any frustrations, anxieties and uncertainties. When fully implemented, teachers subsequently enter the confirmation stage. At this point, entering the confirmation stage, they decide whether to adopt or reject the innovation and seek support for their decision (Sahin, 2006). Kopcha (2010) supported the requirement for time in the adoption and implementation process. Kopcha (2010) asserted the "process of technology integration is an evolutionary one and that teachers' beliefs, pedagogy, and technology skills slowly build upon each other and co-evolve as technology is introduced" (p.176-177). In this research, teachers believed that HEIs placed increasing demands on them to implement additional mobile TEL tools and technologies without any increase in time for the same. This added to teachers' frustration. What we can learn from this study is that if HEI executives afford teachers time to be involved in the formation and execution of the TEL strategy, they can express their anxieties and uncertainties at an earlier and more valuable stage. This is important for more effective adoption and implementation of mobile TEL initiatives by ICT and engineering teachers.

What we also learn from this study is that applying Rogers's DOI theory gives three valuable insights into the process of social change by ICT and engineering teachers' adoption and implementation of mobile TEL which was lacking in current knowledge. We learn what qualities of mobile TEL make its innovation spread successfully, the importance of peer-to-peer communication, and we learn the needs of different ICT and engineering user groups. I gained valuable knowledge of what it was like to be an ICT and engineering teacher who just became aware of mobile TEL, a teacher subject to persuasion, a teacher deciding to use mobile TEL, a teacher implementing mobile TEL and a teacher who had successfully adopted and implemented mobile TEL confirming its successful use. Examining the data through the DOI lens uniquely revealed that the adoption starts with particular enthusiastic ICT and engineering teachers, who then as time moves on, mentor others, communicating with their peers frequently. Of particular significance is the finding that teachers working predominantly online or remotely, are too far removed from experienced early adopters to source knowledge. This means that such late majority adopters are less likely to be proficient mobile TEL practitioners. Consequently, the quality of teaching and learning with mobile TEL for these teachers and their learners is likely to be considerably poorer. The importance for education is that better communication between experienced mobile TEL adopters and those more secluded is crucial for improving the quality of education. Analysing the data through DOI theory, it is clear that with limited time available, teachers' reluctance to adopt mobile TEL is because they want to spend more time doing what they know.

6.3.2 Wenger's CoP Theory

Wenger (2007) stated that those with common concerns, beliefs and knowledge collaborate to achieve a common purpose and improve their practice. Believing that the social theory of learning underpins CoPs, then teachers' experiences are the context for their learning. Also, CoPs emphasise social participation, accepting that learning is a social phenomenon, where the individual is an active participant in the practices of social communities, and in the construction of his/her identity through these communities (Wenger, McDermott, & Snyder 2002). Wenger (1998) posited that CoPs are informal and a central part of life, where learning encompasses collaboration and shared practices. Within communities, "meaning is negotiated

through a process of participation and reification" (Wenger 1998, p. 55). As such, collaboration and shared practise become the basis of unity (Wenger, 1998).

In this study, all participant teachers were members of informal CoPs within their respective HEIs but not organised by their HEIs (Jones & Dexter, 2014)[9]. The creation of these CoPs occurred naturally in participants' normal day-to-day activities (Wenger, 1998). The CoPs existed wherever teachers met together, shared knowledge, and learned to improve mobile TEL practice (Fitzsimmons, 2007). These CoPs were formed by teachers in close contact each day and who purposely sought out others through formal and informal discussions in an effort to improve their teaching with mobile TEL. Often teachers were not cognisant of the development of the emergent CoPs. The majority of these CoPs were face-to-face in nature such as informal discussions during lunch breaks, but some CoPs were virtual in nature as participants interacted virtually via social networking, blogs, and discussion boards (Fitzsimmons, 2007; Kahan, 2004; Wenger, 2002).

The three dimensions of domain, community and practice are contained within Wenger's (1998) CoP model. In addition, the community is engaged in learning through knowledge sharing by mutual respect for each other (Wenger, 1998). In this research, all teachers were group members that valued learning by social interaction. Their group joint objective was to enhance their teaching in today's digital world by adopting and implementing mobile TEL initiatives. All participants expressed how fellow teachers stimulated each other in meeting this objective. Data analysed from the interviews, observations and online focus group revealed that teachers intentionally approached colleagues, both informally and formally, in order to enhance their teaching using mobile TEL initiatives. As teaching faculty openly shared their apprehension, weaknesses and concerns with the adoption and implementation of mobile TEL initiatives, supporting relationships were developed. This communal collaboration and support between participants supports the CoP theory as the teachers build relationships, and through this process develop a sense of belonging and mutual commitment (Wenger et al., 2002).

[9] Some participants were also members of formal PLCs organised by their HEIs, informal PLCs organised by professionals outside their HEIs and some participants were voluntary and often anonymous members of PLNs with no connection to their HEIs.

This research further supported Wenger's CoP theory by the creation of CoPs inherently as part of their regular teaching practice (Wenger, 1998). According to Wenger et al. (2002), human interaction is essential for establishing identity. As such interactions can occur anytime, anyplace, and CoPs can emerge whenever teachers meet, share knowledge and learn how to improve their teaching practice. Teachers outlined how they expressed their concerns regarding mobile TEL adoption and implementation during informal discussions, at breaks, outside lectures, in addition to staff meetings and professional learning communities of practice. As teachers in this research highlighted their difficulties, others offered suggested resolutions. For example, during an informal lunch break meeting, Ian shared how a colleague in the veterinary college was using a smartphone to capture live treatment of animals and then incorporating these into her recorded lectures with Articulate Storyline before making them available on the VLE, so that learners can access them anytime, anywhere using their smartphones. Discussions between other teachers led to a solution using Blackboard Quiz Manager to enable learners to test whether they met their learning outcomes. Teachers not only implemented Blackboard Quiz Manager but shared this practice with other teachers at their HEI. This knowledge sharing endorsed Wenger's (1998) assertion that stories are a significant element of CoPs. In this research, the emerging CoP valued the sharing of practice and innovation as members shared their stories (Wenger et al., 2002). Although teachers were not always aware of the emerging CoP, they gained significantly from the shared expertise.

Teachers in this research shared knowledge, learned from others and developed as mobile TEL practitioners with both face-to-face and informal interactions. Discussions occurred at break times in addition to various virtual exchanges such as social media networking, wikis, blogs and discussion forums (Kahan, 2004; Pyrko**,** Dorfler, & Eden, 2017; Wenger et al., 2002). Teachers in this research outlined the benefits of virtual interaction as they searched for guidance on implementing mobile TEL initiatives successfully. Ben noted how he used synchronous discussion forums with other software engineering lecturers, while Ian emphasised the value of networked learning with ICT and engineering teachers globally. Ian particularly recognised the benefit of being a member of a global community of teachers which provided new insights into the application of mobile TEL initiatives. Kate outlined her

interest with YouTube for developing skills in using reusable learning objects and smartphones for her teaching. Overall it appeared that virtual interaction and networked learning encouraged teachers to develop personalised learning as a means of CPD in their own time. The fact that these participants were enhancing their own teaching skills by means of personal learning meant that they added significantly to the development of any CoPs they belonged to. According to Wenger (1998) when members of CoPs develop their own expertise, their unique identities developed and this subsequently results in greater member interaction. It appears that the diversity in skills, ideas, and perspectives made these CoPs richer creative learning environments for their members (Wenger et al., 2002). Unquestionably, the teachers in this research appeared inspired with the information accessible by online environments accessible with mobile technologies such as YouTube. The inspiration gained from participants anytime, anywhere access may have resulted in greater impetus to implement mobile TEL initiatives in their teaching.

Clearly much opportunity for ICT and engineering teachers to act as mentors to others in developing their mobile TEL skills was afforded by the shared personalised learning experiences of participants. Kopcha (2010) explored the advantages of mentoring with CoPs during the adoption of technology initiatives and discovered that they motivated teachers to explore new uses of technology, while also helping them to overcome obstacles. Kopcha (2010) also found that decisions on whether to adopt the new technology were based on how their peers reacted and accepted the new technology in addition to their own beliefs about technology. On numerous occasions during the interviews and online focus group, teachers in this research eluded to highly experienced colleagues who advised them with the adoption and integration of mobile TEL initiatives. It was apparent that some of the apprehensions, weaknesses and concerns faced by participants with regard to issues with pedagogies and practices for mobile TEL were eased by the CoP support.

A unique insight gained from this study which we did not know before as framed by Wenger's CoP theory, is the need for teachers to discuss with peers what the adoption and implementation of mobile TEL initiatives involves, before attempting to adopt and implement them. Analysing the data through CoP theory revealed that the experiences of fellow practitioners is the ideal context for their learning about mobile TEL adoption. More specifically, active participation in social communities maximises

such learning. This is important as possibly with more mobile technology support for teachers in HEIs by means of CoPs, the frustration faced with such issues will reduce.

6.4 Discussion and Implications in light of Relevant Literature

As outlined earlier in this chapter, the themes and patterns portrayed in the research findings chapter five, were synthesised into six significant overarching statements. These statements completely exhibit an understanding of the research questions and theoretical framework for this research.

6.4.1 Feelings of Frustration, Anxiety and Uncertainty Prevail

Teachers' feelings of frustration, anxiety and uncertainty were widespread in this research. These arose predominantly from technical infrastructure issues and the perceived loss of teaching time from wireless networking connectivity issues and issues related to inadequate and obsolete mobile tools. Issues ranged from unsuitable data plans to outdated operating systems and software to use mobile applications. Teachers reported frustration with having a class planned which was designed for mobile TEL delivery, and subsequently having issues that prevented delivery. Participants believed that designing and developing mobile TEL-based classes was very time consuming and they were annoyed at always having to have an alternative plan.

Based on interviews, observations and online focus group discussions, the requirement for alternative plans also arose from several weeks where the VLE hosting servers behaved as expected for some face-to-face and online facilitation sessions and subsequently had issues. Sessions with issues outlined above were chaotic, as participants tried to resolve issues before following alternative plans. Many of the issues are avoidable if newer, faster and more reliable severs were introduced. Moving VLEs accessible by mobile devices to cloud-based servers rather than on premise where technical support is not available between 7pm and 8am the following day can also eliminate many issues. These easy solutions can increase teaching and learning continuity and ultimately the sustainability of mobile TEL.

Separate from issues related to wireless connectivity and technical infrastructure, a further area of frustration was the lack of time available to participants. Teachers felt increasingly overcome due to the already allocated time where teachers had to deliver their ever-demanding modules. As teachers were uncertain if their mobile TEL tools would function daily, they noted several days when they had to redesign their entire schedule. Always having to have an alternative plan resulted in frustration for teachers who acknowledged designing lessons using mobile TEL tools was already a significant strain on their time. This supports Howard and Mozejko (2015) who asserted that feeling they will not be able to fix technical issues can result in frustration and anxiety for teachers that work excessively to design and develop teaching material whilst effectively implementing technology. Furthermore, participants spent substantial amounts of time learning about mobile TEL tools that their HEIs expected them to adopt and implement. Without doubt, the requirement for additional time to develop alternative classes in lieu of technical infrastructure, wireless networking connectivity issues and issues related to inadequate and obsolete mobile tools can exacerbate the frustration felt by teachers implementing mobile TEL. Teachers in this research expressed the significance of being overcome with the increased workload which mobile TEL initiatives brought. Clearly teachers' beliefs that HEI executives lack appreciation of their needs when adopting technology is significant. The data show that this is a key concern of ICT and engineering teachers in recent times, as HEI executives and policy makers attempt to implement mobile TEL with its related pedagogies and practices. For any significant organisational change to be effective, it is essential that all stakeholders understand each other's needs and maintain a good working relationship (Pieterse, Caniëls, & Homan, 2012). It is also essential that such change is implemented with due consideration for the ability of those most affected to assimilate the change. The data in this study indicate an alarming disconnect between HEI policy makers and HEI executives on the one hand and those operating on the ground as teachers of higher education on the other. This concurs with current research that HEI executives must engage with TEL teachers when formulating policy around mobile TEL adoption (Dougherty, 2015). Policy makers, heads of department and HEI executives must appreciate the obstacles and benefits teachers face and how mobile TEL can best be diffused and adopted (Abrahams, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). As educators, we cannot ignore the possibility of

other detrimental effects on the teacher role, student learning, attrition rates, HEI culture, HEI competitiveness and knowledge creation. As this continual change is outside teacher control, HEI executives and policy makers must seek ways to alleviate teacher frustration, anxiety and uncertainty, particularly with regard to technical infrastructure, networking connectivity and inadequate and obsolete mobile tool issues. Otherwise, we may not see successful mobile TEL adoption and implementation.

Feelings of frustration, anxiety and uncertainty as found in this research by teachers implementing mobile TEL technology that can be obsolete or malfunctioning, are aligned with much literature which found that mobile technology integration failed when mobile devices did not work (Gu et al., 2013; Hammonds et al., 2013). This literature highlighted how unreliable Wi-Fi access resulted in classes and related material available online via mobile devices were frequently inaccessible. In addition, findings from both Gu et al. (2013) and Hammonds et al. (2013) were aligned to this research where learners could not access a collaborative exercise started earlier in the module as it was hosted in the cloud. This happened to Ian while observing him and although he did not confirm he was annoyed and anxious, I sensed his stress as he attempted to resolve the connectivity issue and continue the lesson while avoiding breakdown in learning. Should wireless networking issues arise as often as expressed in the interviews and focus group discussion, Ian's lack of confidence in effective implementation of mobile TEL can be accredited to such frustration, anxiety and uncertainty. Importantly, this teacher was located some distance from the early adopters and mentors in his HEI, so it is likely he felt significantly overcome due to the secluded nature of his role.

Adam and Ian's accounts of inadequate and obsolete tools were aligned not only with Gu et al. (2013) and Hammonds et al. (2013), but also research by Kopcha (2010), which reported that inoperable devices exacerbated teachers' lack of confidence with mobile TEL adoption. These obstacles together were hard to surmount. Kopcha (2010) asserted, "When teachers are given devices that have not been correctly set-up, or fail to perform to expectations, interest in the device is lost; and, furthermore, their interest in future opportunities may be met with the fear of experiencing the same results" (p. 180). Clearly, this was evident in Heather's

observations. Having failed to resolve technical infrastructure and Wi-Fi connectivity issues she was having in one of her online classes, she reverted to face-to-face lessons. In a subsequent observation, her confidence levels with mobile TEL integration had clearly dropped. This lack of confidence must be a crucial impetus to solve these issues and more sustainable access.

6.4.2 Continuing Professional Development Anchored in Teaching Practice is required for Effective Adoption and Implementation

Few of the research participants were provided with formal CPD. However, all teachers stated the greater need for it. At an ICT and engineering faculty level, most had undertaken induction training or attended PLC meetings. However, all participants felt this type of professional development only provided high level knowledge of the technical infrastructure and basic mobile technology skills. There was no specific training as regards the pedagogical change required for teaching with mobile TEL. In addition, participants felt the professional development was not given sufficient time and included vast amounts of knowledge which were difficult to assimilate. Most importantly, the majority of teachers stated that they received little or no in-practice support when attempting to implement mobile TEL afterwards in their daily teaching.

These findings were aligned to literature on PD for HEI mobile TEL initiatives. Any PD was provided to teachers through scheduled, classroom-based sessions (Jones & Dexter, 2014; Jones & Dexter, 2017; Plair, 2008; Tytler, Symington, Malcom, & Kirkwood, 2009). Teachers in this research stated that such PD did not meet their requirements. In their day-to-day role, when faced with practical issues such as how to design and deliver collaborative assignments accessible from the VLE by learners with their mobile devices, or what pedagogy to adopt when integrating mobile TEL, participants felt they required a practice-based mentor who can resolve issues anytime, anywhere. This finding was aligned to current literature on formal PD. Recognised as predominantly ineffective for HEI teachers adopting and implementing mobile TEL, formal professional development in general has not met the requirements of HEI teachers in today's global digital world (Chen & McCray, 2012; Gonzalez-Sanmamed, Munoz-Carril, & Sangra, 2014; Jones & Dexter, 2014;

Opfer & Pedder, 2011; Ross, 2013; Simon, 2012). Reasons for this include the lack of practice-based mentoring support with relevant assessment and feedback available at the appropriate time and place (Mackey & Evans, 2011; Ross, 2013).

Also, ICT and engineering teachers displayed uncertainty regarding how best to use mobile technology in their discipline. Most notably was the absence of Management Information Systems (MIS) teachers prepared to partake in this research. Besides using mobile devices for searching the Internet, MIS teachers, as stated by their computing and engineering colleagues, were less inclined to use mobile TEL tools and technologies for collaborative practice-based activities. This may result in relative advantage (Rogers, 1995), as the MIS teachers doubt the value of mobile TEL for achieving objectives. This finding agrees with Liu, Han, and Li (2010) who found that teachers in mobile learning environments have questioned the value of mobile learning due to low task value. Although teachers appeared comfortable with mobile devices, they doubted their value for teaching and learning (Ertmer & Ottenbreit-Leftwich, 2010; Liu, Han & Li, 2010; Reed, 2014). This perceived low task value has consequently affected HEI-wide adoption and implementation of mobile TEL. This finding coincided with research which stated that teachers continue to doubt the benefits of mobile TEL in student learning (Ertmer et al., 2012; Kopcha, 2010; Kopcha, 2012; Wagner, 2008). When identifying participants for this research, I realised that MIS teachers did not wish to take part as they seldom used mobile tools and technologies in their lessons. It is likely that for MIS teachers, their perceptions of the benefit of mobile devices have negatively impacted their own adoption. Consequently, CPD may be specifically needed for MIS teachers. Otherwise, their learners may not perceive mobile TEL tools and technologies as useful for dealing with real-life problems involving MIS.

Additionally, ten of the teachers in this research felt they lacked sufficient skills to effectively adopt mobile TEL due to the significant amount of technology and classes involved. Recent studies on the adoption and implementation of mobile TEL showed that inadequate PD hindered its adoption. Current studies are consistent in their findings of this research, as ICT and engineering teachers remain inadequately prepared to successfully adopt mobile TEL (Albirini, 2006; Butler & Sellbom, 2002; Khaddage et al., 2011; Pelgrum, 2001). Research is also consistent with the findings of this study that PD focusses predominantly on the practical skills for mobile TEL

implementation, to the detriment of the required pedagogical skills (Baran, 2011; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2010). Moreover, PD programmes have been too short to affect change and generally focused at too high a level (Chen & McCray, 2012; Desimone, 2009; Opfer & Pedder, 2011; Timperley & Alton-Lee, 2008). Confidence issues regarding how to successfully adopt mobile TEL have not just affected ICT and engineering teachers in this research. It is an extensive issue throughout all HEI disciplines. Such uncertainty must be addressed at a HEI executive level. Notably as teachers in this research revealed PLNs as important for PD, HEIs may want to contemplate personal learning with anytime anywhere access as an answer. This research has shown that mobile TEL is as favourable to ICT and engineering teachers as it is to their learners. As such it is an ideal medium for their own PD.

6.4.3 Pervasive Adoption and Implementation will take Significant Time

This research revealed that substantial time is required for pervasive adoption and implementation of mobile TEL initiatives. Particularly, teachers highlighted the vast amount of their own time required. This finding is consistent with research by the Universities and Colleges Information Systems Association (UCISA) which surveys UK institutions on their adoption of TEL, where for the last six iterations (published between 2005 and 2016), ‘time’ has consistently been cited as the biggest barrier to TEL development (Walker et al., 2016). Designing and developing lessons integrating mobile TEL required participants to source appropriate mobile TEL resources and apply appropriate pedagogies for delivery. This is unsurprising considering the assertion of Vaughan (2007) in Alammary, Sheard, and Carbone (2014), who suggests that developing a blended course takes up to three times longer than if the equivalent course were to be delivered in a traditional format. Due to current workloads not reducing and allocated time not increasing, teachers found themselves doing much of this in their own time. In this research, Adam reported how much of their own time was spent designing and developing material integrating mobile TEL, particularly sourcing and integrating RLOs. Literature on the obstacles to technology integration supports this finding (Ertmer & Ottenbreit-Leftwich, 2010; Gregory & Lodge, 2015; Liu, Han, & Li, 2010; Kopcha, 2012; Tsai & Chai, 2012). Research continues to identify time constraints leading teachers to question their

ability to adopt and implement mobile TEL in their teaching (Liu, Han, & Li, 2010; Reed, 2014; Walker et al., 2016). Gwen, who was a late majority adopter, certainly lacked confidence and doubted its value. Research also demonstrates that in addition to the time required by teachers to design and develop mobile TEL-based lessons, additional time is required to set up and maintain mobile TEL environments. There is unequivocal support in the literature for distance teaching taking more time to set up and facilitate than traditional teaching (such as Laurillard, 2009). Unquestionably, participant perceptions of being overwhelmed by the lack of time resulted in considerable frustration, anxiety and uncertainty for teachers and as such slowed the adoption process.

Additionally, teachers had to upskill learners on how to use the mobile TEL tools and devices, and this took significant time. In this research, Eric reported the need to train learners at the start of a module and sometimes class, on how to use the technology as required. Teachers found that although learners were proficient in using mobile technologies for social interaction, they were less so for their own formal education. This finding was evident in recent research that suggested that learners are more motivated to use technology for socialisation and recreation (Clark, 2013; Junco & Cotton, 2012; Ross, 2013). All of the teachers discussed how much time they allocated to the start of term instructing their learners on appropriate use. For learners to recognise mobile technology as a key to learning in today's global digital world, HEIs must afford more time for teachers to upskill learners on digital tools and the need to focus on mobile device use for learning instead of social media. This finding was aligned to current research which asserted that learners had difficulty concentrating on learning when using mobile devices (Clark, 2013; Ertmer et al., 2012; Junco & Cotton, 2012; Ross, 2013).

Participants also described how they needed additional time for CPD and practice. Whether this is one-to-one, online, ad hoc workshops, or part of a structured programme, the need for practice-based CPD supported by a mentor and appropriate assessment and feedback requires significant time (Alammary, Sheard, & Carbone, 2014). Mobile TEL instruction places varying demands on delivery and feedback methods and relies on different teacher skills and knowledge compared to face-to-face tuition (Alvarez et al., 2009). Embedding technology into the daily teaching and learning process often creates an extra load for teachers, as they need

more time to learn how to use technology to their benefit (Charbonneau-Gowdy, Capredoni, Gonzalez, Jayo, & Raby, 2016). Developing institutional competence for mobile TEL instruction requires a careful approach to training online teachers and a workload investment in teacher training and development (Gregory & Lodge, 2015). This was clearly highlighted by Diane in her interview. In this research, ICT and engineering teachers found that training and professional development sessions were too short and required them to be of a much greater duration. This view is consistent with literature that the limited length of training workshops does not provide adequate time for teachers' existing beliefs and practices to be challenged (Debowski, 2016; Swan et al., 2008).

TEL is often seen by academic staff as being asked to do more 'but with no real reward' (Bertolo, 2008). Perhaps ICT and engineering teachers in HEIs will need to be compensated or incentivised to better embrace mobile TEL (Hanson, 2009; Porter, Graham, Spring, & Welch, 2014).

6.4.4 Greater Teacher Collaboration, Networked Learning and Less Seclusion when learning about Mobile TEL are Essential

Findings in this research revealed that personal learning was the primary source of gaining knowledge and guidance for integration of mobile TEL initiatives. Teachers in this research, time after time, stated that they developed skills for integrating mobile TEL by sourcing examples on the Internet. Although after hours training was scheduled for teachers and training was also offered at staff meetings, most participants believed these were insufficient and ended up learning in their own time and at their own cost. Additionally, teachers learned about mobile TEL implementation from colleagues who were more expert in this area. This enabled more flexible and convenient learning at no cost to the teacher. Also, the informal learning effectively resulted in quicker support times. However, many participants reported how they felt secluded in their learning and CPD of mobile TEL. These participants were located in a different area of the campus to the mobile TEL experts. Additionally, many participants worked remotely and never attended campus. These teachers were less motivated to seek out advice and support and thus their mobile TEL learning, implementation and adoption were less effective.

Recent research coincides with these findings and highlights the necessity for appropriate CPD and support for teachers when teaching (Bielefeldt, 2012; Cifuentes, Maxwell, & Bulu, 2011; Jones & Dexter, 2014; Jones & Dexter, 2017; Ross, 2013).

In an attempt to surmount the issues that teacher learning in seclusion brings to the adoption of mobile TEL initiatives, Jones and Dexter (2017) stressed the need for greater collaboration among teachers. Jones and Dexter (2017) believe this leads to more effective teaching practice and technology integration and advised against the seclusion of teachers adopting mobile TEL. Unquestionably, Eric, Gwen, Heather and Ian were quite secluded in comparison to other participants in this research and interestingly found it more difficult to adopt, being more annoyed, anxious and uncertain about the process. If they had been closer to expert peers either physically or virtually, my perception is that their adoption would have been more successful.

Teachers also stated the need for greater collaboration with teachers external to their own HEIs. This included collaboration with experienced teachers from HEIs outside of Ireland and the UK as they felt such teachers had greater levels of knowledge and experience with adopting mobile TEL initiatives. Owing to teacher seclusion and lack of networked learning, participants in this research had only fleeting amounts of time or opportunities to discuss their concerns about mobile technology integration with outside experts. Triggs and John (2004) posited that seclusion among educators is “powerful” and “fuelled by external and internal pressures, of no time or opportunity to reflect on or discuss teaching with colleagues” (p. 437). Teachers in this research unquestionably felt secluded and limited by time constraints.

This research revealed that collaboration occurred mainly through informal conversations with other teachers where not secluded. One of the participants in this research worked primarily remotely, so their feelings of seclusion may have been more predominant. As a result of this seclusion combined with the need for anytime, anywhere support, participants tended to undertake personal learning. Although collaboration with peers was apparent, participants relied on PLNs more due to their individual needs. It was evident that these teachers were determined to adopt mobile TEL even with issues encountered.

These findings were aligned with the literature on how teachers learn about adopting and implementing mobile TEL initiatives. According to Jones and Dexter (2014), forms of personal learning such as blogs, wikis and discussion forums afford teachers access to learning resources anytime, anywhere. This facilitates teachers' learning at a time and place that suits them. Personal learning afforded teachers in this study a means to overcome issues not addressed in scheduled PD. Collaboration occurred through shared experiences with other ICT and engineering teachers on the Internet. Teachers shared the knowledge acquired regarding mobile TEL with their peers through informal conversations and PLCs. Such findings are supported by current research which advocates that teachers are using networked learning to learn about mobile TEL, as online learning enables access to leading edge information on technology (Jones & Dexter, 2014; Jones & Dexter, 2017; Meijs, Prinsen, & de Laat, 2016).

6.4.5 Mobile TEL Devices, Tools and Wireless Networking Technology Access and Availability are Crucial for Successful Mobile TEL Initiatives

Access to mobile devices, tools and Wi-Fi appeared to be a crucial element in influencing teachers' successful adoption of mobile TEL initiatives. All research participants believed teacher and learner anytime, anywhere access to mobile devices, tools and W-Fi as defining the difference between success and failure. Teachers continually reported how not having adequate mobile TEL technologies inhibited their ability to enhance lessons and best convey ICT and engineering concepts. Also, learners not having up-to-date and standard devices with adequate data plans negatively influenced teachers' beliefs of how useful mobile TEL environments were. Only one participant believed HEIs should remain using PC and desktop-based computers where all learners were guaranteed access with sufficient teaching and learning technologies. ICT and engineering teacher perceptions of anytime, anywhere teacher and learner access have been debated in current literature. Obstacles to mobile technology integration reported in research included not only obsolete and inadequate tools and devices but Internet access as well (Alqahtani & Mohammad, 2015; Ertmer & Ottenbreit-Leftwich, 2010; Harrison, Flood, & Duce, 2013; Kopcha, 2012; Montrieux**,** Vanderlinde**,** Schellens, & De Marez, 2015).

Participants in this research highlighted the benefits of access. Teachers and learners accessed online resources remotely using smartphones and other mobile devices, including tablets and PDAs. Also, learners participated in collaborative assignments and teachers practiced networked learning. Adam highlighted that teachers and learners can simply “search Google” for anything. Remote learners without mobile access were at a huge disadvantage not having mobile communication with their teacher, access to course and external resources, and the ability to participate in collaborative activities. Montrieux**,** Vanderlinde**,** Schellens, and De Marez (2015) asserted the value of having access to mobile devices as learners having anytime, anywhere access to key learning opportunities. With mobile TEL environments, the greatest advantage of mobile devices is Internet access (Montrieux**,** Vanderlinde**,** Schellens, & De Marez, 2015; Robb & Shellenbarger, 2012; Shraim & Crompton, 2015). Robb and Skellenbarger (2012) stated “the increase in information and communication technologies provides students with unlimited access to the information superhighway” (p. 260).

Unquestionably, ICT and engineering teachers’ perception about mobile TEL tools, device and Wi-Fi access has inhibited their adoption and implementation of mobile TEL initiatives. Evidence showed that beliefs negatively influenced teachers adopting the initiatives as participants outlined how access issues restricted incorporating collaborative learner activities and delivering lessons where online resources were not accessible.

6.4.6 Enhanced Ability to Convey ICT and Engineering Concepts and Improved Attrition Rates are Key Benefits

This research found that ICT and engineering teachers believed that mobile TEL enhanced the ability to convey ICT and engineering concepts and consequently improved attrition rates. This aligns with current research that endorses the move from didactic teaching practices which are classroom-based to learner-centred, collaborative, task-based practices with the adoption of mobile TEL within these disciplines (Abhyankar & Ganapathy, 2014). Teachers in this research found that mobile TEL helped them to overcome difficulties in learning concepts by situating their learners in real-world learning scenarios, anytime, anywhere and providing a

learning environment that enabled such learners to access digital learning resources. These findings were consistent with recent research (Abhyankar & Ganapathy, 2014; Handal et al., 2013).

This enhancement had a positive impact on the types of assignments teachers planned and gave their learners. Adam, in his interview, reported how he used an application such as ShareSpace which is accessible anytime, anywhere from a mobile device, to allow his learners on a software engineering module to experience greater collaboration. Also, findings in this research were consistent with research that outlined greater integration of mobile TEL in ICT and engineering disciplines, widening the reach to different topics and extending the classroom (Beatty, 2013; Teresevičienė et al., 2015). This was evident by Gwen's interview, where she outlined the ability mobile TEL technologies such as WhatsApp and Google Slides had afforded to add to knowledge of other learners.

Numerous teachers in this research perceived their HEI's use of mobile TEL helped learners to overcome physiological and cognitive differences such as dyslexia or impaired hearing when able to learn anytime, anywhere. This is consistent with research conducted by Traxler and Wishart (2011) who found that mobile TEL enabled contingent learning, situated learning, learning in dead-time and small bursts which addressed such issues. Another area of enhanced ability to convey ICT and engineering concepts is the specific affordance of mobile devices to assist teachers provide dynamic visualisation of concepts to better communicate to learners. In Adam's interview, he reported using a mobile TEL application called Accelerometer Monitor to display both graphically and numerically in real time the projection value of the acceleration of gravity on all three axes of the Cartesian coordinates system. These values were then sent using Bluetooth to be processed using a spreadsheet. This aligns with research by Johnson et al. (2010) who found that mobile TEL applications allow science learners to manipulate data and process statistics, deepening their understanding of complex relationships and concepts. Similarly, In Eric's interview he shared how he uses a smartphone app to improve the precision of angle slope measurements and display. This also agrees with research by Johnson et al. (2010) who found that apps that allow science learners to manipulate data and process statistics, deepen their understanding of complex relationships and concepts. It was clear in this research that mobile TEL adoption

proved a valuable asset in overcoming difficulties in learning ICT and engineering concepts by situating these learners in real-life learning scenarios, anytime, anywhere and providing a learning environment that enables such learners to access digital learning resources (Abhyankar & Ganapathy, 2014; Handal et al., 2013). Consequently, attrition rates improved.

Ertmer and Ottenbreit-leftwich (2010) posited that teachers must update their teaching approach to address the needs of todays' digital global learners. Optimal mobile TEL for ICT and engineering no longer recognises replication of class-based instruction. Today, learners require teachers who will augment and replace such didactic practices with real-life application. During observations of participants, teachers using mobile technologies on field assignments were clearly better able to explain concepts and learners better able to understand issues, particularly due to the greater level of depth teachers can go into. For example, while observing Colin, he used a web cam in the field to illustrate an actual example rather than a picture representation of a concept. In addition, participants were recording these events and making them available online for future classes as RLOs. Interestingly, learners in higher-achieving classes with improved attrition rates had teachers who were implementing mobile TEL to construct profound, connected knowledge together with valuable problem solving and critical thinking skills. In the main, teachers with lower-achieving learners were still applying didactic teaching practices and did not see improved attrition rates.

For some teachers in this research, however, lack of access to mobile TEL, either a device or Wi-Fi, hampered their capacity to plan for task-based learning of concepts that require collaboration, demonstration and observation in real-life settings. These teachers believed that learners without anytime, anywhere Internet access were less capable of understanding ICT and engineering concepts that otherwise appear abstract, compared to those with easily accessible mobile devices and Wi-Fi. The lack of mobile TEL increased the learning curve for those learners, many who were borderline dropping out. For teachers of learners with difficulties comprehending ICT and engineering concepts, the lack of mobile tools and technologies only exacerbated the difficulties for learners as they faced more digitally oriented tasks. These findings when considered in conjunction with recent research, indicates that

failure to successfully adopt mobile TEL may negatively affect attrition rates (Chowdhry, Sieler, & Alwis, 2014; Saylor, 2012).

6.4.7 Summary of Contribution to Current Knowledge

As evidenced by the research findings of chapter five and subsequent discussion above, this study has contributed significantly to current knowledge regarding the adoption and implementation of mobile TEL initiatives for teaching and learning.

Much of the research on mobile learning had previously focused on the teaching and pedagogies related to instances of mobile learning in HEIs (Bebell & O'Dwyer, 2010; Gulek & Demirtas, 2005; Lam, Yau, & Cheung, 2010; Peng et al., 2009; Traxler & Wishart, 2011). Although research in these areas produced valuable information about mobile instructional technology and its adoption and was a solid research base, it is not strong in that little research focused on the experiences of teachers who adopted and implemented mobile TEL within ICT and engineering. Similarly, the impact of mobile TEL on the way we teach and learn within ICT and engineering in Ireland and the UK is understudied.

I used semi-structured interviews, observations and an online focus group that allowed ICT and engineering teachers to tell their stories of mobile TEL adoption and implementation. The use of guided interviews gave ample opportunity for the teacher voices to be heard. The observations and online focus group provided additional opportunity. The results help to fill the gap in the literature concerning ICT and engineering teacher adoption of mobile TEL by telling the story of their teaching experiences.

In summary, we have gained an in-depth understanding of the:

- perceptions and lived experiences of ICT and engineering teaching faculty in HEI's within Ireland and the UK of mobile TEL initiatives;
- ability of mobile TEL initiatives to enhance the teaching and learning of ICT and engineering concepts;
- positive affect this enhancement has on improving ICT and engineering attrition rates;
- obstacles and challenges ICT and engineering teaching faculty face;

- requirements for effective implementation of mobile TEL initiatives;
- criticality of appropriate practice-based CPD, mentoring and CoPs;
- need for close ties between HEI executives, policy makers and teaching faculty;
- the value of Rogers's (1995) DOI and Wenger's (1997) CoP theories as a theoretical framework.

6.5 Limitations

Limitations are an intrinsic aspect of qualitative research (Creswell, 2013). Several limitations existed in this research. Firstly, this research focuses on teachers' perceptions of the adoption and implementation of mobile TEL initiatives, as opposed to students. Neither does it consider the perceptions of administrators, heads of department and those of IT support people who are also key stakeholders in the adoption and implementation process.

A second limitation of this study relates to the theoretical frameworks employed. I have only analysed what teachers meant by their perceptions from DOI and CoP perspectives. There are many alternatives that could have been employed and these may have yielded different results.

A third limitation stems from the lack of data regarding the extent to which teachers used mobile tools and devices for specific types of teaching and learning. Mobile technologies and devices can be used in numerous different ways by teachers (Bebell, Russell, & O' Dwyer, 2004). Depending on how this use is measured, the lessons learned from a study of mobile TEL technology can vary dramatically. In this study, we know that teachers who participated in the mobile TEL initiatives had access to mobile tools and devices. Anecdotal evidence suggests that teachers used their mobile tools and devices for a variety of purposes. However, since we did not systematically collect information about how particular participants used their mobile TEL devices or other types of TEL technologies, I was unable to provide estimates of the effect of specific mobile TEL technology uses by participant teachers on student achievement.

Another limitation of this study relates to the subjectivity of qualitative research, which can lead to bias regarding the research area. As a mentor teacher in the

mobile TEL initiative at a particular HEI in Ireland, I acknowledged any bias that I may have about the adoption and implementation of mobile TEL in the country. During the data collection and analysis, I kept a reflective journal to bracket my own subjective opinion regarding mobile TEL adoption and implementation. In addition, I reviewed the data many times in order to identify themes and patterns from all angles and perspectives.

To ensure trustworthiness in my research, I sought respondent validation of the transcripts, themes and findings. Peers who were familiar with my research and well-informed about mobile technologies and TEL regularly examined the findings with me during the many phases of data analysis. Also, the research methodology comprised three sources of data collection. To make comparisons between the numerous perspectives of participant experiences and perceptions, cross-analysis of data was conducted multiple times. All transcriptions and notes were held in order to provide concise documentation of decisions made throughout the research.

Finally, the purposeful sampling method does not allow researchers to generalise data to all higher education faculty members. Rather, results provide information for a more in-depth understanding of this particular phenomenon, and the results are most pertinent only to ICT and engineering teachers in HEIs in Ireland and the UK.

6.6 Research Implications and Recommendations

In today's global digital world, teachers are faced with persistent and challenging demands to adopt and integrate mobile technologies to enhance teaching and learning (Mitchell, Simpson, & Adachi, 2017). Teachers must be trained, mentored and continually developed to effectively apply mobile TEL initiatives, specifically with regard to difficulties in learning concepts which mostly appear abstract to learners (Johnson et al., 2010). Thus, the importance of involving and hearing the opinions of ICT and engineering teachers as they apply new pedagogies and alter their practices in response to the needs of mobile TEL is crucial. Successful technology integration strategy as proposed by Schneckenberg (2010, p. 981), is based on the assumption that "a successful implementation of technology-driven innovation in universities depends on the capabilities of the leadership management to actively involve

teachers in organisational change". Weak institutional support can hinder effective integration (Shraim, 2012).

The most valuable finding in this research was based on participants' perceptions about the superior ability of mobile Technology Enhanced Learning to convey ICT and engineering concepts and consequently improved attrition rates. Specific ICT and engineering concepts better conveyed by mobile TEL in this study included: mathematical expressions; the configuration of POS laptops and wireless transmission of data to a central server; scientific calculator use when working through an engineering solution; calculating the precision of angle slope measurements in mechanics experiments; and the projection value of the acceleration of gravity on all three axes of a Cartesian coordinates system. Certainly, research has indicated mobile technology has driven significant advances for ICT and engineering HEIs by enabling teachers to better assist learners to grasp learning concepts (Abhyankar & Ganapathy, 2014; Kissinger, 2013; Tsai & Hwang, 2013). In many cases, participants felt that using mobile TEL technologies and devices helped overcome the difficulties in learning concepts which mostly appear abstract to learners. Both Abhyankar and Ganapathy (2014) and Handal et al. (2013) contended that situating learners in real-world learning scenarios, anytime, anywhere and providing a learning environment that enables such learners to access digital learning resources is a valuable asset in overcoming difficulties in learning concepts. Participants were impressed by the affordance of mobile devices to help them provide a dynamic visualisation of concepts to better communicate ideas to their learners, as previously contended by Walters (2011). Teachers must grasp the potential for mobile TEL applications to allow ICT and engineering learners to manipulate data and process statistics, deepening their understanding of complex relationships and concepts. HEI executives and policy makers must look for ways to support ICT and engineering teachers and learners as they seek to effectively use mobile TEL not only for improving communication, collaboration and critical thinking but also for enhanced learning of ICT and engineering concepts. Teachers integrating mobile TEL seemed to have more confidence and persistence when assisting learners to grasp ICT and engineering learning concepts. As recently argued by Darling-Hammond, Hyler, and Gardner (2017) and Jones and Dexter (2017), findings of this study further imply that practice-based CPD geared toward

teachers of ICT and engineering learners together with CoP-led classes may help not only teachers but their learners also. With more support for gaining mobile TEL skills, ICT and engineering learners may approach tasks involving mobile technology with more efficacy, and teachers may feel greater confidence in adopting mobile TEL without concern of losing instructional time.

Another interesting finding in this research was the preference for HEI executives to consult teachers when formulating and implementing an adoption strategy. This preference was due to the perceived lack of appreciation by HEI executives of their needs for successful adoption and implementation. Participants felt a complete disconnect between those teachers on the ground practicing mobile TEL and HEI executives and policy makers. Based on participants' previous experiences with the adoption and implementation of mobile TEL initiatives, it was alarming that all participant teachers felt their voices were disregarded. Irrespective of how mobile TEL has been adopted in HEIs to date, future initiatives to continue the adoption process in HEIs where it has already started and new initiatives yet to be started must include teachers in the formation and execution of any mobile TEL strategy and process (Abrahams, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). Key needs of teachers that need to be appreciated are the need for mobile TEL specific pedagogies, adequate and up-to-date mobile TEL tools, reliable technical infrastructure and Wi-Fi connectivity, practice-based CPD, collaboration with peers in other HEIs, and most importantly adequate time to adopt the initiatives with such a sharp and significant learning curve. HEI executives must appreciate the obstacles and benefits teachers face and how mobile TEL can best be diffused and adopted (Abrahams, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). This implication is particularly important, as most cases of poor or failed adoption and implementation of mobile TEL initiatives in this study appear related to lack of sufficient involvement of ICT and engineering teachers in the process.

A further implication of this research is that ICT and engineering teachers need additional time for pervasive adoption and implementation of mobile TEL initiatives (Gregory & Lodge, 2015; Liu, Han, & Li, 2010; Reed, 2014; Tsai & Chai, 2012). Additional time is required to enable teachers to develop best practices for mobile TEL adoption and implementation and to assist HEI executives in engaging with TEL teachers when formulating policy around mobile TEL adoption (Dougherty, 2015).

ICT and engineering teachers require more continuing professional development with associated on-going support and constructive feedback. Rather than struggling with the assimilation of excessive amounts of information and having little exposure to the practical application of mobile TEL, ICT and engineering teachers require CPD that centres less on the mobile technology skills but more on the pedagogical skills required to best adopt and implement mobile TEL (Ertmer et al., 2012; Kopcha, 2010). Consequently, additional time to practice using mobile technologies effectively for teaching may increase teachers' confidence in adopting mobile TEL and implementing the tools for teaching and learning. HEI executives also require additional time. As feelings of frustration, anxiety and uncertainty were widespread in this research, HEI executives and other HEI stakeholders require additional time and funding to ensure up-to-date technologies and devices, always-on wireless networking and accessible technical and pedagogical support available to teachers. Additionally, HEI executives must consult teachers when developing and implementing policy for the adoption and implementation of mobile TEL initiatives.

Finally, the significance of personal learning was highlighted by the findings of this research. Teachers in this research appeared to learn more about mobile TEL implementation on their own and in their own time using PLNs (Jones & Dexter, 2014). Although such learning met teachers' short-term requirements, they wanted more collaborative and networked learning with other ICT and engineering teachers, locally and globally. CoPs did form in certain areas within the ICT and engineering departments as a result of the need for professional development. Learning through these CoPs together with other informal learning at break times and outside lectures did go some way towards meeting the lack of appropriate skills. However, as long contended by Triggs and John (2004), it was evident here that many teachers felt left out and secluded due to remoteness. In answer to this, it may be beneficial to locate mobile TEL users within reach of each other and to investigate virtual communities of practice. This may stimulate more informal learning. Recognising the successful adoption and implementation of mobile TEL by other ICT and engineering teachers should motivate and increase confidence for those grappling with the change. Such informal learning may subsequently highlight the necessity for additional, practice-based CPD.

6.7 Future Research

Reflecting on the findings of this research, some significant areas should be considered for further research. As only ICT and engineering teachers participated in this study, future research should consider teachers' perceptions of and experiences with the adoption and implementation of mobile TEL initiatives within other subject areas. Thus, future research should consider the use of mobile TEL in teaching within the disciplines of science, dentistry and medicine; for example, how teachers perceive the relative advantage of mobile devices in anaesthetics, where concepts within anaesthetics can be better taught collaboratively in a real-life context.

A further area requiring future research is that of access to mobile technologies for all teachers and learners. In this research, teachers perceived this access as critical to mobile TEL. Unquestionably, this perception affected teachers' adoption and integration of mobile TEL for collaborative practice-based learning. Further research should investigate the perceptions and experiences of teachers and learners who do not have access to mobile technologies. Questions to consider can be how the lack of access affects teacher and learner motivation, engagement, as well as the realisation of skills required for today's global digital world.

The value of RLOs such as YouTube videos was highlighted my many participants. Future research should explore in greater detail the materials used by mobile TEL teachers and the related issues of privacy, data protection, security and copyright. Also, teachers' attitudes towards developing their own material as opposed to using generic-material available on the Internet should be explored.

Also, of importance in this research is teachers' requirements for anytime, anywhere Wi-Fi networked connectivity. Future research can also investigate the changes in achievement and attrition rates based on using mobile TEL on campus as opposed to anytime, anywhere. Certainly, if learner achievement and attrition rates improved with anytime, anywhere access, further research in this area will assist HEI executives implementing mobile TEL initiatives.

Additionally, future research should investigate the effect teacher seclusion has on their adoption and implementation of technology innovations. In this research, ICT and engineering teachers, particularly online facilitators, were secluded in their practice. Professional development and learning for them was personal and

secluded. They lacked adequate technological and pedagogical support. They were less motivated to resolve issues when implementing mobile TEL in their teaching. Further research can evaluate teachers' capabilities with mobile TEL in comparison to their collaboration with experienced mobile TEL adopters.

Furthermore, with teacher perceptions of a lack of appreciation of their needs for successful adoption and implementation of mobile TEL, research is needed on how HEI executives and policy makers can best involve teachers in the formulation and execution of mobile TEL strategy.

Finally, and most significantly, with teachers recognising the superior ability of mobile TEL to convey ICT and engineering concepts to learners and consequently improving attrition rates, future research should investigate how mobile TEL can better convey concepts within other disciplines in relation to improved changes in attrition rates within these disciplines. As teacher perceptions in this area impacted how they adopted mobile TEL, it is vital that this area receive more research so educators can successfully enhance the teaching and learning.

6.8 Summary

Using Rogers's (1995) DOI and Wenger's (1997) CoP theories as a theoretical framework, this research sought to investigate the perceptions and lived experiences of ICT and engineering teachers in higher education institutions within Ireland and the UK who adopt and implement Mobile Technology Enhanced Learning initiatives. Using teacher interviews, observations, and online focus group discussions, an analysis of the data revealed several significant findings. Firstly, teachers' frustration, anxiety and uncertainty were widespread. This frustration was due to several reasons including inadequate and obsolete mobile tools, issues with unreliable technical infrastructure and wireless networking connectivity. Also, teachers were overcome by the amount of time required to develop teaching material where mobile TEL was embedded, to acquire the necessary technical and pedagogical skills to enhance their teaching, and to upskill learners in using mobile TEL technologies. Teachers perceived and experienced a sharp and significant learning curve as they adopted mobile TEL initiatives. In addition, teachers were uncertain as to whether wireless networked connectivity would be available when required. Consequently,

designing lecture content necessitated an alternative plan which further encroached on their time.

Next, teachers required more practice-based CPD. Generally, PD was offered through short scheduled training as part of monthly staff meetings or after normal working hours and was technically focused rather than pedagogically focused. Teachers desired CPD be supported by mentors and include assessment and feedback. Informal conversations with teachers who were experienced mobile TEL adopters was very useful; however, those teachers more secluded or working remotely could not benefit. Such feelings of lack of support resulted in teachers lacking confidence when implementing mobile TEL initiatives. Crucially, these participants required greater collaboration and networked learning with other ICT and engineering teachers, locally and globally.

One of the most significant findings was teachers' perceptions of access. Participants believed anytime, anywhere access to mobile TEL tools, technologies and reliable Wi-Fi networked connectivity were crucial for the successful adoption of mobile TEL. Inadequate access prohibited standardisation of teaching and the use of collaborative tasks by learners. The requirement to have an alternative lesson plan, caused participants to be indecisive when planning classes with mobile TEL. Consequently, participants perceived learners with inadequate access were slower to develop mobile TEL skills, less motivated and engaged and this resulted in poorer attrition rates; thus, responsibility and time constraints felt by teachers were significant. Findings from this research showed ICT and engineering teachers were annoyed when attempting to adopt mobile TEL to better convey ICT and engineering concepts while faced with huge increased demands on their time in upskilling learners on using mobile devices.

Research findings revealed additional time is crucial for pervasive adoption and implementation of mobile TEL initiatives. Providing more time should enable teachers to gain further practice-based CPD and acquire appropriate skills for integrating mobile TEL technologies. The additional time should also enable them to structure their teaching so that they address difficulties in learning concepts which mostly appear abstract to their ICT and engineering learners. Allocating more time, HEI executives may ease the frustration, anxiety and uncertainty teachers felt, by

improving the HEI infrastructure necessary for mobile TEL adoption and implementation and introducing a structure for practice-based CPD. Importantly, additional time would afford all parties prospects to find solutions to ensure teachers and learners have anytime, anywhere access to appropriate mobile TEL tools, devices, data plans and Wi-Fi networked connectivity.

As I explored the participants' perceptions and experiences with mobile TEL adoption and implementation, I obtained a detailed appreciation of the difficult challenges ICT and engineering teachers confronted as they moved from a teaching environment characterised by PC and laptops to adopting and implementing mobile TEL initiatives where they and their learners had negligible experience of mobile TEL tools and related pedagogies. As mobile technology initiatives are rapidly changing, HEI executives must ensure appropriate practice-based continuing professional development is in situ. This in conjunction with supportive mentoring and the development of professional CoPs must be provided for ICT and engineering teachers attempting to adopt and implement mobile TEL initiatives. ICT and engineering teachers in today's global digital world face persistent and challenging demands to better convey concepts while adopting and integrating mobile technologies to enhance teaching and learning. Thus, teachers must be trained, mentored and continually developed to effectively apply mobile TEL initiatives, specifically with regard to difficulties in learning concepts which mostly appear abstract to learners. Additionally, teachers will continue to experience time constraints as they face ongoing curriculum changes. As a result, HEI executives and policy makers will be challenged to appreciate how ICT and engineering teachers' perceptions and experiences with mobile Technology Enhanced Learning affect its pervasive adoption and implementation.

References

Abhyankar, K., & Ganapathy, S. (2014). Technology-enhanced learning analytics system design for engineering education. *International Journal of Information and Education Technology*, *4*(4), 345–350. doi:10.7763/IJIET.2014.V4.427

Abigail, L. K. M. (2016). Do communities of practice enhance faculty development? *Health Professions Education*, *2*(2), 61–74.

Abrahams, D. A. (2010). Technology adoption in higher education: A framework for identifying and prioritising issues and barriers to adoption of instructional technology. *Journal of Applied Research in Higher Education*, *2*(2), 34–49.

Agarwal, R., & Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, *9*(2), 204–215. doi:10.1287/isre.9.2.204

Alammary, A., Sheard, J., & Carbone, A. (2014). Blended learning in higher education: Three different design approaches. *Australasian Journal of Educational Technology*, *30*(4), 440–454.

Albirini, A. (2006). Teachers' attitudes toward information and communication technologies: the case of Syrian EFL teachers. *Computers & Education*, *47*(4), 373–398.

Alderton, E., Brunsell, E., & Bariexca, D. (2011). The end of isolation. *The Journal of Online Learning and Teaching*, *7*(3), 1–16.

Allen, E., & Seaman, J. (2010). *Class Differences: Online Education in the United States,* Babson Survey Research Group.

AlMutlaq, A., Dimitriadi, Y., & McCrindle, R. (2017). Factors affecting academics' involvement in TEL continuing professional development (CPD). *Journal of Education and Practice*, *8*(10), 142–149.

Alqahtani, M., & Mohammad, H. (2015). Mobile applications' impact on student performance and satisfaction. *Turkish Online Journal of Educational Technology*, *14*(4), 102–112.

Alvarez, I., Guasch, T., & Espasa, A. (2009). University teacher roles and competencies in online learning environments: A theoretical analysis of teaching and learning practices. *European Journal of Teacher Education*, *32*(3), 321–336.

Anderson, S. E. (1997). Understanding teacher change: Revisiting the concerns based adoption model. *Curriculum Inquiry*, *27*(3), 331–367. doi:10.1111/0362-6784.00057

Bachmann, A. M. R., Menestrina, R. V., & Domingues, M. J. (2015). The M-learning use in higher education: A study in Santa Catarina universities. In *2015 Ninth International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS '15)* (pp. 427–429). IEEE. doi:10.1109/CISIS.2015.61

Baker-Doyle, K. J. (2011). *The networked teacher: How new teachers build social networks for professional support*. New York, NY: Teachers College Press.

Baran, E. (2011). *The transformation of online teaching practice: Tracing successful online teaching in higher education* (Dissertation, Iowa State University). Graduate Theses and Dissertations. (12206)

Beatty, K. (2013). *Beyond the classroom: Mobile learning the wider world.* Monterey, CA: The International Research Foundation for English Language Education. Retrieved from http://www.tirfonline.org/english-in-the-workforce/mobile-assisted-language-learning/

Bebell, D., & O'Dwyer, L. M. (2010). Educational outcomes and research from 1:1 computing settings. *The Journal of Technology, Learning, and Assessment*, *9*(1), 1–15.

Bebell, D., Russell, M., & O'Dwyer, L. (2004). Measuring teachers' technology uses: Why multiple-measures are more revealing. *Journal of Research on Technology in Education*, *37*(1), 45–64.

Bell, F. (2011). Connectivism: Its place in theory-informed research and innovation in technology-enabled learning. *International Review of Research in Open and Distance Learning*, *12*(3), 98–118.

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

Berry, A. K. (2009). Professional self-understanding as expertise in teaching about teaching. *Teachers and Teaching: Theory and Practice*, *15*(2), 305–318.

Bertolo, E. (2008). Web 2.0: Unlearned lessons from previous virtual learning environments. *Bioscience Education*, 11. Retrieved from http://journals.heacademy.ac.uk/doi/pdf/10.3108/beej.11.7

Bielefeldt, T. (2012). Guidance for technology decisions from classroom observation. *Journal of Research on Technology in Education*, *44*(3), 205–223.

Bloomberg, L., & Volpe, M. (2012). *Completing your qualitative dissertation: A roadmap from beginning to end* (2nd ed.). Los Angeles: Sage Publications.

Brett, P. (2011). Students' experiences and engagement with SMS for learning in higher education. *Innovations in Education & Teaching International*, *48*(2), 137–147.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–42.

Brown, J. S., & Duguid, P. (1991). Organizational learning and communities of practice: Toward a unified view of working, learning, and innovation. *Organization Science*, *2*(1), 40–57.

Butler, D. L. & Sellbom, M. (2002). Barriers to adopting technology for teaching and learning. *Educause Quarterly*, *8*(2), 22–28.

Cano, J. (2006). Essentials for effective professional development. *The Agricultural Education Magazine*, *79*(2), 2.

Charbonneau-Gowdy, P., Capredoni, R., Gonzalez, S., Jayo, M. J., & Raby, P. (2016). Brave forms of mentoring supported by technology in teacher education. *Electronic Journal of e-Learning*, *14*(1), 3–14.

Chen, C. H., Hwang, G. J., Yang, T. C., Chen, S. H., & Huang, S. Y. (2009). Analysis of a ubiquitous performance support system for teachers. *Innovations in Education and Teaching International*, *46*(4), 421–433.

Chen, J. Q., & McCray, J. (2012). A conceptual framework for teacher professional development: The whole teacher approach. *NHSA Dialog*, *15*(1), 8–23. doi:10.1080/15240754.2011.636491

Chou, C. C., Block, L., & Jesness, R. (2012). A case study of mobile learning pilot project in K-12 schools. *Journal of Educational Technology Development and Exchange*, *5*(2), 11–26.

Chowdhry, S., Sieler, K., & Alwis, L. (2014). A study of the impact of technology-enhanced learning on student academic performance. *Journal of Perspectives in Applied Academic Practice*, *2*(3), 3–15.

Chu, H. C., Hwang, G. J., & Tsai, C. C. (2010). A knowledge engineering approach to developing mind tools for context-aware ubiquitous learning. *Computers & Education*, *54*(1), 289–297.

Cifuentes, L., Maxwell, G., & Bulu, S. (2011). Technology integration through professional learning community. *Journal of Educational Computing Research*, *44*(1), 59–82.

Cilesiz, S. (2011). A phenomenological approach to experiences with technology: Current state, promise, and future directions for research. *Education Technology Research Development*, *59*(4), 487–510. doi:10.1007/s11423-010-9173-2

Clarà, M., & Barberà, E. (2013). Three problems with the connectivist conception of learning. *Journal of Computer Assisted Learning*, *30*(3), 197–206.

Clark, C. (2013). *A phenomenological study of the impact of pre-service and in-service training regarding the integration of twenty-first century technologies into selected teachers' instruction* (Unpublished doctoral dissertation). Retrieved from http://digitalcommons.liberty.edu/doctoral/691/

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London, England: Routledge.

Constant, E. W., II (1987). The social locus of technological practice: Community, system, or organization? In W. E. Bijker, T. P. Hughes, & T. J. Pinch (Eds.), *The social construction of technological systems* (pp. 223–242). Cambridge, MA: MIT Press.

Crescente, M., & Lee, D. (2011). Critical issues of m-learning: Design models, adoption process, and future trends. *Journal of the Chinese Institute of Industrial Engineers*, *28*(2), 111–123.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches* (2nd ed.). London, England: Sage.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative and mixed methods approaches* (3rd ed.). Los Angeles, CA: Sage Publications.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Miller, D. L. (2000). Determining validity into qualitative inquiry. *Theory into Practice*, *39*(3), 124–130.

Crompton, H. (2013). A historical overview of mobile learning: Toward learner-centered education. In Z. L. Berge & L. Y. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 3–14). Florence, KY: Routledge.

Crow, R., Santos, I. M., LeBaron, J., McFadden, A. T., & Osborne, C. F. (2010). Switching gears: Moving from e-learning to m-learning. *MERLOT Journal of Online Learning and Teaching*, *6*(1), 268–278.

Cviko, A., McKenney, S., & Voogt, J. (2012). Teachers enacting a technology-rich curriculum for emergent literacy. *Educational Technology and Research and Development*, *60*(1), 31–54.

Dahlstrom, E., & Bichsel, J. (2014). *ECAR study of undergraduate students and information technology*. Louisville, CO: ECAR.

Damanpour, F. (1988). Innovation type, radicalness, and the adoption process. *Communications Research*, *15*(5), 545–567.

Daniels, H. (2011). Vygotsky and psychology. In U. Goswami (Ed.), *The Wiley-Blackwell handbook of childhood cognitive development* (2nd ed., pp. 673–696). New York, NY: Wiley.

Darling-Hammond, L. (1997). Quality teaching: The critical key to learning. *Principal*, 77(1), 5–6.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Palo Alto, CA: Learning Policy Institute.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340.

Debowski, S. (2016). *Developing academics: The essential higher education handbook*. New York, NY: Routledge.

Delahunty, J., Jones, P., & Verenikina, I. (2014). Movers and shapers: Teaching in online environments. *Linguistics & Education*, *28*(4), 54–78.

Denzin, N. (1989). *The research act: A theoretical introduction to sociological methods* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Denzin, N., & Lincoln, Y. (2000). *Handbook of qualitative research* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Derting, T. L., Ebert-May, D., Henkel, T. P., Maher, J. M., Arnold, B., & Passmore, H. A. (2016). Assessing faculty professional development in STEM higher education: Sustainability of outcomes. *Science Advances*, *2*(3), e1501422. doi:10.1126/sciadv.1501422

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199.

Dettelis, P. (2010). New York State technology education: History, the current state of affairs and the future. *Technology and Engineering Teacher*, *70*(4), 34–38.

De Wever, B., Hämäläinen, R., Voet, M., & Gielen, M. (2015). A wiki task for first-year university students: The effect of scripting students' collaboration. *The Internet and Higher Education, 25*, 37–44.

Dewey, J. (1916). *Democracy and education.* New York, NY: The MacMillan Company.

Dohn, N. B. (2009). Web 2.0: Inherent tensions and evident challenges for education. *International Journal of Computer-Supported Collaborative Learning*, *4*(3), 343–363. doi:10.1007/s11412-009-9066-8

Donnelly, R. (2008). Virtual problem-based learning communities of practice for teachers and teacher educators: An Irish higher education perspective. In C. Kimble & P. Hildreth (Eds.), *Communities of practice: Creating learning environments for educators* (Vol. 2). Charlotte, NC: Information Age Publishing.

Dougherty, K. (2015). Factors that influence college faculty to adopt digital technologies in their practice. *Higher Education in Transformation Conference* (pp. 307–318). Dublin, Ireland.

Drouin, M., Vartanian, L. R., & Birk, S. (2014). A community of practice model for introducing mobile tablets to university faculty. *Innovative Higher Education*, *39*(3), 231–245. doi:10.1007/ s10755-013-9270-3

Dufour, R. (2004). What is a professional learning community? *Educational Leadership*, *61*(8), 6–11.

Dufour, R., Dufour, R., & Eaker, R. (2008). *Revisiting professional learning communities at work: New insights for improving schools*. Bloomington, IN: Solution Tree Press.

Duran, M., Brunvard, S., & Fossum, P. (2009). Preparing science teachers to teach with technology: Exploring a K-16 networked learning community approach. *The Turkish Online Journal of Educational Technology*, *8*(4), 21–43.

Echeverría, A., Nussbaum, M., Calderón, J. F., Bravo, C., Infante, C., & Vásquez, A. (2011). Face-to-face collaborative learning supported by mobile phones. *Interactive Learning Environments*, *19*(4), 351–363. doi:10.1080/10494820903232943

Elias, T. (2011). Universal instructional design principles for mobile learning. *The International Review of Research in Open and Distance Learning*, *12*(2), 143–156.

Ensminger, D. C., Surry, D. W., Porter, B. E., & Wright, D. (2004). Factors contributing to the successful implementation of technology innovations. *Educational Technology Society*, *7*(3), 61–72.

Ertmer, P., & Ottenbreit-Leftwich, A. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255–284. doi:10.1080/15391523.2010.10782551

Ertmer, P. A., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, *59*(2), 423–435.

Fabian, K., & MacLean, D. (2014). Keep taking the tablets? Assessing the use of tablet devices in learning and teaching activities in the further education sector. *Research in Learning Technology*, 22, 1–14. doi:10.3402/rlt.v22.22648

Farley, H., Murphy, A., Johnson, C., Carter, B., Lane, M., Midgley, W., Hafeez-Baig, A., Dekeyser, S., & Koronios, A. (2015). How do students use their mobile devices to support learning? A case study from an Australian regional university. *Journal of Interactive Media in Education*, *14*(1), 1–13.

Firestone, W. A. (1993). Alternative arguments for generalizing from data as applied to qualitative research. *Educational Researcher*, *22*(4), 16–23.

Fitzgerald, E. (2012). Creating user-generated content for location-based learning: An authoring framework. *Journal of Computer Assisted Collaborative Learning*, *28*(3), 195–207. doi:10.1111/j.1365-2729.2012.00481.x

Fitzsimmons, T. (2007). *Using communities of practice for the professional development of workplace learning and performance professionals* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses Database. (UMI No. 3288858)

Flanigan, R. (2011). Professional learning networks taking off. *Education Week*. Retrieved from http://www.edweek.org/ew/articles/2011/10/26/09edtechnetwork.h31.html?tkn=NXCFrTi53Q/

Foti, M. K., & Mendez, J. (2014). Mobile learning: How students use mobile devices to support learning. *Journal of Literacy and Technology*, *15*(3), 58–78.

Franklin, T. (2011). Mobile learning: At the tipping point. *Turkish Online Journal of Educational Technology*, *10*(4), 261–275.

Frohberg, D., Goth, C., & Schwabe, G. (2009). Mobile learning projects: A critical analysis of the state of the art. *Journal of Computer Assisted Learning*, *25*(4), 307–331. doi:10.1111/j.1365-2729.2009.00315.x

Gall, M., Gall, J., & Borg, W. (2007). *Educational research: An introduction* (8th ed.). Boston, MA: Pearson.

Galvan, J. (2009). *Writing literature reviews: A guide for students of the social and behavioral sciences* (4th ed.). Glendale, CA: Pyrczak Publishing.

Garmston, R., & Wellman, B. (1998, April). Teacher talk that makes a difference. *Educational Leadership*, *55*(7), 30–34.

Gast, I., Schildkamp, K., & van der Veen, J. T. (2017). Team-based professional development interventions in higher education: A systematic review. *Review of Educational Research*, *87*(4), 736–767. doi:10.3102/0034654317704306

Gerard, L. F., Bowyer, J. B., & Linn, M. C. (2010). How does a community of principals develop leadership for technology-enhanced science? *Journal of School Leadership*, *20*(2), 145–183.

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education*, *19*, 18–26. doi:10.1016/j.iheduc.2013.06.002

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers: An introduction*. White Plains, NY: Longman.

Gonzalez-Sanmamed, M., Munoz-Carril, P. C., & Sangra, A. (2014). Level of proficiency and professional development needs in peripheral online teaching roles. *The International Review of Research in Open and Distance Learning*, *15*(6), 162–187.

Gourlay, L. (2011). New lecturers and the myth of 'communities of practice'. *Studies in Continuing Education*, *33*(1), 67–77.

Greener, S., & Wakefield, C. (2015). Developing confidence in the use of digital tools in teaching. *The Electronic Journal of eLearning*, *13*(4), 260–267.

Gregory, M. S.-J., & Lodge, J. M. (2015). Academic workload: The silent barrier to the implementation of technology-enhanced learning strategies in higher education. *Distance Education*, *36*(2), 1–21. doi:10.1080/01587919.2015.1055056

Gu, X., Zhu, Y., & Guo, X. (2013). Meeting the 'Digital Natives': Understanding the acceptance of technology in classrooms. *Educational Technology*, *16*(1), 392–402.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In K. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Thousand Oaks, CA: Sage.

Gulek, J. C., & Demirtas, H. (2005). Learning with technology: The impact of laptop use on student achievement. *The Journal of Technology, Learning, and Assessment*, *3*(2), 1–39.

Hadar, L., & Brody, D. (2010). From isolation to symphonic harmony: Building a community of learners among teacher educators*. Teaching and Teacher Education*, 26(8), 1641–1651.

Hadar, L. L., & Brody, D. L. (2017). *Teacher educators' professional learning in communities*. London: Routledge.

Hammonds, L., Matherson, L. H., Wilson, E. K., & Wright, V. H. (2013). Gateway tools: Five tools to allow teachers to overcome barriers to technology integration. *The Delta Kappa Gamma Bulletin*, Fall, 36–41. Retrieved from https://www.dkg.org/sites/default/files/files-for download/Fall%202013_Future%20of%20Education_0.pdf#page=36

Handal, B., Macnish, J., & Petocz, P. (2013). Academics adopting mobile devices: the zone of free movement. In H. Carter, M. Gosper, & J. Hedberg (Eds.), *Electric Dreams: 30th Ascilite Conference 2013 Proceedings* (pp. 350-361). North Ryde, NSW: Macquarie University.

Hanson, J. (2009). Displaced but not replaced: The impact of e-learning on academic identities in higher education. *Teaching in Higher Education*, *14*(5), 553–564. doi:10.1080/13562510903186774

Harrison, R., Flood, D., & Duce, D. (2013). Usability of mobile applications: Literature review and rationale for a new usability model. *Journal of Interaction Science*, *1*(1), 1–16. doi:10.1186/2194-0827-1-1

Hintze, D., Hintze P., Findling R. D., & Mayrhofer R. (2017). A large-scale, long-term analysis of mobile device usage characteristics. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, *1*(2), 1–21. doi:10.1145/3090078

Hornik, R. (2004). Some reflections on diffusion theory and the role of Everett Rogers. *Journal of Health Communication*, *9*(S1), 143–148. doi:10.1080/1081070490271610

Howard, S. K., & Mozejko, A. (2015*).* Teachers: Technology, change and resistance. In M. Henderson & G. Romeo (Eds.), *Teaching and digital technologies: Big issues and critical questions* (pp. 307–317). Port Melbourne, VIC: Cambridge University Press.

Huang, S. H., Wu, T. T., Chen, H. R., Yang, P. C., & Huang, Y. M. (2012*).* Mathematics assisted instruction system of M/U-learning environment. In *2012 IEEE Seventh International Conference on Wireless, Mobile and Ubiquitous Technology in Education (WMUTE)* (pp. 301–305). doi:10.1109/WMUTE.2012.72

Husserl, E. (1970). *The crisis of European sciences and transcendental phenomenology.* Evanston, IL: Northwestern University Press.

Hwang, G.J., & Chang, H.F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, *56*(4), 1023–1031.

Hwang, G. J., & Wu, P. H. (2014). Applications, impacts, and trends of mobile technology-enhanced learning: A review of 2008–2012 publications in selected SSCI journals. *International Journal of Mobile Learning and Organisation*, *8*(2), 83–95.

Hwang, G. J., Wu, P. H., & Ke, H. R. (2011). An interactive concept map approach to supporting mobile learning activities for natural science courses. *Computers & Education*, *57*(4), 2272–2280.

Isabwe, G. M. N. (2014). *Mobile learning: Learning supported by mobile technology based tools*. Retrieved from http://ufbutv.com/2014/03/16/mobile-learning-learning-supported-by-mobile-technology-based-tools/

JISC (2011). *Mobile learning*. Retrieved from https://www.jisc.ac.uk/guides/mobile-learning

JISC (2015). *Developing students' digital literacy.* Retrieved from https://www.jisc.ac.uk/guides/developingstudents-digital-literacy

Johnson, D. (2014, January). *Teaching above the line. Educational leadership*. Retrieved from http://www.ascd.org

Johnson, L., Becker, S., Estrada, V., & Freeman, A. (2014). *NMC horizon report: 2014 higher education edition*. Austin, TX: The New Media Consortium.

Johnson, L., Levine, A., Smith, R., & Stone, S. (2010). *The 2010 horizon report*. Austin, TX: The New Media Consortium.

Jones, M., & Dexter, S. (2017). Teacher perspectives on technology integration professional development: Formal, informal, and independent learning activities. In J. Johnston (Ed.), *Proceedings of EdMedia 2017* (pp. 566–577). Washington, DC: Association for the Advancement of Computing in Education (AACE). Retrieved from https://www.learntechlib.org/p/178490/

Jones, W., & Dexter, S. (2014). How teachers learn: The roles of formal, informal, and independent learning. *Educational Technology Research & Development*, *62*(3), 362–384. doi:10.1007/s11423-014-9337-6

Junco, R., & Cotton, S. R. (2012). No A 4 U: The relationship between multitasking and academic performance. *Computers & Education*, *59*(2), 505–514.

Kahan, S. (2004). Engagement, identity and innovation: Etienne Wenger on communities of practice. *Journal of Association Leadership*, *2*(3), 26–37.

Katz, L. (1987). *The experience of personal change*. (Unpublished doctoral dissertation). Graduate College, The Union Institute, Cincinnati, OH.

Keengwe, J., Kidd, T., & Kyei-Blankson, L. (2009). Faculty and technology: Implications for faculty training and technology leadership. *Journal of Science Education and Technology*, *18*(1), 23–28.

Keengwe, J., & Onchwari, G. (2011). Fostering meaningful student learning through constructivist pedagogy and technology integration. *International Journal of Information and Communication Technology Education*, *7*(4), 1–10.

Keengwe, J., Pearson, D., & Smart, D. (2009). Technology integration: Mobile devices (iPods), constructivist pedagogy, and student learning. *AACE Journal, 17*(4), 333–346.

Kenny, R. F., Park, C. L., Van Neste-Kenny, J. M. C., Burton, P., & Qayyum, A. (2012). Using self-efficacy to assess the readiness of nursing educators and students for mobile learning. *International Review of Research in Open and Distance Learning*, *13*(3), 277–296.

Khaddage, F., & Lattemann, C. (2013a). iTeach we learn via mobile apps: 'A case study in a business course'. In R. McBride & M. Searson (Eds.), *Proceedings of SITE 2013: Society for Information Technology & Teacher Education International Conference* (pp. 3225–3233). New Orleans, LA: Association for the Advancement of Computing in Education (AACE). Retrieved from https://www.learntechlib.org/p/48591/

Khaddage, F., & Lattemann, C. (2013b). The future of mobile apps for teaching and learning. In Z. Berge & L. Muilenburg (Eds.), *Handbook of mobile learning*. London: Routledge.

Khaddage, F., Lattemann, C., & Bray, E. (2011). Mobile apps integration for teaching and learning. (Are teachers ready to re-blend?). In M. Koehler & P. Mishra (Eds.), *Proceedings of SITE 2011: Society for Information Technology & Teacher Education International Conference* (pp. 2545–2552). Nashville, Tennessee: Association for the Advancement of Computing in Education (AACE). Retrieved from https://www.learntechlib.org/primary/p/36694/

Kietzmann, J., Plangger, K., Eaton, B., Heilgenberg, K., Pitt, L., & Berthon, P. (2013). Mobility at work: A typology of mobile communities of practice and contextual ambidexterity. *Journal of Strategic Information Systems*, *22*(4), 282–297.

Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, *29*(1), 76–85. doi:10.1016/j.tate.2012.08.005

King, E., & Boyatt, R. (2015). Exploring factors that influence adoption of e-learning within higher education. *British Journal of Educational Technology*, *46*(6), 1272–1280. doi:10.1111/bjet.12195

Kirkwood, A. (2014). Teaching and learning with technology in higher education: Blended and distance education needs 'joined-up thinking' rather than technological determinism. *Open Learning: The Journal of Open, Distance and e-Learning, 29*(3), 206–221.

Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching in higher education: What is 'enhanced' and how do we know? A critical literature review. *Learning, Media and Technology*, *39*(1), 6–36.

Kirschner, P. A., & Lai, K.-W. (2007). Online communities of practice in education. *Technology, Pedagogy and Education*, *16*(2), 127–131. doi:10.1080/14759390701406737

Kissinger, J. S. (2013). The social and mobile learning experiences of students using mobile ebooks. *Journal of Asynchronous Learning Networks*, *17*(1), 153–169.

Kissko, J. (2010). *The blind side of mobile learning: Exposing the opposition*. K-12 Mobile Learning Conference.

Klopfer, E., Sheldon, J., Perry, J., & Chen, V. H. H. (2012). Ubiquitous games for learning (UbiqGames): Weatherlings, a worked example. *Journal of Computer Assisted Learning*, *28*(5), 465–476. doi:10.1111/j.1365-2729.2011.00456.x

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.

Kop, R., & Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past. *The International Review of Research in Open and Distance Learning*, *9*(3), 1–13.

Kopcha, T. (2010). A systems-based approach to technology integration using mentoring and communities of practice. *Educational Technology Research and Development*, *58*(2), 175–190.

Kopcha, T. (2012). Teachers' perceptions of the barriers to technology integration and practices with technology under situated professional development. *Computers & Education*, *59*(4), 1109–1121.

Koszalka, T., & Ntloedibe-Kuswani, G. (2010). Literature on the safe and disruptive learning potential of mobile technologies. *Distance Education*, *31*(2), 137–157.

Krull, G., & Duart, J. (2017). Research trends in mobile learning in higher education: A systematic review of articles (2011–2015). *The International Review of Research in Open and Distributed Learning*, *18*(7), 1–23.

Kukulska-Hulme, A., Sharples, M., Milrad, M., Arnedillo-Sánchez, I., & Vavoula, G. (2009). Innovation in mobile learning: A European perspective. *International Journal of Mobile and Blended Learning*, *1*(1), 13–35.

Lam, J., Yau, J., & Cheung, K. S. (2010). A review of the use of mobile learning in education. In *Proceedings of the International Conference on ICT in Teaching and Learning* (pp. 441–450). 30 June–2 July 2010, SIM University, Singapore.

Lan, Y. J., Sung, Y. T., & Chang, K. E. (2007). A mobile-device-supported peer-assisted learning system for collaborative early EFL reading. *Language Learning & Technology*, *11*(3), 130–151.

Land, S. M., & Zimmerman, H. T. (2015). Socio-technical dimensions of an outdoor mobile learning environment: A three-phase design-based research investigation. *Educational Technology Research and Development*, *63*(2), 229–255. doi:10.1007/s11423-015-9369-6

Lave, J. (1987). *Cognition in practice*. New York, NY: Cambridge University Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Laurillard, D. (2009). The pedagogical challenges to collaborative technologies. *International Journal of Computer-Supported Collaborative Learning*, *4*(1), 5–20.

Laurillard, D. (2013). *Rethinking university teaching: A conversational framework for the effective use of learning technologies*. London & New York, NY: Routledge.

Lee, C. G. (2012). Reconsidering constructivism in qualitative research. *Educational Philosophy and Theory*, *44*(4), 403–412.

Lee, J., & Spires, H. (2009). What students think about technology and academic engagement in school. *AACE Journal*, *17*(2), 61–81.

Liaw, S. S., Hatala, M., & Huang, H. M. (2010). Investigating acceptance toward mobile learning to assist individual knowledge management: Based on activity theory approach. *Computers & Education*, *54*(2), 446–454.

Lin, H. (2015). Implementing large-scale mobile device initiatives in schools and institutions. In X. Ge, D. Ifenthaler, & J. Spector (Eds.), *Emerging technologies for STEAM education: Educational communications and technology: Issues and innovations*. Cham, Switzerland: Springer.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Liu, S. H. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers & Education*, *56*(4), 1012–1022.

Liu, Y., Han, S., & Li, H. (2010). Understanding the factors driving m-learning adoption: A literature review. *Campus-Wide Information Systems*, *27*(4), 210–226.

Liu, T., Lin, Y., Tsai, M., & Paas, F. (2012). Split-attention and redundancy effects on mobile learning in physical environments. *Computers & Education*, *58*(1), 172–180.

Locke, J. V. (2006). A new image: Online communities to facilitate teacher professional development. *Journal of Technology and Teacher Education*, *14*(4), 663–668.

Lopez, J. P., Cerezo, A., Menendez, J. M., & Ballesteros, J. P. (2015). Usage of mobile devices as collaborative tools for education and preparation of official exams. In *2015 I.E. International Symposium on Consumer Electronics* (ISCE ’15) (pp. 1–2). IEEE. doi:10.1109/ISCE.2015.7177809

Loving, C.C., Schroeder, C., Kang, R., Shimek, C., & Herbert, B. (2007). Blogs: Enhancing links in a professional learning community of science and mathematics teachers. *Contemporary Issues in Technology and Teacher Education*, *7*(3), 178–198. Waynesville, NC: Society for Information Technology & Teacher Education. Retrieved from https://www.learntechlib.org/primary/p/24373/

Lyytinen, K., & Damsgaard, J. (2001). What’s wrong with the diffusion of innovation theory? In *Proceedings of the IFIP TC8 WG8.1 Fourth Working Conference on Diffusing Software Products and Process Innovations* (pp. 173–190). Banff, Canada. Retrieved from http://dl.acm.org/citation.cfm?id=722713

MacCallum, K., & Jeffrey, L. (2009). Identifying discriminating variables that determine mobile learning adoption by educators: An initial study. *Proceedings of ASCILITE: ‘Same places, different spaces’*. Auckland, New Zealand.

MacCallum, K., Jeffrey, L., & Kinshuk. (2014). Factors impacting teachers’ adoption of mobile learning. *Journal of Information Technology Education*, *13*, 141–162.

Mackey, J., & Evans, T. (2011). Interconnecting networks of practice for professional learning. *The International Review of Research in Open & Distance Learning*, *12*(3), 1–18.

Maddin, E. (2011). Using TPCK with digital storytelling to investigate contemporary issues in educational technology. *Journal of Instructional Pedagogies*, *7*(2), 1–11.

Mahamad, S., Ibrahim, M. N., & Taib, S. M. (2010). M-learning: A new paradigm of learning mathematics in Malaysia. *International Journal of Computer Science and Information Technology*, *2*(4), 76–86.

Marinakou, E., & Giousmpasoglou, C. (2014, March). M-learning in higher education in Bahrain: The educators' view. *Proceedings of the HBMeU Congress 2014: Leading Transformation to Sustainable Excellence.* Dubai, UAE.

Martin, M. (2011). Professional learning communities. In A. McMahon, C. Forde, & M. Martin (Eds.), *Contemporary issues in learning and teaching* (pp. 142–152). London: Sage Publications.

Meek, J., Fitzgerald, E., Priestnall, G., and Sharples, M. (2013). Learning on field trips with mobile technology. In W. Kinuthia and S. Marshall (Eds.) *On the move: Mobile learning for development* (pp. 1–15). Charlotte, NC: Information Age Publishing.

Meijs, C., Prinsen, F. R., & de Laat, M. F. (2016). Social learning as approach for teacher professional development: How well does it suit them? *Educational Media International*, *53*(2), 85–102.

Melhuish, K., & Falloon, G. (2010). Looking to the future: M-learning with the iPad. *Computers in New Zealand Schools: Learning, Leading, Technology*, *22*(3), 1–16.

Menkhoff, T., & Bengtsson, M. L. (2012). Engaging students in higher education through mobile learning: Lessons learnt in a Chinese entrepreneurship course. *Educational Research for Policy and Practice*, *11*(3), 225–242.

Menkhoff, T., Chay, Y. W., Bengtsson, M. L., Woodard, C. J., & Gan, B. (2014). Incorporating microblogging ('tweeting') in higher education: Lessons learnt in a knowledge management course. *Computers in Human Behavior, 51,* 1295–1302.

Mercer, J. (2007). The challenges of insider research in educational institutions: Wielding a double-edged sword and resolving delicate dilemmas. *Oxford Review of Education*, *33*(1), 1–17. doi:10.1080/03054980601094651

Miller, K. L. (2015). *Motivating factors and barriers to online faculty professional development* (Doctoral dissertation). Retrieved from ProQuest. (3701019)

Miller, P. H. (2011). *Theories of developmental psychology* (5th ed.). New York, NY: Worth Publishers.

Milrad, M., & Spikel, D. (2007). Anytime, anywhere learning supported by smart phones: Experiences and results from the MUSIS project. *Educational Technology & Society*, *10*(4), 62–70.

Minocha, S. (2009). A case study-based investigation of students' experiences with social software tools. *New Review of Hypermedia and Multimedia*, *15*(30), 245–265.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Mitchell, K., Simpson, C., & Adachi, C. (2017). What's in a name: The ambiguity and complexity of technology enhanced learning roles. In H. Partridge, K. Davis, & J. Thomas. (Eds.), *Me, Us, IT! Proceedings ASCILITE2017: 34th International Conference on Innovation, Practice and Research in the Use of Educational Technologies in Tertiary Education* (pp. 147–151).

Montrieux, H., Vanderlinde, R., Schellens, T., & De Marez, L. (2015). Teaching and learning with mobile technology: A qualitative explorative study about the introduction of tablet devices in secondary education. *PLoS ONE*, *10*(12): e0144008. doi:10.1371/journal.pone.0144008

Morse, J. M. (1994). Designing funded qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed). Thousand Oaks, CA: Sage.

Moses, J., & Knutsen, T. (2007). *Ways of knowing: Competing methodologies in social and political research.* Basingstoke, England: Palgrave Macmillan.

Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage Publications.

Mouza, C. (2008). Learning with laptops: Implementation and outcomes in an urban, under-privileged school. *Journal of Research on Technology in Education*, *40*(4), 447–472.

Munawar, M., & Cukier, W. (2011). Assessing the m-learning hype: Do mobile technologies enhance the overall learning experience? In *Proceedings of World Conference on e176 Learning in Corporate, Government, Healthcare, and Higher Education 2011* (pp. 792–807). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Murray-Johnson, K. K. (2014). 'Faculty professional development – a virtual reality?' A critical literature review of online communities of practice in post-secondary settings. *Adult Education Research Conference*. Retrieved from http://newprairiepress.org/aerc/2014/papers/53

Ntinda, M., Thinyane, H., & Sieborger, I. (2014). M-learning system enhancing mathematical concepts (m-LSEMC): A case study of University of Namibia and Rhodes. In 2014 *IST-Africa Conference Proceedings* (pp. 1–13). Le Meridien Ile Maurice: IEEE. doi:10.1109/ISTAFRICA.2014.6880659

Oblinger, D. (2008). Growing up with Google: What it means to education. *Becta Research Report: Emerging Technologies for Learning, 3,* 11–29.

O'Donnell, E., & Sharp, M. (2012). Students' views of e-learning: The impact of technologies on learning in higher education in Ireland. In K. Moyle & G. Wijngaards and InHolland University (Eds.), *Student reactions to learning with technologies: Perceptions and outcomes*. Hershey, NY: Information Science Reference.

Oliver, M. (2012). *Technology and change in academic practice*. In P. Trowler, M. Saunders, & V. Bamber (Eds.), *Tribes and territories in the 21st century: Rethinking the significance of disciplines in higher education*. Oxford: Routledge.

Opfer, V.D., & Pedder, D. (2011). Conceptualizing teacher professional learning. *Review of Educational Research*, *81*(3), 376–407.

Orr, J. E. (1990). Sharing knowledge, celebrating identity: Community memory in a service culture. In D. Middleton & D. Edwards (Eds.), *Collective remembering* (pp. 169–189). Newbury Park, CA: Sage Publications.

Ottenbreit-Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education*, *55*(3), 1321–1355.

Park, Y. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *International Review of Research in Open and Distance Learning*, *12*(2), 78–102.

Parker, M., Patton, K., & Tannehill, D. (2012). Mapping the landscape of Irish physical education professional development. *Irish Educational Studies Journal*, *31*(3), 311–327.

Patton, M. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Pegrum, M., Oakley, G., & Faulkner, R. (2013). Schools going mobile: A study of the adoption of mobile handheld technologies in Western Australian independent schools. *Australasian Journal of Educational Technology*, *29*(1), 66–81.

Pelgrum, W.J. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. *Computers & Education*, *37*(2), 163–178.

Peng, H., Su, Y. J., Chou, C., & Tsai, C.C. (2009). Ubiquitous knowledge construction: Mobile learning re-defined and a conceptual framework. *Innovations in Education and Teaching International*, *46*(2), 171–183.

Petherbridge, D. T. (2007). *A concerns-based approach to the adoption of Web-based learning management systems*. Raleigh, NC: North Carolina State University.

Phan, H. P. (2012). *A sociocultural perspective of learning: Developing a new theoretical tenet.* Paper presented at the Australian Association for Research in Education, University of Sydney, Sydney, NSW.

Phillips, D.C. (Ed.) (2000). *Constructivism in education: Opinions and second opinions on controversial issues*. Chicago, IL: University of Chicago Press.

Pieterse, J. H., Caniëls, M. C., & Homan, T. (2012). Professional discourses and resistance to change. *Journal of Organizational Change Management*, *25*(6), 798–818.

Pimmel, R., McKenna, A. F., Fortenberry, N. L., Yoder, B., & Chavela Guerra, R. C. (2013, June). Faculty development using virtual communities of practice. In *Proceedings of the 2013 Annual Conference of the American Society of Engineering Education.* Atlanta, GA.

Pimmer, C., & Pachler, N. (2014). Mobile learning in the workplace: Unlocking the value of mobile technology for work-based education. In M. Ally & A. Tsinakos (Eds.), *Perspectives on open and distance learning: Increasing access through mobile learning* (pp. 193–204). Retrieved from http://dspace.col.org/handle/123456789/514

Plair, S. (2008). Revamping professional development for technology integration and fluency. *Clearing House*, *82*(2), 70–74.

Polit, D. F., & Beck, C. T. (2008). *Nursing research, generating and assessing evidence for nursing practice* (8th ed.). Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins.

Porter, W. W., Graham, C. R., Spring, K. A., & Welch, K. R. (2014). Blended learning in higher education: Institutional adoption and implementation. *Computers & Education*, *75*, 185–195. doi:10.1016/j.compedu.2014.02.011

Prensky, M. (2006). Listen to the natives. *Educational Leadership*, *63*(4), 8–13.

Prescott, M. B. (1995). Diffusion of innovation theory: Borrowings, extensions, and modifications from IT researchers. *SIGMIS Database*, *26*(2–3), 16–19. doi:10.1145/217278.21728

Puentedura, R. (2014). *Ruben R. Puentedura's Weblog*. Retrieved from http://www.hippasus.com/rrpweblog/

Puntambakar, S., & Kolodner, J. L. (2005). Toward implementing distributed scaffolding: Helping students learn science from design. *Journal of Research in Science Teaching*, *42*(2), 185–217.

Pyrko, I., Dörfler, V., & Eden, C. (2017). Thinking together: What makes communities of practice work? *Human Relations*, *70*(4), 389–409.

Ravenscroft, A. (2011). Dialogue and connectivism: A new approach to understanding and promoting dialogue-rich networked learning. *International Review of Research in Open and Distance Learning*, *12*(3), 139–160.

Reed, P. (2014). Staff experience and attitudes towards technology-enhanced learning initiatives in one Faculty of Health and Life Sciences. *Research in Learning Technology*, 22. doi:10.3402/rlt.v22.22770

Reid, P. (2014). Categories for barriers to adoption of instructional technologies. *Education and Information Technologies*, *19*(2), 383–407.

Reiser, R. A., & Dempsey, J. V. (Eds.) (2007). *Trends and issues in instructional design and technology* (2nd ed.). Saddle River, NJ: Pearson Education.

Richardson, W., & Mancabelli, R. (2011). *Personal learning networks.* Bloomington, IN: Solution Tree Press.

Robb, M., & Shellenbarger, T. (2012). Using technology to promote mobile learning: Engaging students with cell phones in the classroom. *Nurse Educator*, *37*(6), 258–261.

Roblyer, M. D., & Doering, A. H. (2010). *Integrating educational technology into teaching* (5th ed.). Boston, MA: Ally & Bacon.

Roblyer, M. D., & Doering, A. H. (2013). *Integrating educational technology into teaching* (6th ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Rogers, E. (1983). *Diffusion of innovations* (3rd ed.). New York, NY: Free Press.

Rogers, E. (1995). *Diffusion of innovations* (4th ed.). New York, NY: Free Press.

Rogers, E. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.

Rogers, Y., Connelly, K., Hazlewood, W., & Tedesco, L. (2010). Enhancing learning: A study of how mobile devices can facilitate sense making. *Personal and Ubiquitous Computing*, *14*(2), 111–124.

Roschelle, J., Rafanan, K., Bhanot, R., Estrella, G., Penuel, B., Nussbaum, M., & Claro, S. (2010). Scaffolding group explanation and feedback with handheld technology: Impact on students' mathematics learning. *Educational Technology Research & Development*, *58*(4), 399–419.

Ross, K. (2013). *Teacher implementation of 'bring your own device' at a suburban high school serving high SES students* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses Database. (UMI No. 3559642)

Rothwell, P. (2016, April). Mobile moments: How modern students make learning their own. In *Innovate & Educate's Teaching and Learning Conference by Blackboard (BbTLC16)*. Groningen, The Netherlands.

Sad, S. N., & Goktas, O. (2013). Preservice teachers' perceptions about using mobile phones and laptops in education as mobile learning tools. *British Journal of Educational Technology*, *45*(4), 606–618. doi:10.1111/bjet.12064

Sahin, I. (2006). Detailed review of Rogers' Diffusion of Innovations theory and educational technology-related studies based on Rogers' theory. *The Turkish Online Journal of Educational Technology*, *5*(2), 14–23.

Saldaña, J. (2009). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications.

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1997). *Teaching with technology: Creating student-centered classrooms*. New York, NY: Teachers College Press.

Savill-Smith, C., Attewell, J., & Stead, G. (2006*). Mobile learning in practice: Piloting a mobile learning teachers' toolkit in further education colleges*. London: Learning and Skills Network.

Saylor, M. (2012). *The mobile wave: How mobile intelligence will change everything* (p. 176). New York, NY: Vanguard Press.

Schauer-Crabb, C. (2002). *A case study of adoption and diffusion of an existing asynchronous distance learning program* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses Database. (UMI No. 3106792)

Schlager, M. S., & Fusco, J. (2004). Teacher professional development, technology, and communities of practice: Are we putting the cart before the horse? In S. A. Barab, R. Kling, & J. H.Gray (Eds.), *Designing for virtual communities in the service of learning* (pp. 120–153). Cambridge: Cambridge University Press.

Schneckenberg D. (2010). Overcoming barriers for eLearning in universities: Portfolio models for eCompetence development of faculty. *British Journal of Educational Technology*, *41*(6), 979–991.

Schwandt, T. (2007). *The Sage dictionary of qualitative inquiry* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Schwandt, T. A., Lincoln, Y. S., & Guba, E. G. (2007). Judging interpretations: But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New Directions for Evaluation*, *2007*(114), 11–25.

Serin, O. (2012). Mobile learning perceptions of the prospective teachers (Turkish Republic of Northern Cyprus sampling). *The Turkish Online Journal of Educational Technology*, *11*(3), 222–233.

Sharples, M. (2013). Mobile learning: Research, practice and challenges. *Distance Education in China*, *3*(5), 5–11.

Sharples, M., Arnedillo-Sanchez, I., Milrad, M., & Vavoula, G. (2009). Mobile learning: Small devices, big issues. In S. Ludvigsen, N. Balacheff, T. de Jong, A. Lazonder, & S. Barnes (Eds.), *Technology-enhanced learning: Principles and products* (pp. 233–249). Dordrecht, The Netherlands: Springer.

Sharples, M., Scanlon, E., Ainsworth, S., Anastopoulou, S., Collins, T., Crook, C., Jones, A., Kerawalla, L., Littleton, K., Mulholland, P., & O'Malley, C. (2014). Personal inquiry: Orchestrating science investigations within and beyond the classroom. *Journal of the Learning Sciences*, *24*(2), 308–341.

Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews & C. Haythornthwaite (Eds.), *The Sage handbook of e-learning research* (pp. 221–247). London: Sage Publications.

Shih, J. L., Chu, H. C., Hwang, G. J., & Kinshuk, D. (2011). An investigation of attitudes of students and teachers about participating in a context-aware ubiquitous learning activity. *British Journal of Educational Technology*, *42*(3), 373–394.

Shraim, K. (2012). Moving towards e-learning paradigm: Readiness of higher education institutions in Palestine. *International Journal on E-Learning*, *11*(4), 441–463.

Shraim, K., & Crompton, H. (2015). Perceptions of using smart mobile devices in higher education teaching: A case study from Palestine. *Contemporary Educational Technology*, *6*(4), 301–318.

Siemens, G. (2004). *Connectivism: A learning theory for the digital age*. Retrieved from http://www.elearnspace.org/Articles/connectivism.htm

Silverman, D. (2006). *Interpreting qualitative data: Methods for analysing talk, text and interaction* (3rd ed.). London: Sage Publications.

Simon, E. (2012). *The impact of online teaching on higher education faculty's professional identity and the role of technology: The coming of age of the virtual teacher* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (3508146)

Solvberg, A. M., & Rismark, M. (2012). Learning spaces in mobile learning environments. *Active Learning in Higher Education*, *13*(1), 23–33.

Somekh, B. (2008). Factors affecting teachers' pedagogical adoption of ICT. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 449–460). Dordrecht, The Netherlands: Springer Science + Business Media, LLC.

Srivastava, P., & Hopwood, N. (2009). A practical iterative framework for qualitative data analysis. *International Journal of Qualitative Methods*, *8*(1), 76–84.

Stayton, L. (2011). *Mobile learning: Look before you leap*. Retrieved from https://www.td.org/Publications/Newsletters/Learning-Circuits/Learning-CircuitsArchives/2011/06/Mobile-Learning-Look-Before-You-Leap

Stoll, L. (2011). Leading professional learning communities. In J. Robertson & H. Timperley (Eds.), *Leadership and learning* (pp. 103–117). London: Sage Publications.

Stoll, L., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change*, *7*(4), 221–258.

Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research*, *79*(2), 625–649.

Straumsheim, C., Jaschik, S., & Lederman, D. (2015). 2015 survey of faculty attitudes on technology (Rep.). *Gallup* and *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/audio/2015/11/12/2015-survey-faculty-attitudes-technology

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, *94*, 252–275.

Surej, P. J. (2015). The integration of information technology in higher education: A study of faculty's attitude towards IT adoption in the teaching process. *Contaduría y Administración*, *60*(1), 230–252.

Swan, K., Lin, L., & van't Hooft, M. (2008). Teaching with (digital) technology. In C. Lassonde, R. Michael, and J. Rivera-Wilson (Eds.), *Current issues in teacher education: History, perspectives and implications*. Springfield, IL: Charles C. Thomas Publishing.

Taleb, Z., & Sohrab, A. (2012). Learning on the move: The use of mobile technology to support learning for university students. *Procedia-Social and Behavioral Sciences*, *69*, 1102–1109.

Taylor, J., Sharples, M., O'Malley, C., Vavoula, G., & Waycott, J. (2006). Towards a task model for mobile learning: A dialectical approach. *International Journal of Learning Technology*, *2*(2/3), 138–158.

Teresevičienė, M., Volungevičienė, A., Trepulė, E., Žydžiūnaitė, V., Rutkienė, A., Tait, A. W., & Kaminskienė, L. (2015). *Technology-enhanced learning integration into organizations: Mokslo studija*. Kaunas, Vytautas Magnus University, Lithuania: Versus Aureus.

Thomas, K., & O'Bannon, B. (2013). Cell phones in the classroom: Preservice teachers' perceptions. *Journal of Digital Learning in Teacher Education*, *30*(1), 11–20.

Timperley, H., & Alton-Lee, A. (2008). Reframing teacher professional learning: An alternative policy approach to strengthening valued outcomes for diverse learners. *Review of Research in Education*, *32*(1), 328–369.

Ting, Y. (2012). The pitfalls of mobile devices in learning: A different view and implications for pedagogical design. *Journal of Educational Computing Research*, *46*(2), 119–134.

Tobin, K., & Kincheloe, J. (Eds.). (2006). *Doing educational research.* Rotterdam, The Netherlands: Sense Publishers.

Travis, J. (1999). Exploring the constructs of evaluative criteria for interpretivist research. In *Proceedings of 10th Australian Conference on Information Systems* (pp. 1037–1049). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.4.1994&rep=rep1&type=pdf

Traxler, J. (2010). Students and mobile devices. *ALT-J*: *Association for Learning Technology Research*, *18*(2), 149–160.

Traxler, J., & Wishart, J. M. (2011). Making mobile learning work: Case studies of practice. *Discussion Papers in Education*. Bristol: ESCalate: HEA Subject Centre for Education.

Tremblay, E. (2010). Educating the mobile generation: Using personal cell phones as audience response systems in post-secondary science teaching. *Journal of Computers in Mathematics and Science Teaching*, *29*(2), 217–227.

Triggs, P., & John, P. (2004). From transaction to transformation: Information and communication technology, professional development and the formation of communities of practice. *Journal of Computer Assisted Learning*, *20*(6), 426–439.

Tsai, C. C., & Chai, C. S. (2012). The 'third'-order barrier for technology-integration instruction: Implications for teacher education. *Australasian Journal of Educational Technology*, *28*(6), 1057–1060.

Tsai, C. C. & Hwang, G. J. (2013). Issues and challenges of educational technology research in Asia. *The Asia Pacific Education Researcher*, *22*(2), 215–216.

Tytler, R., Symington, D., Malcolm, C., & Kirkwood, V. (2009). Assuming responsibility: Teachers taking charge of their professional development. *Teaching Science*, *55*(2), 9–15.

Uden, L. (2007). Activity theory for designing mobile learning. *International Journal of Mobile Learning and Organization*, *1*(1), 81–102.

Unal, Z., Bodur, Y., & Unal, A. (2012). Extending distance learning courses for mobile internet users: The case study of mobile moodle. In P. Resta (Ed.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2012* (pp. 3499–3506). Chesapeake, VA: AACE.

Vaughan, N. (2007). Perspectives on blended learning in higher education. *International Journal on E-Learning*, *6*(1), 81–94.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478.

Verenikina, I. (2010). Vygotsky in twenty-first century research. In J. Herrington & B. Hunter (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia, and Telecommunications* (pp. 16–25). Chesapeake, VA: AACE.

Verhagen, P. W. (2006). *Connectivism: A new learning theory?* Retrieved from http://elearning.surf.n1/e-learning/english/3793

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education*, *24*(1), 80–91.

Wagner, E. (2008). Realizing the promises of mobile learning. *Journal of Computing in Higher Education*, *20*(2), 4–14.

Wall, J. (2015). Leadership in implementing technology-enhanced learning in educational institutions. In B. Gradinarova (Ed.), *E-learning – instructional design, organizational strategy and management*. doi:10.5772/61108

Walker, R., Voce, J., Swift, E., Ahmed, J., Jenkins, M., & Vincent, P. (2016). *Survey of technology-enhanced learning for higher education in the UK*. Oxford: Universities and Colleges Information Systems Association.

Walters, E. A. (2011). *Will the iPad revolutionize education?* Retrieved from http://www.iste.org/Libraries/Leading_and_Learning_Docs/May-2011-PointCounterpoint.sflb.ashx

Warschauer, M., Zheng, B., Niiya, M., Cotten, S., & Farkas, G. (2014). Balancing the one-to-one equation: Equity and access in three laptop programs. *Equity & Excellence in Education*, *47*(1), 46–62. doi:10.1080/10665684.2014.866871

Watson, C. (2014). Effective professional learning communities? The possibilities for teachers as agents of change in schools. *British Educational Research Journal*, *40*(1), 18–29.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York, NY: Cambridge University Press.

Wenger, E. (2007). *Communities of practice: Learning, meanings, and identity.* New York, NY: Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *Cultivating communities of practice* (1st ed.). Watertown, MA: Harvard Business School Press.

Wheeler, S. (2010). Open content, open learning 2.0: Using wikis and blogs in higher education. In U.-D. Ehlers & D. Schneckenberg (Eds.), *Changing cultures in higher education* (pp. 103–114). Heidelberg, Germany: Springer.

White, S. (2007). Critical success factors for e-learning and institutional change: Some organisational perspectives on campus-wide e-learning. *British Journal of Educational Technology*, *38*(5), 840–850. doi:10.1111/j.1467-8535.2007.00760.x

Williams, I. M., & Olaniran, B. A. (2012). Professional development through web 2.0 collaborative applications. *Virtual Professional Development and Informal Learning Via Social Networks*, 1.

Wilson, G., & Stacey, E. (2004). Online interaction impacts on learning: Teaching the teachers to teach online. *Australasian Journal of Educational Technology*, *20*(1), 33–48.

Wood, E., De Pasquale, D., & Cruikshank, R. (2012). Examining mobile technology in higher education: Handheld devices in and out of the classroom. *International Journal of Higher Education*, *1*(2), 43–54.

Woodcock, B., Middleton, A., & Nortcliffe, A. (2012). Considering the smartphone learner: An investigation into student interest in the use of personal technology to enhance their learning. *Student Engagement and Experience Journal*, *1*(1), 1–15. doi:10.7190/seej.v1i1.38

Wu, P. H., Hwang, G. J., Su, L. H., & Huang, Y. M. (2012). A context-aware mobile learning system for supporting cognitive apprenticeships in nursing skills training. *Educational Technology & Society*, *15*(1), 223–236.

Wu, W. H., Wu, Y. C. J., Chen, C. Y., Kao, H. Y., Lin, C. H., & Huang, S. H. (2012). Review of trends from mobile learning studies: A meta-analysis. *Computers & Education*, *59*(2), 817–827.

Yang, G., Chen, N. S., Sutinen, E., Anderson, T., & Wen, D. (2013). The effectiveness of automatic text summarization in mobile learning contexts. *Computers & Education*, *68*(4), 233–243.

Yang, S. H. (2012). Exploring college students' attitudes and self-efficacy of mobile learning. *Turkish Online Journal of Educational Technology*, *11*(4), 148–154.

Yelland, N. (2006). Changing worlds and new curricula in the knowledge era. *Educational Media International*, *43*(2), 121–131.

Yin, C. J., Sung, H. Y., Hwang, G. J., Hirokawa, S., Chu, H. C., Flanagan, B., & Tabata, Y. (2013). Learning by searching: A learning environment that provides searching and analysis facilities for supporting trend analysis activities. *Educational Technology & Society*, *16*(3), 286–300.

Young, C. A., & Bush, J. (2004). Teaching the English language arts with technology: A critical approach and pedagogical framework. *Contemporary Issues in Technology and Teacher Education*, *4*(1), 1–22.

Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., Simeoni, Z., Tran, M., & Yukhymenko, M. (2012). Our princess is in another castle: A review of trends in serious gaming for education. *Review of Educational Research*, *82*(1), 61–89.

Zaltman, G., Duncan, R., & Holbek, J. (1973). *Innovations and organizations*. New York, NY: John Wiley.

Zhang, S., Zhao, J., & Tan, W. (2008). Extending TAM for online learning systems: An intrinsic motivation perspective. *Tsinghua Science & Technology*, *13*(3), 312–317. doi:10.1016/S1007-0214(08)70050-6

Zurita, G., & Nussbaum, M. (2007). A conceptual framework based on activity theory for mobile CSCL. *British Journal of Educational Technology*, *38*(2), 211–235.

Appendix One

Lancaster University Ethics Approval

Ethics approval (REC reference number FL16228-please quote this in all correspondence about this project)

FASS and LUMS Research Ethics

Fri 14/07/2017, 11:14

Dear Chris

Thank you for submitting your ethics application and additional information for *The lived experiences of teaching faculty in higher education institutions who implement mobile technology enhanced learning initiatives: A phenomenological investigation.* The information you provided has been reviewed by member(s) of the Faculty of Arts and Social Sciences and Lancaster Management School Research Ethics Committee and I can confirm that approval has been granted for this project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress) to the Research Ethics Officer;
- submitting details of proposed substantive amendments to the protocol to the Research Ethics Officer for approval.

Please do not hesitate to contact me if you require further information about this.

Kind regards

Debbie

Debbie Knight

Secretary, FASS-LUMS Research Ethics Committee fass.lumsethics@lancaster.ac.uk

Phone (01524) 592605| D22 FASS Building, Lancaster University, LA1 4YT | Web: http://www.lancaster.ac.uk/arts-and-social-sciences/research/ethics-guidance-and-ethics-review-process/ & http://www.lancaster.ac.uk/lums/research/ethics/

www.lancaster.ac.uk/50

Appendix Two

Permission from the department head of each HEI to approach the potential participants

Request for permission to ask Adam to participate in my PhD Research

Dear Brian,

My name is Chris O' Toole and I am currently undertaking a PhD in Technology Enhanced Learning at Lancaster University. I would like your permission to ask Adam to participate my means of an interview, observations and an online focus group

I attach a copy of my participant information sheet and consent forms which will give you more details of my research area. I also attach my approval from Lancaster University. I can assure you that no reference to either Adam or your Institute will be mentioned in my Thesis. All participant details will be anonymised.

I would be grateful if you could let me know your decision by return email when you can.

Yours Sincerely

Chris O'Toole

Appendix Three

Participant Recruitment Email

{name} {address}

Dear {name},

RE: The Doctoral Program in E-Research and Technology Enhanced Learning

I am a postgraduate researcher at Lancaster University, England. I am very interested in the application and adoption of mobile technology enhanced learning (TEL) by ICT and Engineering teaching faculty and its implications for learning. I am contacting you to invite you to take part in a research study called 'The lived experiences of teaching faculty in higher education institutions who implement mobile technology enhanced learning initiatives: A phenomenological investigation'.

The study aims to provide a phenomenological view of how ICT and Engineering teaching faculty in Higher Education Institutions (HEIs) perceive the adoption of mobile TEL initiatives. It also aims to explore how they perceive the adoption impacts the teaching and pedagogy used. In doing so, it will provide valuable insight into whether mobile TEL environments prove a valuable asset to learn about the concepts that mostly appear abstract to ICT and Engineering learners and consequently reduce the high dropout rates within the disciplines.

You are a very important person; you are an experienced ICT and Engineering teaching professional. I am inviting as many ICT and Engineering teaching faculty of HEIs in Ireland and the UK to participate with the view to getting twenty participants.

If you take part in this study, you will take part in a brief on the research, during which you will have ample time to read and understand the participant information sheet and consent form and consider whether you would like to sign the informed consent. I have included a detailed participant information sheet about the study with this email. If you agree to take part, I will telephone you in the very near future to discuss the study in more detail.

To participate in this study, read and complete the consent form. Please include your contact information. Then return the documents to at Lancaster University.

Thank you. Yours sincerely,

Chris O' Toole

BA, Dip Law, Dip CCI, MSc CCI, QFA

MBA Technology Management

On behalf of The Doctoral Program in E-Research and Technology Enhanced Learning, Lancaster University.

Appendix Four

Snowball Participant Recruitment Email

Dear [Mr. / Ms. LAST NAME],

Thank you for your interest in my research project. I am writing to ask whether you would be willing to pass along the enclosed information to friends and/or family members who may also be interested in learning about this research study. You are under no obligation to share this information and whether or not you share this information will not affect your relationship with the staff at Boise State University.

If you would, please contact me at Lancaster University.

Thank you for your time and consideration.

Sincerely,

[Chris O' Toole]

Appendix Five

Participant Information Sheet

Participant Information Sheet

The lived experiences of teaching faculty in higher education institutions who implement mobile technology enhanced learning initiatives: A phenomenological investigation.

Chris O' Toole, Doctoral Programme in E-Research and Technology Enhanced Learning

Dear colleagues,

I would like to invite you to take part in my planned research study about the lived experiences of teaching faculty in higher education institutions who implement mobile technology enhanced learning initiatives. Please take time to read the following information carefully before you decide whether or not you wish to take part.

What is the study about?

The overarching aim of this research is to provide a phenomenological view of the lived experiences of teaching faculty within HEIs who implement mobile TEL initiatives.

Specific aims are to investigate faculty perceptions and experiences with the adoption and integration process as faculty at HEIs transition from environments of teaching supported by basic technology (standalone PCs) to TEL environments with institution wide adoption of mobile TEL. TEL environments are defined as classrooms both physical and virtual, where faculty and learners use a variety of TEL technologies and devices across multiple platforms to enhance their learning. The adoption process is defined as the way through which an individual or group seeks and processes information about an innovation, then forms an attitude and decides to either adopt or reject the innovation.

Why have I been invited?

I have approached you because I am interested in representing teaching faculty who are currently implementing TEL initiatives and I know that you are doing so and are experiencing the phenomenon. I would be very grateful if you would agree to take part in this study, but you are in no way compelled to do so. It is entirely up to you if you want to take part.

What will I be asked to do if I take part?

If you decided to take part, this would involve the following sessions which I will personally orchestrate:

Semi-structured interviews, online focus groups and observations to understand:

1. What are HEI teaching faculty experiences with and perceptions of mobile TEL adoption and its integration process?
2. In what ways do faculty values, beliefs, professional needs, and past experiences with technology impact the adoption and integration process?
3. What are faculty perceived obstacles and or benefits for mobile TEL adoption and integration?
4. What guidance (collaboration and networked learning sources) do faculty use to develop, distribute, source and learn about mobile TEL initiatives?

The majority of these sessions will take place in a seminar room or IT suite at your place of work. It is likely that the project will take around 2 sessions, each of around 60 mins. These will span the latter half of 2017 and the former half of 2018. During the sessions I will ask participants for opinions and we'll complete exercises, including discussions about how we experience some of the challenges of teaching and learning, and what we could do about them.

Interviews will be conducted with myself only. All focus group sessions and observations will be conducted in groups and will be audio recorded to allow me to analyse our work and to re-introduce it for referencing in subsequent sessions. I will personally take responsibility for the orchestration of sessions, for securing our data and turning it into material that can be analysed, a process which is called transcription and which I will conduct myself. During transcription, everybody will be anonymised. I will transcribe and encrypt the data on site, and I will securely store it on site in the backup vaults, where only the ITSO and I will be able to access the storage media (an encrypted removable hard drive).

The research is sanctioned by the Lancaster University Research Ethics Committee.

What are the possible benefits from taking part?

Taking part will allow you to contribute to our understanding of TEL initiatives in future teaching and learning. It will also allow you to personally gain an understanding of how our own HEI community thinks about some of our challenges with implementing TEL initiatives. Another benefit is the opportunity to shape your HEI's teaching and learning activity, since during the study we'll consider the future of how TEL initiatives for teaching and learning will contribute to HEIs.

Do I have to take part?

No, definitely not. It's completely up to you to decide whether or not you take part and your participation is entirely voluntary.

What if I change my mind?

If you change your mind, you are free to withdraw at any time during your participation in this study. If you want to withdraw, please let me know, and I will extract any data you contributed to the study and destroy it. Data means the information, views, ideas, etc. that you and other participants will have shared with me. However, it is difficult and often impossible to take out data from one specific participant when this has already been anonymised or pooled together with other people's data, and their reactions to it.

What you have said during focus sessions, for example, could influence others who may reflect or even refer to your input. Therefore, I think that it is reasonable to say you can withdraw up to 2 weeks after taking part in the first focus group session. If you withdraw prior to this point, we will make an appointment to redact your input, and then when I transcribe the sessions I will avoid your personal data and work around it. If any of this is not clear, please let me know and I'll explain.

What are the possible disadvantages and risks of taking part?

The only disadvantage that I can think of is the commitment of time. This will be across 2 sessions, each of around 60 mins. These will span the latter half of 2017 and the former half of 2018.

Will my data be identifiable?

After the focus group sessions only I, as the solo researcher conducting this study, will have access to the data you share with me. I will keep all personal information about you (e.g. your name and other information about you that can identify you) confidential, that is I will not share it with others. I will anonymise any audio recordings and hard copies of any data. This means that I remove any personal information. I will also ask that we all make a verbal contract not to disclose information outside the group sessions which could identify colleagues. The easiest way to manage this will be to not discuss what happens during the sessions, and if anybody tries to encourage you to identify any comments from others or yourself I'll give you a slip to pass on which refers them to me.

How will my data be stored?

Your data will be stored in encrypted files (that is no-one other than me, the researcher will be able to access them) and on password-protected computers. After transcription of our data to the anonymised versions, I'll encrypt everything. It will then be stored on removable media, a removable hard drive, in the secure vaults at National University of Ireland. In accordance with UK and Irish data protection guidelines, I will keep the encrypted data secured for 10 years, since although it will be masked with white noise it will include audio and which may feasibly identify us.

How will we use the information you have shared with us and what will happen to the results of the research study?

I will use the data you have shared, when it has been transcribed and anonymised, to generate discussions and findings. These will be submitted as part of a thesis and doctoral examination called a viva-voce, so a number of academics will read my study and question me on its content and meaning. This could include anonymised extracts and quotes of our discussions, and pixelated still images, supplemented by my analyses. The work may also be abridged for publication in: academic journals; institutional journals of technology enhanced learning and academic conferences. As previously stated , all participants will by anonymised prior to encryption by using pseudonyms in text, white noise in audio and pixilation of visual facial features.

Who has reviewed the project?

This study has been reviewed and approved by the Faculty of Arts and Social Sciences and Lancaster Management School's Research Ethics Committee

What if I have a question or concern?

If you have any queries or if you are unhappy with anything that happens concerning your participation in the study, please contact myself or my supervisor at Lancaster University:

Chris O'Toole, Department of Adult learning and Professional Development, National University of Ireland, Nuns Island, Galway. 00 353 86 1666808
c.otoole1@lancaster.ac.uk
or
Doctor Murat Oztok, Department of Educational Research, County South, Lancaster University, Lancaster LA1 4YD. 01524 592863 ***m.oztok@lancaster.ac.uk***

If you have any concerns or complaints that you wish to discuss with a person who is not directly involved in the research, you can also contact:

Professor Paul Ashwin, Department of Educational Research, County South, Lancaster University, Lancaster LA1 4YD. 01524 594443 ***paul.ashwin@lancaster.ac.uk***

Thank you for considering your participation in this project.

Appendix Six

Informed Consent

CONSENT FORM

Project Title: The lived experiences of teaching faculty in higher education institutions who implement mobile technology enhanced learning initiatives: A phenomenological investigation.

Name of Researchers: Chris O' Toole
Email: c.otoole1@lancaster.ac.uk

Please tick each box

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time during my participation in this study, without giving any reason. If I withdraw within two weeks of the final interview, focus group or observation my data will be removed. I understand that as part of the Interview or Focus Group sessions I will take part in, my data is part of the ongoing conversation and cannot be destroyed. I understand that the researcher will try to disregard my views and influence when analysing the focus group data, but I am aware that this will not always be possible. ☐

3. I understand that any information disclosed within data gathering sessions remains confidential to the group, and I will not discuss the sessions with or in front of anyone who was not involved. ☐

4. I understand that any information given by me may be used in future reports, academic articles, publications or presentations by the researcher/s, but my personal information will not be included and I will not be identifiable. ☐

5. I understand that my name/my organisation's name will not appear in any reports, articles or presentation. ☐

6. I understand that any interviews, focus groups and observations will be audio-recorded, subsequently transcribed and that data will be protected on encrypted devices and kept secure. ☐

7. I understand that data will be kept according to University guidelines for a minimum of 10 years after the end of the study. ☐

8. I agree to take part in the above study. ☐

_____	_____	_____
Name of Participant	Date	Signature

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm

that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Signature of Researcher /person taking the consent_____ Date _____ Day/month/year

One copy of this form will be given to the participant and the original kept in the files of the researcher at Lancaster University

Appendix Seven

Interview Question Protocol

Interview Question Protocol

Note: These interview questions will be spread over two interview sessions.

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1. Is this your first experience with using Mobile TEL initiatives to enhance learner learning? (If the participant answers no, I will continue the interview. If the participant answers yes, I will thank him/her for participating in the interview. This question ensures all participants meet the criteria of being an experienced participating teacher in a Mobile TEL environment.)

2. What are your perceptions about the adoption process of Mobile TEL initiatives?

   What do you perceive as obstacles to its adoption? What do you perceive as benefits to your teaching?

3. In what ways does the use of Mobile TEL technologies impact how and what you teach?

   Can you provide a real life example where you experienced a benefit?

4. What learning approach (teaching pedagogies and practices) did you use before the Mobile TEL environment?

5. How has your learning approach changed since the implementation of the Mobile TEL initiatives?

6. How have the Mobile TEL initiatives impacted the type of resources you use in your teaching? Can you provide a real life example?

7. What role does the Mobile TEL initiative have on your decision-making when planning your lessons?

8. What additional resources are needed to enhance the adoption of the Mobile TEL initiatives? Can you give any real life examples?

9. How do you prepare your learners for utilising Mobile devices for developing reading, writing, math, science, or social studies skills?

10. What benefits, if any, have the Mobile TEL initiatives brought to learner engagement, motivation, and achievement? Can you give any real life examples?

11. What professional development, if any, have you received to assist you in integrating Mobile technology into your daily teaching schedule?

12. How has professional development benefited you in terms of integrating the technology into your teaching practices? Can you give a few examples?

13. What do you wish HEI Executives and Department heads who deal with policy knew about teaching and learning as it corresponds to the Mobile TEL initiatives?

14. Is there anything else you'd like to tell me about Mobile TEL and its related technologies?

Appendix Eight

Observation Protocol

Observation Protocol

_____

Name (pseudonym): _____

Date and Time: _____

Content/Subject Taught: _____

Observations of Mobile TEL initiatives and related teaching and pedagogical practices:

_____

_____

_____

_____

_____

_____

_____

Comments/Summary:

_____

_____

_____

_____

_____

Appendix Nine

Focus Group Protocol

Focus Group Protocol

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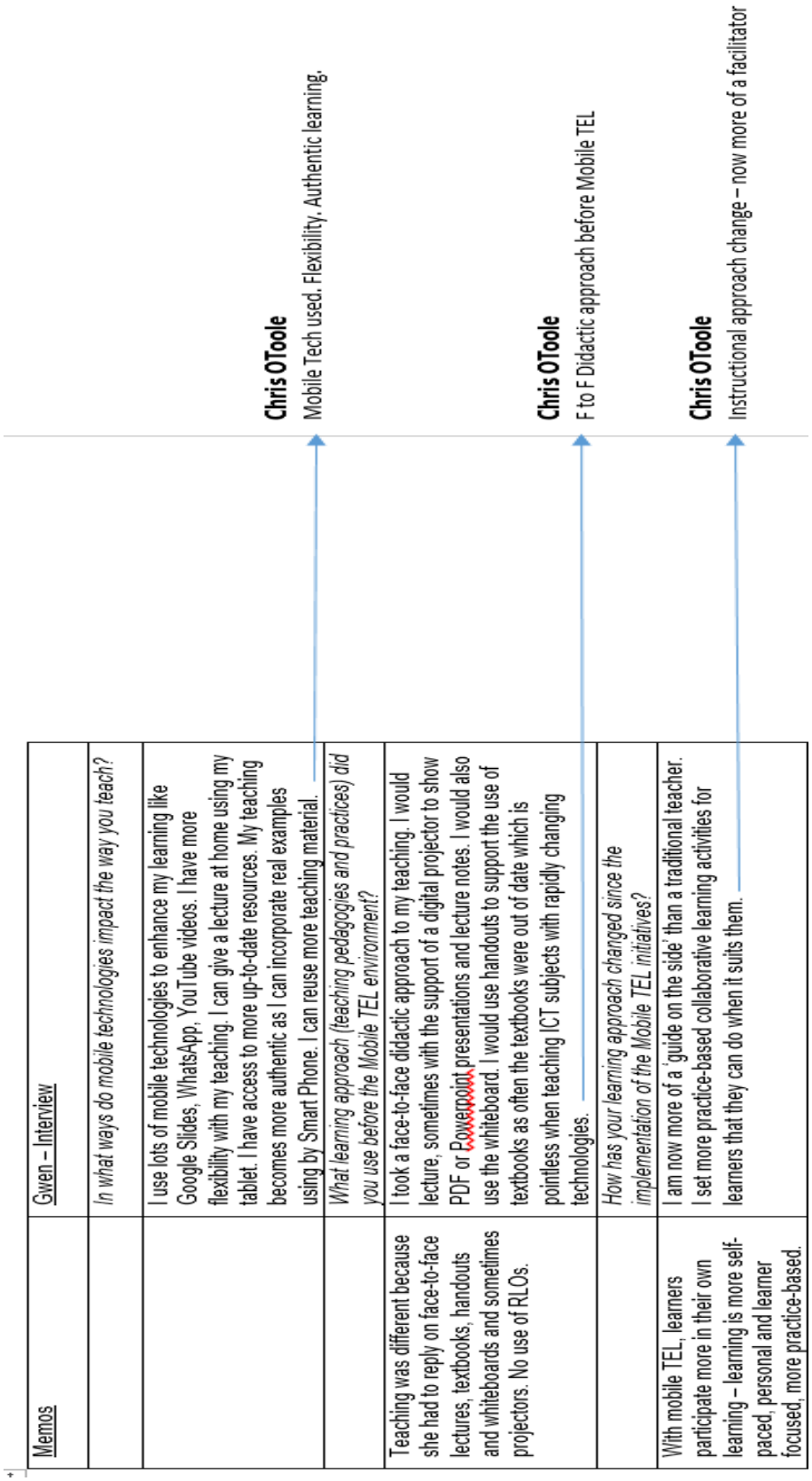
1. Based on interviews and observations, each of you has experienced Mobile TEL technology issues. On a typical day, how frequently do these issues occur?
   a. How do these issues impact your confidence in using the devices?
   b. How much time do these issues take to resolve?
   c. When they do occur, how likely are you to have plans for other activities that do not use the devices?
2. Have you experienced the enhanced ability of mobile TEL to convey ICT and Engineering concepts? Can you provide any real life examples?
3. What challenges, if any, do teachers encounter as they learn to use Mobile TEL technology and how do these challenges affect them? Can you provide some real life examples?
4. Have you experienced the adoption of any Mobile TEL initiatives that did not result as planned or where the adoption failed? Can you provide any real life examples?

Appendix Ten

Example of Coding and Memoing



Memos	Gwen – Interview	
	In what ways do mobile technologies impact the way you teach?	
	I use lots of mobile technologies to enhance my learning like Google Slides, WhatsApp, YouTube videos. I have more flexibility with my teaching. I can give a lecture at home using my tablet. I have access to more up-to-date resources. My teaching becomes more authentic as I can incorporate real examples using by Smart Phone. I can reuse more teaching material.	**Chris OToole** Mobile Tech used. Flexibility. Authentic learning.
	What learning approach (teaching pedagogies and practices) did you use before the Mobile TEL environment?	
Teaching was different because she had to reply on face-to-face lectures, textbooks, handouts and whiteboards and sometimes projectors. No use of RLOs.	I took a face-to-face didactic approach to my teaching. I would lecture, sometimes with the support of a digital projector to show PDF or Powerpoint presentations and lecture notes. I would also use the whiteboard. I would use handouts to support the use of textbooks as often the textbooks were out of date which is pointless when teaching ICT subjects with rapidly changing technologies.	**Chris OToole** F to F Didactic approach before Mobile TEL
	How has your learning approach changed since the implementation of the Mobile TEL initiatives?	
With mobile TEL, learners participate more in their own learning – learning is more self-paced, personal and learner focused, more practice-based.	I am now more of a 'guide on the side' than a traditional teacher. I set more practice-based collaborative learning activities for learners that they can do when it suits them.	**Chris OToole** Instructional approach change – now more of a facilitator

Appendix Eleven

Example of Coding

Open-Codes	Enumeration of open-code appearance across data sets	Themes
Unreliable Technical Infrastructure	32	Frustration At The Ability To Make Progress
Wireless Networking Connectivity Issues	16	
Inadequate and Obsolete Mobile TEL Tools	25	
Time Consuming Process	17	
Appreciation of Teachers' Needs Required	27	HEI Executives Need To Consult Teachers On Related Policy
Teachers' Involvement with Mobile TEL Strategy	14	
Using Mobile Devices and Technologies for Teaching	19	Sharp And Significant Learning Curve
Change in Approach	15	
More Collaborative	10	
More Learner Centred	9	
Training and Practice Takes Time	14	
Need to Prepare Learners	7	
Increased Flexibility – Anytime Anywhere Access	21	Improved Attrition Rates
Greater Learner Collaboration	15	
Better Technologies – Learner Portals	9	
Increased Learner Motivation, Engagement and Satisfaction	17	
Teacher Concerns about CPD	27	Continuing Professional Development (CPD) Required
Formal Training Linked to TEL Strategy	24	
Practice-based Training Required	10	
Not Pedagogically Focused	19	
Feedback Required	13	
Insufficient Time	16	
Mentoring Required	8	
Concepts Explained in Greater Depth	23	Enhanced Ability To Convey ICT And Engineering Concepts
Real-life Settings for Teaching and Learning	16	
Wider Reach of Topics	18	
Increased Learner Participation	21	
Informal Discussions	22	Sources Of Teacher Collaboration
Learning is Personal	9	
Professional Learning COPs	17	
Additional Collaboration and Networked Learning Required	16	
Access 24/7 – Devices, Internet, Data Plans	25	Obstacles
Sustainability	27	
Uncertainty – Always need Alternative Plan	10	
Increased Learner Collaboration and Global Communication	18	Benefits
Increased Learner Motivation	15	
Increased Learner Engagement	22	
Increased Learner Achievement	19	
Immense Resources	13	
Improved Teaching	21	