QUEEN'S UNIVERSITY BELFAST

DOCTOR OF PHILOSOPHY

The use of mobile devices for learning in post-primary education and at university: student attitudes and perceptions

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Award date:
2020

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The Use of Mobile Devices for Learning in Post-Primary Education and at University:

Student Attitudes and Perceptions

By

Úna Lynch BA (Hons) MSc

A dissertation submitted as part of the requirements for the Degree of Doctorate in Education in the School of Education, Queen's University Belfast

March 2019

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ABSTRACT

A new paradigm of placeless and timeless access to technologies encouraging a movement from electronic to mobile access of services and resources (Lehner, Nosekabel & Lehmann, 2002) through mobile learning has been gaining momentum in education. There is a growing body of research investigating the impact of mobile devices in combination with wireless technologies and if they can provide for a new approach to education (Craig and Van Lom, 2009). Gikas and Grant (2013) highlight the growth in use and importance of mobile wireless devices on university campuses. This has contributed to the escalation of student options and learning experiences both on and off campus and a need for the higher education sector to meet prospective student digital demands and expectations of a quality learning experience (Garrison and Kanuka, 2004).

Adequate support and resource provision of information technologies to maximise student skills and experiences is essential (Anagnostopoulou and Parmer, 2010). Much e-learning research has focused primarily on the practitioner perspective and design of e-learning materials with a definite disregard for the learner's view (Conole et al., 2006). The successful integration and implementation of technology in teaching and learning requires an understanding of student attitudes and acceptance of technology (Davis, 1993). The goal of this mixed method research inquiry was to investigate in Phase I the attitudes and perceptions of upper-sixth post-primary level users and in Phase II the attitudes and perceptions of first year undergraduate students' to the use of mobile devices for learning. Phase II introduced a longitudinal element interrogating first year undergraduate student attitudes at three points during the academic year. This provided the researcher with data from students' use of the mobile device at two distinct levels of education.

The data gathered has been analysed, evaluated and discussed through the lens of the extended Technology Acceptance Model (TAM2). TAM measures users' perceptions of Usefulness, Ease of Use, Attitude to Use and Intention to Use and the model is extended through the introduction and measurement of external variables Perceived Resources and Perceived Media Richness. In Phase I post-primary student attitudes (n = 579) have been derived from a quantitative data collection method: a closed survey of upper-sixth level students followed by qualitative data collection through focus group sessions. In

Phase II three closed surveys of first year undergraduate students were introduced at the beginning of semester one (n = 1,162) and the end of semester one and two (n = 190). The data obtained from these collection methods has been analysed and interpreted based on three key questions, which stem from the aim of the inquiry:

- Is there a relationship between students' perceptions of Resources, Usefulness, Ease of Use, Attitude and Use of a mobile device?

- Is there a relationship between students' perceptions of Media Richness, Usefulness, Ease of use, Attitude and Use of a mobile device?

- Is there a relationship between students' perceptions of Usefulness, Ease of Use, Attitude and Use of a mobile device?

Knowledge is acquired and transformed when users interact socially and the use of mobile technologies in teaching and learning contexts can aid this if integrated successfully taking into account the social and cultural factors involved (Keengwe and Bhargava, 2014). The design for long-term effective persistent use of new technologies will present challenges for educational institutions and this study aims to address Information Technology (IT) knowledge, research and educational policy and practice. Overall, the study results confirm the acceptability of the extended technology acceptance model and provides an informative representation of the mechanisms which influence user acceptance of mobile device use for learning and should therefore be helpful in applied contexts for forecasting and evaluating user acceptance of the mobile device. Implications for future research and practice are discussed.

ACKNOWLEDGEMENTS

I would like to thank my husband, Eddie and my beautiful children Muireann and Ultán for their patience, tolerance and enduring support throughout. I also owe a special recognition and deep gratitude to my wonderful parents Colette and John. Without their support, guidance and love of learning which has been instilled in me since my earliest years this dissertation would not have been possible.

I owe sincere and earnest thankfulness to my principal dissertation supervisor, Dr. Pamela Cowan, for all the help, advice and time that she provided to me. Her wide knowledge, guidance and unwavering support was invaluable throughout this dissertation process.

I am truly indebted to all the post-primary schools and students as well as the first year undergraduate students who willingly and voluntarily participated in this study. Their involvement and contribution provided me with a wealth of rich, valuable and unique data.

Finally, I am obliged to many of my colleagues who supported me and in particular to Mr. Patrick Brannigan for his enduring support.

ABBREVIATIONS

AI	Artificial Intelligence
ATT	Attitude to Use
C2K	Classroom 2000
DE	Department of Education (NI)
DELNI	Department of Employment and Learning Northern Ireland
EA	Education Authority
ECAR	EDUCAUSE Centre for Analysis and Research
E-learning	Electronic Learning
GBL	Game-Based Learning
GCSE	General Certificate of Secondary Education
HE	Higher Education
HEFCE	Higher Education Funding Council for England
HESA	Higher Education Statistics Agency
ICT	Information Communication Technology
IM	Instant Messaging
IT	Information Technology
IU	Intention to Use
MALL	Mobile assisted language learning
ML	Machine Learning
MOOCS	Massive Open Online Courses
MIP	Mobile Infrastructure Project

M-learning	Mobile Learning
MRT	Media Richness Theory
NAACE	National Association Advisors of Computers in Education
NSS	National Student Survey
NI	Northern Ireland
OECD	Organisation for Economic Co-operation and Development
Ofcom	Office of Communications
PDA	Personal Digital Assistant
PC	Personal Computer
PMR	Perceived Media Richness
PR	Perceived Resources
PU	Perceived Usefulness
PEOU	Perceived Ease of Use
RSS	Really Simple Syndication
SAMR	Substitution Augmentation Modification Redefinition
SMS	Short Messaging Service
TAM	Technology Acceptance Model
TEL	Technology Enhanced Learning
TRA	Theory Reasoned Action
TPB	Theory Planned Behaviour
UTAUT	Unified Theory Acceptance and Use of Technology
Ufi	University for Industry
UK	United Kingdom

US	United States of America
VLE	Virtual Learning Environment

CHAPTER 1 INTRODUCTION

1.1 Chapter Overview

The digital and information revolutions and the proliferation of information, communication and learning technologies have positively impacted and proven to be essential to the UK higher education (HE) sector facilitating faster communication, information sharing, and collaboration between students and university (Walker et al., 2016). Computing and mobile communication, especially mobile technologies, are impacting students' interactions and communication behaviours amongst themselves and with others in society (Becker et al., 2017). The use of handheld mobile technologies, accelerated by the evolving handheld computer is year on year continuing to grow and become an integral part of everyday life (Mifsud, 2002; Schuck et al., 2017).

This is an introductory chapter describing the background of this research which discusses the emergence and evolvement of mobile technologies across a rapidly evolving digital society and the impact on education, particularly the challenges, issues and developments faced by universities including evolving student demands and needs. The chapter will also detail the study rationale indicating the existing research gap followed by the contribution of this study to knowledge. In addition to this the educational and research study context and settings are illustrated.

1.2 Introduction

The 1970s marked the beginning of the digital revolution and since then the use of technology has permeated throughout society (Valék and Sladék, 2012). Across the world educational sectors are infusing digital skills into teaching, learning and assessment with the aim of nurturing digitally competent members of society (Scherer et al., 2019). The continuing growth and development of mobile technologies over the past 20 years, in conjunction with high bandwidth infrastructure, wireless platforms and the Internet, has been providing users with more flexible access to communication, interaction and sharing of information than ever before (Robson, 2003; Sheng et al., 2005). The British Government have introduced the fifth generation (5G) wireless technology for digital cellular networks to improve access to mobile and digital

technologies and the Mobile Infrastructure Project (MIP) delivered mobile telephone coverage to 7,199 premises in areas which previously had no mobile signal (Department for Culture, Media and Sport, 2017). UK Universities in the last decade have seen a rapid rise in the use of Technology Enhanced Learning (TEL) due to, for example, government incentives and student expectation requirements (Dunn and Kennedy (2019).

The emergence and acceptance of Android-based devices such as the Blackberry and the introduction of the iPad has led to a rapid advancement in mobile computing providing flexible access to the World Wide Web, a vast array of applications and social networking platforms (Tossell et al., 2015). The use of mobile technologies is widely documented with the majority of 18-24-year-olds owning a mobile device, many with multiple functions (Barnes and Tynan, 2007; Tossell et al., 2015) and an identified surge in iPad ownership and its use in Higher Education (HE) (Nguyen et al., 2014). The adoption and reliance of information and communication technologies across society as a whole (Mutekwe, 2015) has had a direct impact on education, and emerging technologies are viewed by some as integral and essential to effective classroom teaching and learning, playing a key and transformative role in education (Garrison and Kanuka, 2004; Pegrum et al., 2013). However, the debate continues as to how best and most effectively integrate and use mobile technologies in education for the benefit of teaching and learning in order to help students achieve higher-order learning outcomes (Naismith et al., 2006; Vol et a., 2017). Alnabhan and Jaafer (2012) argue that m-learning is not about working with emerging and advanced technologies but tailoring learning to suit the requirements of each individual learner.

The University (referred to as THE University throughout this study) involved in this study is keen to progress the concept of student-centric technology, where the use of institutional and student-based technology are blended to maximise student engagement and offer the best possible learning experience both on and off campus. This research is aimed at exploring student attitudes and perceptions of mobile technologies at two distinct levels of academic life and how these technologies can be used to support learning both inside and outside of formal education. The focus is attitudes towards devices owned or easily accessible by the user, with generic, inbuilt functions and how these devices are used to communicate and access resources in the support of learning both inside and outside of educational institutions. The two-phased study has a transitional element with contributions from upper-sixth post-primary students in Phase I to gain insights into user attitudes and experiences before the transition into third level

education. Phase II, with a longitudinal element, surveys first-year undergraduate attitudes at three time points during the academic year.

Mobile technologies provide educational institutions with the opportunity to access a range of communication and information resources in support of student teaching and learning (Hsieh and Tsai, 2017; Ozdamli and Uzunboylu, 2015), allowing students in learning contexts the ability to learn unlimited by time or place (Hsu and Ho, 2012). Gikas and Grant (2013) contend that the use of mobile devices in conjunction with social media and other web tools can increase accessibility for students to course materials and improve collaboration and engagement with peers and tutors. Devices such as the smartphone, digital media player and the tablet personal computer have been engaging educators and policy makers alike (Yang, 2012) with their use across the education sector increasing annually, because of the potential to transform communication, engagement and learning without the barriers of time and space (Ahmed and Parsons, 2013; Castano-Munoz, 2014).

Fuller and Joynes (2015) argue that m-learning will be vital to teaching and learning; alongside the development of optimal learning design strategies and requirements of use in order to mould the future of m-learning in education. The development of effective m-learning necessitates the meaningful inclusion of technology in teaching and learning contexts (OECD, 2015; Siddiq et al., 2016) and Kim et al (2017) remind us of the recent studies pointing out restrictions and limitations of mobile device use in learning and the need for more empirical studies providing a deeper understanding of student attitudes to mobile devices. This study aims to contribute to the use of the mobile device for teaching and learning with emphasis on higher education, presenting models for using and accepting technology and underlining gaps in knowledge in technology acceptance among students at the end of their second level education and beginning of first year undergraduate study in third level education.

1.3 Background of the Study

Wireless mobile devices are intrinsically personal items, wearable, constantly accessible, place independent and location smart (Campbell and Kwak, 2010; Keegan, 2005; O' Bannon and Thomas, 2015). Mobile wireless devices are at the heart of how most people stay in touch, impacting on everyday life communication, interaction,

teaching, learning and work (Parson and Ryu, 2007) and can form bridges between different technologies, contexts, experiences and learning spaces (Şad, and Göktas, 2014; Vavoula et al., 2007). Mobile technology presents compelling opportunities to effectively support self-led and tailored learning (Dunn and Kennedy, 2019; Shuler, 2009). The ECAR study of undergraduate students and IT (2012) emphasises the importance of the student voice in 'shaping the learning environment of higher education' and this view is echoed in recent empirical studies from Al-Emran et al. (2018), Crompton and Burke (2018) and Wakefield et al. (2018). This research utilised a questionnaire with a model design based on the TAM2 extended to include Perceived Resources (PR) and Media Richness Theory (MR) as external constructs to explore the student voice by investigating student perceptions of mobile device use both at school and in university.

The technological capabilities of households in the UK are changing at a rapid rate and Ofcom (2017) reports that 76% of the population own a smartphone and 58% rate it as the most important device for going online. There has also been a rise in tablet ownership with three in five households owning a device in contrast to 11% who use a desktop personal computer to access the internet (Ofcom, 2017). These handheld technologies allow for the delivery of varied multimedia materials such as video, audio, graphics and various applications integrated with social media cloud computing (Lim and Churchill, 2016). The most recent technological developments such as gesture-based computing, augmented reality and collective intelligence have further heightened the need for ongoing developments in the mobile learning sphere (Ng'ambi, 2013; Schuck et al., 2017). Conversly, Sandu and Gide's (2018) study found that artificial intelligence (AI) and machine learning (ML) can potentially help student learning by offering a more tailored, interactive learning process and there is a growing body of empirical studies investigating the use of game-based learning in a vast array of subject areas with successful outcomes (Sánchez-Mena et al., 2017).

Literature is reporting an increase in the use of mobile technologies in schools and the learning opportunities that they can provide to students (Al-Emran et al., 2018; Scherer and Teo, 2019; Ahmed and Parsons, 2013). Students can use mobile devices to communicate with peers, friends and tutors through various forms of media using a range of mobile applications. Studies such as Hartnell-Young and Heym's (2008) investigation into the use of mobile telephones for learning found that mobile telephones contributed positively to the valid collection of data in science experiments and Kukulska-Hulme and Viberg's (2012-2016) review paper of mobile collaborative language learning studies

found compelling evidence supporting this. Although technology has been recognised as an effective tool to enhance learning (Evans, 2014), the introduction of technology into the classroom to promote a more flexible learning environment for a diverse range of learners also presents challenges to teacher-led traditional styles and roles (Walker et al., 2018).

The process of integrating technology has been found to be complex process of educational change, and the extent of the use of technological applications in schools is varied (Fraillon et al., 2013). While educational technology use in (teacher) education has increased in recent years, however technology acceptance and usage continue to be problematic for educational institutions (Berrett et al., 2012; Straub, 2009) and does not mean that learning will spontaneously occur. Higgins et al. (2012) study which focused on the impact of digital technology on learning concluded that the disruptive potential of mobile learning in education can only be fully realised through the application of sound pedagogic approaches. The integration of mobile technologies to effectively support current teaching and learning practices is not an easy task as it inevitably requires careful pedagogic planning and preparation time by teachers and tutors (Clarke and Abbott, 2016). Dunn and Kennedy (2019) point to the mixed results in studies focusing on the contribution of TEL to teaching and learning, with positive and others negative. And indeed their study questioned the pedagogical value of institutional-led technologies such as discussion boards which were not mobile compatible. Although Walker et al. (2016) argue that lack of opportunities for academic staff training and support staff provision have over time become less of a barrier to the use of TEL nevertheless it is still an obstacle which must be tackled by HE establishments to fully integrate technologies.

In order to meet challenges faced by universities, a new and innovative approach must be embraced through the successful and effective integration of digital technology use in education (Garrison and Kanuka, 2004). Fuller and Joynes (2015) argue that mobile learning should be compulsory in preparing students for the workplace. Technology use in learning has witnessed an increase in use in recent years due to increased government spending and policy changes such as the first HE strategy for Northern Ireland (NI) ‘Graduating to Success’ (2012) (Kennedy and Dunn, 2018). Universities are expected to be technological leaders, meet student requirements and although a heavily debated phenomenon, there are preconceptions that the ‘‘Generation Me’’ expectations

and learning is impacted by prior experiences of information technology (IT) use (Trushell and Bryne, 2013).

Stakeholders in a mobile learning system including students, university academics, administrators and support staff (Jafari et al., 2006) must be addressed to ensure effective decisions regarding the role, application of mobile learning and the integration of mobile technologies in the educational system are implemented. Each group will by very nature have different perceptions on the usefulness for learning and intention to use mobile technologies for learning may also differ. However, it must be noted the majority of m-learning studies investigating mobile device use include specific devices alongside specific applications, software or hardware (Hayati et al., 2013). It is thus important to investigate user requirements before a system is implemented. The scope of this research will focus on the students' perceptions and preferences in connection with the acceptance of mobile learning using a validated model that has dominated research, the information technology acceptance model (TAM) (Scherer et al., 2019). The importance of student expectations regarding technology in education is acknowledged across research studies (Head and Ziolkowski, 2012; Paterson and Low, 2011; New Media Consortium and ELI, 2008).

To help us understand and explore student intention to use mobile devices for learning, this study aims to understand the context from where these attitudes and perceptions were constructed and developed, namely at post-primary level. The use of mobile devices such as the iPad are gaining momentum in both primary and post-primary schools across the world and studies such as Copeland (2011) found that pupil use of the iPad promotes the development of ICT skills naturally without formal teaching and Zydney and Warner's (2016) review point to research that found tablet based learning in science increased student engagement and interest. Clarke and Abott's (2016) iPad study conveys improvement in pupil understanding of literacy and numeracy concepts alongside spontaneous group collaboration. While there is undoubtedly a growing number of digital technologies from interactive whiteboards to iPads utilised in schools throughout the UK there is; however, a need for more evidence of the positive impact on educational results (Quinlan, 2014). There is a need for more research on how digital technologies are used in different schools to develop more effective and beneficial use of ICT in formal education (Perrotta, 2013).

Learners use mobile devices because of the learning opportunities they afford (Scott, 2012) such as accessing course resources or communicating and collaborating with tutors and peers (Gikas and Grant, 2013) which has accelerated student use and demand for personal mobile devices inside and outside the formal learning environment (Burden et al., 2012). Mobile, across context learning can occur in different locations such as home and on campus, between informal and formal learning and between personal and collaborative learning (Andrews and Jones, 2015). Hutchings and Quinney (2015) argue that HE institutions must strive to demonstrate innovativeness in research, teaching and professional practice in a student-centric learning environment. While it is argued that HE must embrace evolving technologies impacting the educational landscape, institutional conditionals and pedagogical approaches need to be addressed to aid the development of a transformative model of practice to support effective teaching and learning (Ng'ambi, 2013). However, Luckin et al. (2012) argue that more evidence is required demonstrating how digital technologies can not only support but effectively benefit and improve learning and teaching. This study explores student attitudes and use of mobile device and technologies not only within formal learning but outside the classroom and lecture theatre.

Educational institutions are facing the challenge of providing students with increasingly creative and purposeful access to ICT with the aim of enhancing learning opportunities. The 'MyArtSpace' project executed by Sharples et al. (2007) pursued a link between museum and school learning where mobile technology was utilised as a bridging tool between the two learning contexts. The research concluded that mobile devices can successfully connect resources and information gathered by the students between the two environments and create a bridge between students' learning. Contrary to this, Gronemann's (2017) study reports negative and apathetic user attitudes to the use of portable tablets for learning in out-of-school contexts, in this scenario a science museum. Davis et al.'s (1989) comparative study of TAM and the theory of reasoned action (TRA) reminds the reader that although ease of technology use is important to the user, the usefulness of the technology cannot be underestimated as an essential criteria affecting user attitudes and intention to use technology. The different locations and domains of learning with technology including classroom-based and informal learning outside the classroom must be addressed in the study of mobile learning technologies (Attewell and Hughes, 2010) and this study addresses this requirement focusing on what and how students use a mobile device such as the smartphone as a tool for learning and how it

can be used to address learning needs in formal learning situations or for example as a collaborative medium studying with peers outside of formal learning.

1.4 Study Rationale

Technology plays an important part across all areas of a university's foundations whether it be educational, administrative, or supportive. Universities must provide the optimum educational environment and tools for all its students and staff and investment in technology requires an understanding of student technology perceptions and needs so these can be incorporated into technology investment and integration across teaching, learning and support services to ultimately enhance teaching and pedagogy (Schuck et al., 2013; Slater and Lally, 2018). Drennan and Moll (2018) argue that a changed pedagogy alongside the use of mobile devices can help students move away from passive consumption of multimedia and develop students problem-solving skills along with innovative, collaborative and communication skills. Becker et al. (2017) argue that if educational institutions do not have vigorous strategies for the integration of approaches such as mobile learning, then they simply will not survive.

The very nature of HE is changing due to multiple multi-faceted global factors and

> *there is a need to theorise and organise in the face of complex and emerging realities (Sclater and Lally, 2018, p47)*

HE institutions use technology to support the academic life cycle of the student, a holistic approach from first year undergraduate registration, progression through academic career to completion and preparation for graduate life in the workplace. Mobile technologies have become not only a necessity but an integral part of 21st century university life and study (Elwood et al., 2006). Over the previous decades the e-learning approach has been tried, tested and has evolved through technological advancements and enhanced goals. The importance of e-learning is now evident, whether it is used in a stand-alone mode or in a blended approach with traditional classroom delivery and can be used to facilitate great teaching and improve student learning when it is designed in 'as part of the overall pedagogic approach of the course' (Davies et al., 2017).

Empirical research studies and literature highlight the growth in use and significance of mobile learning at HE level (Fuller and Joynes, 2015) and help inform our understanding of successful integration in education and enhance the user learning experience indicating that mobile learning can offer convenience, mobility, and increased access

(Gronemann, 2017; Hayati et al., 2013). The ongoing developments in evolving technologies that can be used in learning highlight the need for university policy development, guidance and technology support for staff and students to enable the successful adoption of emerging mobile technologies in education. Lim and Churchill (2016) highlight the urgent need for more theoretically underpinned empirical research studies presenting recommendations for policy and practice and influential educational researchers highlight the importance of an understanding of student attitudes on learning and study preferences (Andrews and Jones, 2015).

Mobile technologies are recognised as important to education across all sectors and studies such as Mtebe and Raisamo (2014) explore the concept of m-learning from the users' perspective and highlight user perceptions regarding the adoptability of m-learning methods. It is vital that the student voice, attitude and perception to technology is addressed (Dahlstrom, 2012) and in order to promote technology integration for learning it is essential that users are informed of the technology and ultimately accept it. The factors that affect technology acceptance must be understood as this is the very core of technology adoption (Hoi, 2020). Ng and Nicholas (2013) found that sustainable and effective ICT integration and the consolidation of mobile learning into teaching and learning is complex and person-related fundamental issues require consultation such as the development of positive user attitudes, required support and effective communication between students and staff.

Many empirical studies in the last twenty years has focused on use within the formal classroom-based context reviewing the potential impact of technology on pedagogy, its methods, objectives and results and the potential to improve student engagement, interactions and success in educational environments (Cuban, 2014). There is a lack of significant research investigating the spontaneous use of mobile technologies across settings and contexts, focusing on the learners' attitudes, experiences and perceptions towards the use of mobile technologies for learning (Tossell et al., 2015). Much of the published work on mobile learning focuses on student attitudes use of handheld devices in education in subject specific environments with small cohorts of participants (Fuller and Joynes, 2015). Andrews and Jones (2015) agree that the study of mobile technology use has documented studies in specific subject disciplines, specific age groups, in specific educational national contexts. The transitional nature of this research across two separate educational settings allows for data collection of attitudes and perceptions of mobile device use for learning of post-primary and first year undergraduate university

students, from a plethora of subject areas, inside and outside of the formal learning institution and in social contexts (Schuck et al., 2016).

This study is unique as data is gathered over two distinct phases in two distinct UK educational sectors. Phase I investigates pre-university student attitudes and use of mobile technologies both inside and outside of school. Phase II investigates first year undergraduate student attitudes to mobile technologies in daily learning and communication contexts both on and off-campus. It is vital that user attitudes are researched at different stages of academic life as literature highlights that young users' technology access, aptitude with and choice of ICT are not homogeneous (Trushell and Byrne, 2013). Higgins (2012) argues that successful and effective e-learning requires motivated and experienced learners. The two phased transitional nature of this research allows the researcher to explore if the students have the motivated intention to use mobile devices for current and future use, both at school and at university. Phase I explored upper-sixth school pupils' current and past experiences of mobile devices and technologies for learning, inside and outside of school. Phase II collected data from first year undergraduate students at the beginning (first week of studies), middle and end of the academic year. This provides an overview and insight into historical, transitional and current perceptions of mobile device use at post-primary and university education level.

The HE arena plays a key role in the social and economic development of the UK in the 21st century and is becoming an increasingly competitive and complex arena (Universities UK, 2015). Institutions are expected to respond to a variety of socio-economic, political agendas and pressures within an increasingly competitive HE sector where university funding budgets are decreasing (Daniel, 2015). A substantial portion of students today only enrol at university to gain a qualification and enhance job and career opportunities (Evans, 2014). HE must meet the skill needs of business and industry as employers today require adaptable and flexible employees who can successfully contribute in collaborative and task-orientated work environments (Schuck et al., 2017). Many students entering university have to juggle undergraduate life with other commitments in their personal and social lives (Anagnostopoulou and Parmar, 2010). HE institutions must wholly support this integration through information and communication technologies which are flexible and useable on a daily basis, not just because the technology exists but to potentially enhance the student experience (Caruso and Kvavik, 2005).

The requirement of regular, flexible access to technology and electronic services is increasing in third level education and it is essential that the institutions develop an information communications technology (ICT) strategy in order to fully service all its students (Collis and van der Wende, 2002). A rising student expectation of academic quality and a high quality of service in return for paying more for their studies is also presenting challenges to third level institutions (The Times Higher, 2015). Universities are increasingly customer-focused with a growing importance being placed on the overall student experience at third level education. The Department of Employment and Learning NI (DELNI, 2012) HE strategy highlights that all students attending university expect a quality academic and 'student' experience. Student services are expected to be readily available at the users' convenience to optimise the overall learning experiences (Garrison and Kanuka, 2004). It is crucial that education adapts to the world-wide adoption of mobile technology (Lindsay, 2016) as teaching and learning and student support services must be at an optimum in order to attract both domestic and international students in a climate of financial turbulence for education as a whole.

1.4.1 Importance of the study

The transition from school, a familiar teacher-led environment to university, an unfamiliar self-managed learning and social environment can be a significant and overwhelming experience for the undergraduate student. Matuga (2009) points to the definite gap in the transition from school to university which can present the student with a variety of problems. Gao et al. (2017) point to studies that suggest mobile telephones can help social relationships and interaction with peers and Bergdahl et al. (2020) agree that digital technology use outside structured formal learning can aid social inclusion and positively benefit the student experience. Governments across the world have been providing funding to schools for the provision of digital technologies. However, the lack of empirical research into students' attitudes towards use has minimised the impact technology has on the student experience (Beckman et al., 2014). Crompton and Burke (2018) argue that users' perceptions ultimately influence behaviour so how the users perceives mobile learning is vital to its use and effectiveness. Learners need adequate support and guidance in order to evolve into successful university learners.

The HE institution must not only address the retention and success of these undergraduate students but also the engagement of each student throughout the undergraduate pathway to enable them to adjust academically, socially and personally

to encountered challenges and to succeed (Lowe and Cook, 2003). Therefore, inquiries such as this one are a vital source of information for HE establishments' integration of mobile technologies into the student learning experience. The research will aim to develop an understanding of student experiences and intention to use mobile technologies with the potential to inform policy and procedure in transforming and maximising the potential for mobile learning opportunities in HE.

Student support is core to securing potential benefits from the integration of technology such as increased motivation, retention rates and academic accomplishments (Ufi/learndirect and Kineo, 2007). However, if the acceptance and implementation of new technologies are resisted by any of the stakeholders involved then this poses a risk to the institution such as loss of time, effort and cost of the technology integration which in turn can negatively impact potential benefits of the technology use for teaching and learning (Al-Emran et al., 2018; Birch & Burnett, 2009; Davis and Venkatesh, 1996; Verhoeven et al., 2010). Educational institutional stakeholders need to not only understand the factors that affect student acceptance of information and communication technologies prior to the purchase or development of the technology but they also need to understand student actual use of m-learning to plan forward for the development and implementation of m-learning systems (Abu-Al-Aish, 2014; Sandu and Gide, 2018).

The acceptance of any technology by the user is key its successful use in teaching and learning (Al-Emran et al., 2018). Ng (2012) emphasises that the student voice is essential to advise and inform planning and investment in technology access across HE. Student opinion and knowledge on preferred technology use can essentially guide the focus on key strategic areas of requirement and development. Mathieson et al.'s (2001) study extended the technology acceptance model (TAM) to include PR as although a user may find a device useful or easy to use, resources such as money or the required skills may not be available. This study provides the student with a voice and an opportunity to express opinions and experiences of technology where there is currently a gap in the research (Sharpe et al., 2005). This study will inform on student expectations of mobile and wireless technologies both inside and outside of the educational environment.

UK universities, specifically the Russell Group, place a high importance on the benefits offered by TEL in the delivery of world-class student centred, teaching and learning experience in an increasingly competitive market (Walker et al., 2016). Corbeil and Valdes-Corbeil (2007) caution that frequent use of mobile technologies does not mean

that the user is ready for mobile learning. Learners by nature will carry with them from second level into third level education vast differences in engagement with mobile and communication technologies based on experiences, needs and expectations (Sharp, 2005). The effective and sustainable embedding of technologies in pedagogical practice requires large amounts of time and effort from staff and educational institutions and an understanding of student attitudes and perceptions of mobile devices inside and outside of educational environments to inform practice, in a student-centred shell approach (Hutchings and Quinney, 2015).

Empirical research studies from the United States (US) suggest that TEL implemented alongside curriculum re-design can improve learning outcomes for HE institutions (Davies et al., 2017). The effective use of TEL blended with face-to-face teaching can provide and support an effective disruptive pedagogy in the classroom (Hutchings and Quinney, 2015). However, much research in the area of technology and education focus on benefits and outcomes rather than examination of evidence process and results. Sclater and Lally (2018) suggest the urgent need for more research focusing on TEL framed through a theoretical lens to help learners and teachers across education initiate and mould pedagogically sound teaching and learning environments.

The use of the Internet as ‘an interactive learning catalyst’ is integral to increasing effectiveness in teaching and learning in an institution (Castano-Munoz et al., 2014) alongside access to mobile handheld wireless devices which has changed HE at its core (Motiwalla, 2007). However, technology must be accessible, flexible and improve learning in order to be truly effective in education (Robson, 2003) and the transition from second to third level education can be a challenging period for first year undergraduate students. A gap exists in the understanding of student attitudes and perceptions towards technology and this presents a barrier to realisation of the true potential of technology for HE (Lai et al., 2012; Mayes, 2006; Sharpe et al., 2005). It is vital that HE institutions have knowledge and information of student attitudes and experiences with ICT at school to assist with successful transition and integration into academic studies at third level. Lau and Woods’s (2007) empirical investigation of user perceptions and attitudes to learning objects in a specific academic programme confirm the validity of TAM in the prediction of user’s future behaviour, central also to the foundations of this empirical study.

Price et al. (2009) argue that the effective use of technology in education, where it contributes to learning both inside and outside the educational context, has yet to be fully realised. While digital technologies have radically changed the banking and publishing sectors over the past 20 years, the education sector has witnessed minimal change (Davies et al., 2017). The education sector can use existing and emerging technologies to engage, motivate, and provide effective learning experiences for students (Geer et al., 2017). Thus, this research is aimed at assessing the capabilities and limitations of mobile devices and technologies from the perspective of post-primary and undergraduate students and their view of how mobile technologies impact on learning. This research is critical and seeks to explore and understand the learner's voice and intention to use mobile technologies both inside and outside of formal learning. The results are expected to contribute to the subject area of learning and student attitudes to the use of mobile technologies for learning both inside and outside the formal classroom environment.

1.5 Study Settings

1.5.1 Study Phase I – Post-primary schools

The integration of IT in schools has historically faced many obstacles including technology and specialist equipment financial costs, administrative challenges such as charging and ownership, alongside staff expertise (Clarke and Abbott, 2016). There is increasing evidence highlighting that UK schools (Burden et al., 2012; DOE, 2012; Perrotta, 2013) and schools in NI (Clarke and Abbott, 2016; CLC, 2013; Roulston, 2013) use technology for learning inside and outside the classroom such as accessing resources for module work, use of a VLE such as Fronter; a High School in County Derry, NI created a digital repository of resources for students studying General Certificate of Secondary Education (GCSE) ICT with mobile devices playing a pivotal role in the provision of resources (C2k NI, 2015).

Phase I of this study was conducted in post-primary schools with upper-sixth level students aged between 17 and 18 years. There were approximately 175 post-primary schools in Northern Ireland with pupils in years 13 and 14 in 2012 (EA, 2012), 70% of grammar school students entered HE and nearly 90% of all full-time undergraduate enrolled students who entered third level education were from Northern Ireland (HESA, 2013). In phase I, purposive sampling was applied and stratified by school management type, gender (single sex or co-educational schools) and based upon EA figures. In total,

138 of post-primary schools were targeted from each education authority area in Northern Ireland, with a total of 16 post-primary schools agreeing to participate in the research study. It must be noted that no single sex boys' school participated in the research, a school had initially agreed to participate but had to withdraw due to an imminent school inspection. The participating post-primary institutions for anonymity and confidentiality purposes are referred to as 'THE Schools' throughout the research report. At the time of the study this included schools identified as NAACE ICT Mark schools accredited for demonstrating good use of technology for teaching, learning and administration (NAACE, 2018). In total, 16 schools agreed to participate which included a variety of single and mixed gender school types from the post-primary sector including controlled, maintained and integrated schools (grammar and secondary).

1.5.2 Study Phase II – THE University

THE University hosts a myriad of events and programmes aimed at upper-sixth level students. The aim is to aid and ease the transition between post-primary and university. There are regular Open Days for students and family including events and talks organised by individual Schools in THE University. There is a widening participation programme specifically to support Year 13 students in non-selective schools and further education colleges to develop potential progress to HE. The Library host a programme including workshop sessions focusing on transition skills required by the post-primary student for undergraduate studies. The School-University Partnership provided 150 students from schools in NI an opportunity to engage with researchers in three faculties at THE University (THE University, 2015).

The mission of a university campus is primarily of learning, research and education through which the acquisition of knowledge positively contributes to and enhances people and the broader society (Griswold et al., 2002). The UK University in which my study is set will be referred to as 'THE University' throughout the report for confidentiality and anonymity purposes. University support services are required to support teaching and learning and any administrative tasks related to education (Elwood, Changchit and Cutshall, 2006). THE University IT Department manages the development and provision of integrated IT facilities, services and resources to support staff and student education and research activities in conjunction with THE University's mission and strategy. It highlights the importance of the student experience and it is responsive to a demand for

increased accessibility of digital resources on a device of choice alongside flexibility, regardless of time or place (IT Department, THE University, 2012).

Student technology is used as an aid to support and enhance the student experience and flexible access to resources and communication tools on and off campus (THE University Education Strategy, 2016). Student ownership of mobile devices has pushed forward the integration of mobile and wireless technologies. These will play an increasingly important part in the provision of services and information to enhance the student, teaching and learning experience in a user-friendly, accessible manner, tailored to suit the individual needs of the learner. This in conjunction with a campus-wide wireless service will enable all users access on an anytime, anywhere basis to the resources required and to work flexibly across the campus using a mobile device (IT Department, THE University, 2012). THE University developed and launched in September 2018 an in-house mobile application, providing access to useful information such as campus maps, timetables and PC availability on-campus.

THE University offers all first year undergraduate students IT induction sessions at the beginning of semester one. The sessions are specifically tailored to introduce THE University IT facilities and services available both on and off-campus and help orientate and navigate the student through the variety of IT provisions available. There has also been an increase in information and resources available via wireless and mobile devices in the form of video tours of services, virtual inductions and access to student email before studies commence providing the student some understanding of what to expect from life at THE University.

In 2014 over 11,000 full-time first year undergraduate students entered university level education in Northern Ireland. Phase II part A of this study was conducted in the University with 1,162 first year undergraduate students The subsequent parts of Phase II (B and C) electronic survey gathered a total of 209 responses. Purposive sampling was carried out and was stratified by gender, university school and faculty.

1.5.3 Information communication technologies - THE University

The strategic investment in IT infrastructure alongside ICT plays an essential role to help meet changing institutional requirements and opportunities essential in the support of teaching and learning. The need for dynamism and flexibility in teaching and learning contexts has placed more focus on the e-learning arena. The development of a more

student-driven and personalised learning environment is facilitated by learner mobile device ownership. It has been identified that mobile delivery of programme information, namely examination results, course materials and course management systems are the three areas of key importance to students (Ng, 2012). THE University has taken a college-wide approach in the provision of technology-enhanced education, alongside digital learning resources offering increased opportunity, flexibility and accessibility of learning (Caird and Lane, 2015). THE University ICT infrastructure continuously extends to include development of wireless networks alongside the introduction of cloud computing via Microsoft Office (MS) 365 including collaborative apps such as Teams, One Note and the introduction of a new cloud-based virtual learning environment (VLE).

THE University Online services platform was developed in 2000, and in 2006 moved to SharePoint Portal Services, with a mobile friendly approach to enhance the user experience. This environment plays a pivotal role in student learning and communications offering the opportunity to extend learning beyond classroom boundaries. The online environment was built on the concepts of ease of use and a single accessible user environment for all online services for learning support and communication including a managed VLE. The managed environment includes access to storage space on THE University server, student Library and student card accounts and general services such as group study room bookings (THE University, Website Board, 2012).

THE University Online initially began as a VLE used to promote self-directed learning asynchronously. The VLE has now evolved from a passive environment where the student could access only content download with limited interaction potential to a communication and resource tool accessible to all students and staff (Donnelly and O'Rourke, 2007). Students on and off campus have access to a whole portfolio of university-based resources such as teaching resources, wiki tools, assignment and assessment facilities. It also encompasses staff tracking for staff to highlight student engagement with study materials (THE University, Information Services Department, 2015). The Learning Resources area has attracted a high score in the years 2015 to 2018 in the National Student Survey (NSS) results, a UK-wide anonymous online questionnaire measuring student satisfaction levels with their respected institution.

THE Information Services Department has started to exploit new and emerging technologies including actively encouraging student use of mobile devices to access facilities both on and off campus. Social media via platforms such as Twitter and

Facebook are also used to provide learner support and information that are location and time independent. Cloud integration underpinned by fast reliable broadband has the potential to improve links between home and school accessible anytime for teaching, learning and assessment resources and activities. THE University Corporate Plan (2020) commits to the availability of high quality support and a sustainable infrastructure to enable staff to develop and deliver a world-class student learning experience beyond the next decade (2027). In order to support this plan, THE University initiated A procurement process in 2017 for a new cloud-based VLE which was rolled out for student delivery in the academic 2018/19.

1.6 Dissertation Overview

Creswell (2013) notes that in order to communicate study aims and objectives with the reader the inclusion of a comprehensive guideline is an essential component of quality research. Thus, this sub-section provides a guide to this dissertation to facilitate its readers. This chapter develops the foundation for the study by identifying the study background and corresponding study rationale leading to the importance of this study to research. The chapter also highlights the possible contribution to knowledge from the study and an overview of the entire dissertation.

The second chapter reviews the relevant research literature with particular focus on mobile learning literature and factors impacting mobile technology use and the potential of mobile technology use for learning. This chapter also explores the research framework and describes the theoretical model which guides this study. The research revolves around the extended TAM (TAM2), which includes external constructs PR and Perceived Media Richness (PMR). TAM is an internationally acknowledged conceptual model used to investigate user intention to use technology (Al-Emran et al., 2018).

The third chapter is dedicated to the research methodology and explains why the mixed research approach is selected for the attainment of the research targets. It details the use of data collection and analysis tools, which were a questionnaire survey and SPSS software; focus group sessions and thematic analysis. The fourth chapter includes analysis of the qualitative and quantitative data obtained in the study. And finally the fifth chapter critically reviews the results obtained, summarises and discusses the study findings based on the research questions, potential implications for stakeholders, conclusions and future research recommendations.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Chapter 1 introduced the background to the research study and identified that new and emerging technologies are growing in use inside the classroom forcing the re-thinking of teaching and learning as well as working as a generator for change and innovation across society as a whole (Groff, 2013; Kim et al., 2019). This chapter reviews literature relevant to the study, and this has been completed using a thematic approach with the first part of the chapter focusing on growth in the use of ICT education, mobile device use and its impact for the user and the growing trend of use in teaching and learning including barriers to use. The chapter then proceeds to present a history of the evolving theories of learning with focus on the development of electronic learning and the emergence of mobile learning. Literature and research on mobile learning, its definition and how it differs from other learning paradigms are discussed. The researcher's search of literature focused on e-learning, technology enhanced learning and mobile learning.

The challenges and issues facing education and HE are then discussed alongside mobile technology evolvement and the implementation of technology as a tool to support teaching and learning at post-primary and HE level. Analysis of research in this area introduced further themes not anticipated by the researcher at the start of the research project. The chapter goes on to evaluate and discuss formal and informal learning, inside and outside the classroom and where informal learning can occur through the creation of content using mobile devices. The researcher interrogates digital literacy, its meaning and whether students today can potentially improve digital literacy skills via mobile technology use in learning. The evolution of student learning, the emergence of mobile learning and the impact on teaching and learning are considered. Finally, the conceptual framework for this research occupies the space after the literature review and before the methodology chapter because the development of the conceptual framework guides the researcher and organises every part of the research project to help communicate the research as effectively as possible and essentially make it more understandable to the audience (Hall et al., 2013). The theoretical concepts (TAM2 and PMR) that form the underlying foundations of the research model and its dimensions are presented followed by the research questions, which are vital to the very core of this study

The review is based on a thematic analysis of peer-reviewed research literature collected over the period between 2011-2020 through the following databases: British Education Index, ERIC and ProQuest Education Journals. Articles have been collected from several peer-reviewed journals including but not limited to: British Journal of Educational Technology, Computers & Education, Learning, Media and Technology using search terms including keywords such as 'mobile learning', 'mobile devices', 'mobile technologies', 'TEL' 'e-learning', 'digital learning' and 'TAM'. Once identified by the researcher, a free online critical appraisal tool (CASP) was used to help identify the most useful articles. The researcher focused on research areas including theories of learning, mobile learning, e-learning, TEL, digital learning, technology acceptance models such as the TAM and Media Richness theory. The researcher also summarised and briefly described each article to try to extract the unique concepts of the article, central to a full understanding of the topic. A thematic approach to this was developed by the researcher around which this chapter was compiled.

2.2 ICT and Education

Information is continually created and knowledge is evolving in today's dynamic and interactive society (Lim et al., 2010; Scherer et al., 2019). And the transfer of information and acquisition of knowledge is vital in educational settings with its wide range of potential users of technology making the integration of technology in teaching and learning a key areas of significance (Granić and Marangunić, 2019). Technology has been blurring the lines between work, school, leisure and social activities for nearly two decades (Kadyte, 2004) and the evolving power and portability of mobile technologies are changing how the user works, learns and socialises by breaking down barriers of time, place and the potential to combine the physical and the virtual (Schuck et al., 2017). Kobus et al (2013) also highlight that effective use of information technology can contribute to higher national productivity growth. The European Union (EU) advised its member states to invest in digital technologies in education and countries in Europe, following advice from the Organisation of Economic Co-operation and Development (OECD) have significantly invested in ICT for education (Ferraro, 2018). Indeed globally teachers and lecturers are encouraged to integrate technology into teaching and digital competences are being integrated into curricula and assessment (Scherer et al., 2019).

Technology has become an essential component of society with enormous implications for work, communication, teaching, learning and daily social interactions (Hatlevik and Christophersen, 2013; Mistler-Jackson and Songer, 2000) where the advances in micro- and nano-technology, combined with the growth of the Internet and wireless technologies widening access to information and revolutionising life, work and society as a whole (Gillen and Barton, 2007; OECD, 2015). The rise of the Information Age and digital communications globally has seen an increased demand for more technological choice and quality in all sectors of society including education (Pegrum et al., 2013) with devices such as the smartphone becoming more widespread (Kim et al., 2019). Ferraro (2018) advocates the integration of ICT technologies in the classroom to improve student competency with technology and his study found that tablet or laptop use improved student performance in mathematic tests. Greener and Wakefiled (2015) predict that the rise in the use of mobile technologies across society as a whole means that teachers cannot afford to ignore student expectation for the integration of digital approaches in teaching and learning.

It is argued that technology is not a stand-alone entity but is best utilised as a bridge between teaching and learning in the form of both an educational and a learning technology (Amemado, 2014). TEL has become crucial to the provision of teaching and learning alongside online tools and services in the UK HE sector (Walker et al., 2016) and are presented as a method of improving current and emerging modes of course delivery challenging the established role of teacher and learner (Walker et al., 2018) across educational sectors. Rajasingham (2011) argues that ICT use in learning can provide for more interactive learning experiences due to the use of images which can promote learner retentive memory skills and Ekanayake and Wishart, (2015) highlight that it is now well recognised that new technology can introduce different approaches to science teaching and learning via a multitude of software and hardware.

However Walker et al. (2018) argue that the actual impact that technology has had on teaching and learning over the previous 15 years is questionable. Indeed their study of UCISA TEL surveys and case-studies (2012, 2014, 2016) on TEL developments across the UK HE sector found a schism between institutional assertions of the impact on teaching and learning and the actual reality of use. Dunn and Kennedy (2019) echo this view highlighting a mixed bag of research findings on the impact of TEL on learning outcomes, some showing little and others show no benefit; however, they also point to studies highlighting the positive impact of technology on student learning, engagement

and motivations. This again highlights the importance of this study investigating the use of mobile device for learning in an effort to understand students' perceptions and attitudes to the use of technology, and in this case specifically mobile devices for learning.

2.3 The Rise in Use of the Mobile Device

Portable technologies are one of the key changes in technology over the last decade (Jones and Healing, 2010), their use spreading at a ferocious pace with 95% of the world's population covered by a mobile network; and the majority of adults owning more than one mobile device (Crompton and Burke, 2018) and the number of new mobile subscribers estimated to reach 5.9 billion by 2025 (Hoi, 2020). Mobile, wireless technologies are multifunctional, networked and widely accessible by nature (Ala-Mutka, 2012) when used in conjunction with the internet, and a global positioning system (GPS) allow for instantaneous communication and access to content at a specific location (Ozdamli and Uzunboylu, 2015). Mobile technologies are portable so consequently move with the user (Merchant, 2012) and alongside features of mobile technologies such as email, internet access and audio/video recording have been firmly accepted as a key requirement in today's society for everyday life, social communications, work and learning (Hoi, 2020).

The past twenty years have witnessed the rise of mobile technologies and handheld devices such as the smart phone have changed communication and the exchange of information across society breeding an interconnectedness between users' work, social and leisure lives offering greater avenues of flexibility (Carroll et al., 2002; Lindberg and O'Brien, 2012; Luckin et al., 2005; Nayak, 2018). The growth of third generation and emergence of fourth generation telecommunication (3G and 4G) infrastructures in conjunction with wireless local area networks have evolved the potential and everyday use of mobile technologies pushing them to the forefront of agendas in educational establishments (Keegan, 2005). Along with the release of 5G technologies that are more intelligent and wireless mobile multimedia internet networks, can provide wireless communication without limitation (Patil and Wankhade, 2014).

Mobile device use is particularly prevalent among the younger population (Şad and Görktaş, 2014). In the UK nearly two-thirds of 16-34-year-olds regard their smartphone

as the most important device for accessing the Internet (Ofcom, 2017). Accessibility to ICT and the use of mobile devices have increased annually and the NI public are increasing time spent online, in 2014, 13.8 hours weekly was spent online rising to an average of 20 hours per week in 2017 (Ofcom, 2017). This increase has led to the increased availability and accessibility of many services across society including telephony, television or radio, video and banking services (OECD, 2015)**.** In the UK, 88% of adults have internet access at home (Ofcom, 2017). The growing consumption of technology has provided more people with the access to knowledge via mobile telephones and now they have become learning devices and de Waard et al's. (2011) study of the consumption of mobile telephones also highlights an increase in developing countries due to their affordability.

2.4 Mobile Device Use in UK education

Personal, mobile, internet connected devices, according to Bjerede and Bondi (2012) are essential for all 21st century students and are being used as learning devices and collaborative tools (O' Bannon and Thomas, 2015). Most students now carry a handheld device, capable of retrieving communication and information yet the full potential for mobile learning in education has yet to be fully realised (Keegan, 2005; Walker et al., 2018) and the mobile device is at the centre of this learning. An empirical study using part of the M3 evaluation framework (Vavoula et al., 2009) carried out by Ahmed and Parsons (2013) found evidence that use of mobile technologies can engage and promote deeper understanding in the science classroom, experimenting in real environments where students not only developed hypotheses but also strengthened critical thinking skills.

In order to satisfy learner expectations regarding the learning environment it has become essential for educational systems to consider the importance of mobile devices (Cochrane, 2010). While this may be the case there are many formal educational contexts were mobile device use is restricted or banned due to the potential disruptive influence that can be seen to go hand in hand with the use of handheld devices in learning thus posing a key for education (Merchant, 2012). The UK government is keen to tap into the advantages offered by the mobile education sector and have guaranteed funds to address this (Şad, and Göktas, 2014). The Higher Education Funding Council for England (HEFCE) has also sponsored 'Changing the Learning Landscape' in an

attempt to have 59 institutions strategically adopt the use of mobile learning and technology (Garcia et al., 2015).

Students expect access to resources and services at a time convenient to the user both on and off campus (Barnes and Tynan, 2007) which can be provided by the use of mobile technologies, allowing for greater flexibility and access to digital resources enhancing learning possibilities inside and outside of educational institutions (Cheon et al., 2012). In mobile learning mobile devices, including tablets and handheld computers, mobile telephones, smartphones and MP3 players, are being used in innovative and new ways to support learning. Hoi (2020) points to the growing number of research studies conveying the effectiveness of mobile assisted language learning (MALL) that supports the various facets of learning a language.

Students are driving the adoption of mobile devices at HE with 67% of 10,000 students surveyed agreeing that mobile devices are important to academic activities and success (Ng, 2012). The portability, availability of low cost options and communication features associated with the mobile device provides the potential to impact learning (Roschelle, 2003; Sung et al., 2016) and change the culture of the classroom (Lindsay 2016; Mifsud, 2003). Access to a mobile device such as the iPad can evolve the traditional classroom environment leading to an opening of more varied learning possibilities than had been previously attainable (Burden et al., 2010). Clarke et al.'s (2013) survey conducted using the Mosley Model circle time technique (Mosley, 1996) of year seven UK post-primary pupils concluded that 87% had positive attitudes towards the use of tablets in school for learning and engagement purposes.

The use of new technologies has provided opportunities for increased interactive and hands-on learning within real contexts increasing the opportunity for collaborative and cooperative learning (Chang et al., 2017; Price et al., 2009). The reduction in cost of emerging technologies and the recognition by educational institutions of the importance of learners' digital skills for the workplace have all aided the growth of mobile computing (Moran et al., 2010). Lim and Churchill (2016) argue that mobile learning is crucial to the further development of education at primary, post-primary, further and HE levels. And Ally and Prieto-Blazquez (2014) argue that mobile learning is necessary for today's society and a demand of students, so, it is important to facilitate these needs and do what is required to implement effective mobile learning.

Mobile technology offers the user increased choice and new flexible opportunities for learning providing scope to connect, engage and interact with others across time and location beyond the formal learning environment (Looi et al., 2010; Luckin et al., 2005; Sharples, 2006). Kennedy et al.'s (2010) qualitative investigation identified student benefits of using mobile devices to support studies at HE such as communication accessibility, convenience of access to resources, learning materials and distance learning opportunities. While UK educational institutions have been well equipped with ICT practices over the past decades, and the use of digital resources and e-education is well-established (Driscoll, 2010) and studies have highlighted how devices such as the smartphone can enhance the learning experience when used in combination with specific learning objectives; however, Tossell et al., (2015) argue that the current HE model offers limited opportunities to utilise these tools. Drennan and Moll (2018) argue that in order to be effective for learning, devices such as the iPad and applications must be embraced and hosted by the teacher to allow for active student engagement with the materials to facilitate learning.

There is an abundance of empirical studies advocating the benefits of the use of mobile digital technology for learning and how they have changed the social, cultural and cognitive face of education forever in the new opportunities they afford (Gillen and Barton, 2010). Geer et al.'s (2017) investigation, for example, into the impact of the iPad on classroom pedagogy to enhance student-learning utilising the SAMR model (Puentedura, 2009) reports increased student collaboration, communication and authentic learning experiences. However, research focusing on the integration of technology into the classroom argues that this does not guarantee that technology is understood and used effectively to enhance the user educational experience (Jackson and Songer, 2000; Pegrum et al., 2013). Much of mobile device literature focuses on applying a device to publish information using specific resources or learning applications. In order to effectively integrate technology for teaching and learning, HE institutions must understand student attitudes and perceptions of technology use, hence the need for ongoing research on mobile learning to determine the use and impact of the mobile device for learning both inside and outside of formal learning as the potential long-term effect of these device on HE teaching and learning is still to be determined (Gikas and Grant, 2013).

There are also recognised barriers to the use and integration of technology in the classroom such as potential disruption to student learning, lack of user motivation, and

functionality issues such as small screen size which can in turn affect teacher willingness to effectively integrate into the teaching and learning process (Gao et al., 2017; O'Bannon and Thomas, 2015). Greener and Wakefield (2015) highlight that academics are very much motivated to engage and integrate TEL in order to provide students with the highest quality learning experience although barriers such as confidence issues with technology can negatively impact this. There is also research arguing that there has been a shift in from for example smartphone usage to smartphone addiction ultimately impacting the users' personal life determinately. Nayak's (2018) study found that the smartphone adversely affect the users academic studies and argues that careful pedagogic thought must sit alongside technology integration in learning both inside and particularly outside the classroom.

We also read widely in literature of the technology advancements enabling mobile devices such as the smartphone that has the capability to be a powerful devices for learning with functionality exceeding the generics of simple calling and texting (Fuller and Joynes, 2015). However, if generic features of the mobile device can service and optimise student learning, outside the traditional teacher-led style classroom then these features cannot be dismissed as obsolete and may be a way for teachers to ease and contribute to the effective introduction of mobile learning into the classroom. For example Hayaati's (2013) using SMS (Short Message Service) to teach English idioms to English as Foreign Language (EFL) students found that SMS a viable, user-ready, cost effective vehicle for foreign/second teaching and learning.

2.5 A Theory for Learning – an on-going Debate?

It is crucial that 21st century pedagogy and the transmission of knowledge must adapt and education must pursue a higher, more sophisticated level of functioning (Knowles, 1996). Technology cannot be viewed, analysed or disseminated in isolation, it is part of an overarching education system. New technologies can provide a platform for learning with the opportunity for increased interaction and collaboration with peers and educators and hands-on active learning experiences (Jones et al., 2004; Price et al., 2009). The investigation of student attitudes and perceptions of mobile device use for learning means that associated pedagogical and learning theory implications must be addressed. Lan and Sie (2010) argue that factors such as the media richness of a technology, or in

other words the ability of a media to moderate shared understandings, affects learning processes and learner acceptability in the learning process also requires investigation.

The question of how learning occurs and the type of information accessed and how we can evaluate this information is of key consideration and importance to education. With the aid of sound methodological and pedagogical approaches, technology can increase opportunity and access to student-driven, self-directed, innovative, mobile and collaborative learning (Groff, 2013). Information and communication technologies have the potential to improve and modulate the traditional learning experience (Donnelly and O'Rourke, 2000). The important role ICT and online learning play in education should not be underestimated and can be utilised to connect the transition from second level into third level education (Valtonen et al., 2009).

Students learn in many different ways and there are various forms of learning that incorporate technology. There is an on-going debate regarding the value or impact technology can offer education and it is crucial that an agreed balance exists between pedagogy and technology before the benefits for both second and third level education can emerge. Bergdahl et al. (2020) argue that student engagement with technology enhanced learning, particularly in upper secondary level education appears to have been overlooked and this is required as the wide and growing use of technology in education does not guarantee effective blending into teaching and learning (Hauge, 2014). It is clear that technological foundations should not be a standalone facility and should create an efficient link between teaching and learning (Amemado, 2015). ICT is effective only when its strengths and weaknesses are appreciated and it is integrated alongside sound pedagogy (Motiwalla, 2007).

2.5.1 What is learning?

The process whereby learning occurs is a complex and much researched phenomenon (Liaw et al., 2007). The historical paradigm debate for learning and instruction has existed for decades (Alessi and Trollop, 2001). Boyd and Apps (1980) describe learning as the acquisition of information, knowledge and skills alongside changes in learner behaviour and the formation of opinions and views. Learning, according to Pritchard (2014) is the acquisition of more knowledge or finding out how to do something. Harasin, (2000) argues that learning occurs in small groups in an instructional setting where students collaborate and interact. Successful learning can occur based upon a clear

understanding of student learning characteristics, which affect what and how pedagogies are used in teaching at HE level (Laurillard, 2002). Pedagogical and learning theory research must be addressed for mobile learning to be successful (Goh and Kinshuh, 2006).

One of the greatest challenges for HE institutions in the 21st century is understanding how students learn. The government is calling for digitally literate graduates with transferable skills who can positively contribute to the economy (Pegrum et al., 2013). The evolving knowledge around the science of learning is revealing a deeper understanding of how people learn (Sharples et al., 2016). There has been a consistent edge to movement in the relationship between technology and pedagogy in order to achieve an equilibrium in online learning (Donnell and O'Rourke, 2007). Mobile technologies are presenting a direct impact on 'pedagogy and learning theories' (Craig and Van Lom, 2009). It is imperative that the different roles played by both technology-based communication and non-technology forms of communication for effective teaching and learning are identified (Roschelle, 2003).

2.5.2 A learning theory for the mobile age?

A theory of learning for the mobile age is a hotly debated issue and there is a need for correlation between it and integration of mobile technologies and how we might draw on existing theories of learning to help us evaluate the most relevant applications of mobile technologies in education. Any study on mobile learning is incomplete without marking the variations between mobile learning and other kinds of learning. In the creation of instructional environments behaviourism, cognitivism and constructivism are all broad learning theories. However, these theories, for the most part, were developed during the period when the learning process had not yet been impacted by technology so have limitations in the digital age (Siemens, 2004).

Mobile technologies are impacting traditional learning theories, the shape of the traditional learning paradigm and influencing how learning theories are being applied in education. Naismith et al. (2004) argue that traditional learning theories can and must be changed to suit the advancement of m-learning. Kim et al. (2017) highlight the growth in interest, both academic and practical in mobile learning as a distinct type of learning. The development of a learning theory for mobile learning must explore the fact that a volume of learning can occur outside the traditional, formal classroom-based settings where

students collaborate, formulate ideas and communicate in daily activities (Sharples et al., 2005).

However Kafyulilo and Keengwe (2013) argue that technology appropriately integrated into science and mathematics learning alongside constructivist pedagogical approaches can enhance collaboration, communication and interactions among students via the vehicle of active learning. The emergence of constructivism from proponents such as Piaget (1896-1980) proposed that learning occurs when an individual can actively construct their own understanding based on experiences (Alessi and Trollip, 2001; Harasim, 2000; Pritchard, 2014). Craig and Van Lom (2009) argue that mobile technologies and constructivist theory are an evolving paradigm impacting on how new and emerging technologies are integrated into education. Constructivist learning theory demonstrates how a traditional learning theory can impact upon a new dynamic technology (Craig and Van Lom, 2009). Constructivist theory unleashes the potential of mobile technologies as an autonomous learning tool where the student can take control and independently access resources and materials (Pritchard, 2014).

Different varieties of constructivism have emerged over the 21st century due the growth in use of information communication and digital technologies in education, such as social constructivism, which reflects on the social aspect of knowledge constructed where students are required to build on their own understanding based on different perspectives in real-life tasks and acquired through interactions and collaboration with others (Sharples et al., 2005; Stone, 2003). Social constructivism adds another layer to the constructivist approach where learning opportunities not only occur inside the traditional classroom setting but also between peer communication and interactions, in social situations and at home (Cakir, 2013; Pritchard, 2014; Sharples et al., 2005; Wake et al., 2007) where the use of the mobile device can enhance and complement the learning model (Motiwalla, 2007; Pelgrum et al., 2013). These dynamic, communities of practice are empowering learners to source, identify, manipulate and analyse existing knowledge in order to problem solve, communicate knowledge and information collaboratively playing a greater role in the teaching and learning arena (Brown, 2005).

Iqbal and Qureshi (2013) addressed that theoretical frameworks of mobile learning have to be designed in a manner that can help by integrating important technologies along with learning scenarios. Learning engages situated learning practice whereby the interactions of communities of practice sharing common aims learn from each other

(Cuban, 2014; Şad, and Göktas, 2014) and learners can essentially create their own knowledge out of the benefit of past experiences such as social collaborations and interactions with others, the environment cues, and the social culture that the community develops and maintains (Brown et al., 1989). It enables more constructivist learning using authentic contexts, enables just in time rather than just in case learning and blurs boundaries between formal and informal learning (Burden et al., 2012; Gikas and Grant, 2013).

Situated learning is widely embraced in mobile learning literature, which is owed primarily to the location-aware function afforded by mobile technologies. Research conducted by Hwang and Tsai (2011) has portrayed the fact that situated learning that has been supported through handheld devices and mobile technologies can help towards eliminating the vacuum between practical problem solving and the formal school setting. This also helps potential learners to interact along with the real environment. Jones et al. (2013) identify the possibilities of mobile devices for situated learning as they allow the learner to identify resources within the learning context and support communication, collaboration and interaction among learners and teachers.

The theory of connectivism, develop by Downes and Siemens (2008) was ignited by the emergence of the digital revolution and is used to explain how new opportunities have been created by internet technologies and how people today have better opportunities to learn and share information across the Web and amongst themselves (Transue, 2013). Connectivism was essential created as a learning theory for the digital age, a successor to behaviourism, cognitivism and constructivism (Kivunja, 2014). The key feature of connectivism theory is associated with the perspective that a lot of learning can take place across peer networks that take place online, for instance, in an attempt to support the learning and sharing of students. Also, according to the connectivism theory, a teacher guides the students to information and provides answers to key questions. Social networks, wikis, blogs and massive open online courses (MOOCs) delivered via the vehicle of a mobile device enable connectivism inside and outside of the classroom setting where users can create personalised interconnections with others in formal and informal learning environments (Garcia et al., 2015). Critics argue that not enough empirical evidence yet exists to accept connectivism as more than a pedagogy because it cannot sufficiently inform learning (Bell, 2011). However, even as a pedagogy,

connectivism can widen opportunity and potential for learning using mobile devices alongside Web 2.0 technologies outside of formal learning contexts**.**

2.5.3 The development of electronic learning (e-learning)

The growth and development of the Internet, an ideal vehicle for the delivery of learning materials along with the use of the world wide web and email in education led to the emergence of e-learning (Bworn, 2005; Shim et al., 2007). Electronic learning is the use of online resources in both distance and conventional learning contexts and is often referred to as online or web-based learning (Smart and Cappel, 2006). Forsyth et al. (2010) describes e-learning as 'learning environments created using digital technologies' which are in the main networked, collaborative, delivered via Internet technologies (Liaw et al., 2007). The predicted rise of e-learning can be traced as far back as the late 1990s (Bell et al., 2004) with a shift towards the learning paradigm stabilising by the mid-2000s (Bayne, 2015) and by the year 2010 Forsyth et al. (2010) declare that e-learning had changed the face of HE.

The learning theories or pedagogical principle that rule educational practice and in the case of e-learning instructional design were developed in conjunction with three learning theories; behaviourism, cognitivism and constructivism. Skinner's behaviourist model in the 1950s and his work on programmed instruction are often referred to as the beginnings of computer-based training which then evolved into computer aided instruction in the 1970s (Woollard, 2007). Since the 1970s ICT has progressively become more personalised to the user and their needs (Motiwalla, 2007). Harasim (2000) argues that a shift in paradigm towards online education occurred in the 21st century with changes becoming increasingly significant as educators realised the potential for communication in teaching and learning settings. The Open University over 50 years ago initiated a model to support online learning that has been praised, recognised for academic excellence and assumed across the globe (Keegan, 2005; Mason, 2000). The 1980s and 1990s saw the uprising of online learning in the form of computer-based learning regularly founded on the constructivist and cognitive approaches to learning.

Computer-based learning gave rise to the increasingly digitised forms of communication which emerged through the invention of the World Wide Web in 1992 and the development of distance education. It used technology to provide learning opportunities for learners free from time and place constraints. The tutor, learner and the learning

population although all separate were connected through a technology-based communication and learning environment (Keegan, 2005). This coupled with the growing popularity of the constructivist view of learning and more educators acknowledging the potential to easily access diverse learning materials and opportunities outside of the traditional classroom setting witnessed the emergence of the e-learning revolution (Gaskill and Mills, 2014). E-learning technologies can be used to support and complement the student learning experience and aid the development of communities of practice both on and off campus (Bell et al., 2004).

As technology integration has increased in education, e-learning as a whole has significantly grown and is interchangeable with online and web-based learning (Smart and Cappel, 2006). Online learning is foundationally based on group communications and interaction, a key building block in education and learning (Cakir, 2013; Harasim, 2000; Kuo et al., 2014). It is argued by researchers who have integrated Media Richness Theory (MRT) with TAM (Liu et al., 2009; Sun and Cheng, 2007) that one of the key characteristics of e-learning is its ability to mix different media such as text, picture and video in the creation of multimedia learning. It is important that educational organisations have an insight and understanding of student attitudes to the use of multimedia learning materials delivered via mobile devices and if it affects user intention to use a device. Kakai and Cooper's (2003) study highlights the need for more empirical studies combining MRT with other theoretical approaches to help understand user acceptance of new and emerging technologies. The importance of online learning to HE in the facilitation and service of student needs and to fulfil the expectation of a world-class learning experience cannot be underestimated (Garrison and Kanuka, 2014). Park (2009) and other empirical studies (Farahat, 2012; Saadé et al., 2007) confirm TAM to be a valid theoretical model to help understand and explain intention to use e-learning.

2.5.4 The emergence of mobile learning

The past few decades have experienced revolutionary progress in the field of information and technology and many sectors across society are enjoying benefits as a result of this. Likewise, as in every other field, the field of education is also passing through a phase of incredible transformation (Transue, 2013). Gedik et al. (2012) declare mobile learning technology as the key driver for learning in the 21st century, with an abundance of articles focusing on the similarities, connections and differences between e-learning (web-based computer assisted learning), w-learning (wireless networks available on campus) and m-

learning (any-time, anywhere learning through the use of mobile devices) (ECAR, 2005). The extension of e-learning to incorporate mobile wireless devices offers an approach to learning, which Khaddage et al. (2015) describe as a sub-space, in which learners can participate interactively in learning in a more flexible and location-free way (JISC, 2005) through the use of sophisticated wireless technologies (McLean, 2003). Park et al. (2010) highlight that although there are many definitions of mobile learning the common dominator is the use of electronic devices such as the Smart Phone or tablet in the design of learning activities and are not necessarily mobile, just portable used with the traditional classroom setting.

However, Woodhill (2010) disagrees and argues that mobile learning is not the regurgitation and minimisation of e-learning materials so they can be accessed on a smaller handheld device. Mobile learning can break-down access barriers for learners and compliment e-learning providing potential learning opportunities unrestricted by time or place (Goh and Kinshuk, 2006; Kim et al., 2017). The fundamental approach must be different in order to take advantage of the new opportunities offered by mobile technologies (Sad and Goktas, 2014) to learners through appropriate learning strategies and the creation of engaging, self-directed learning experiences that fulfil the user (Sharples, 2006). Mobile learning can empower students who can create their own content and record personal learning outcomes by increasing access to dynamic learning opportunities, learning resources, activities and opportunities (Corbeil and Valdes-Corbeil, 2007; Drummond, 2007; Wakefield et al., 2018).

Distance education research laid the foundations for the emergence of mobile learning through the premise that distance education technologies are accessible and flexibly available to the user (Keegan, 2005). Mobile learning is driven predominantly by the ease and flexible access to learning possibilities through a mobile device and is argued to be the fastest growing aspect of ICT in education (Pelgrum et al., 2013). Robson (2003) views mobile learning as the expansion of a movement that started with the introduction of the graphing calculator in 1986, which changed the very nature of classroom pedagogy. M-learning is described as a subset or different approach to e-learning enabled and facilitated by the emergence of mobile and wireless devices, the Internet and wireless networks (Motiwalla, 2007; Parsons and Ryu, 2007). Although an exact definition for m-learning is difficult to affirm, there is a growing abundance of credible and empirically tested definitions available in literature (Crompton and Burke, 2018;

Sharples, 2007; Terras and Ramsey, 2012). M-learning means more than having access to a computer, it is access to the Internet and resources via interactive technologies at anytime from anywhere across multiple contexts (Moran et al., 2010; Shareples et al., 2007).

M-learning presents exciting potential both for student learning purposes and as a new emerging area in educational research (Brand et al., 2011). Mobile learning is founded on learning supported by mobile devices that give the user control and enables interactions and collaborations between users due to its accessible connectivity (Fernandez-Lopez et al., 2013). M-learning provides learners with an opportunity to learn in a manner tailored to suit the individual, unbound by location or time, across contexts through interaction and support from mobile ICT (Lam and Tong, 2012; Sharples et al., 2005). Lai and Chang's (2011) study using the TAM model concludes that media richness played an important influencing factor on user acceptance of e-book readers due to the potential for more dynamic content mixed with various multimedia. Mobile learning has demonstrated the potential to attract young people to learning, personalise information, maintain engagement and support learning and further development (Attewell, 2005; Lai, 2019). Mobile learning in the form of game-based learning (GBL) has become increasingly significant because of mobile devices such as the iPad and tablet computers and can provide engaging and more complex learning environments by increasing student interaction with learning materials (Chen et al., 2016; Downes, 2010).

Of course mobile devices can mediate learning offering portability, connectivity, accessibility, engagement, 24/7 access where resources and information can be learner tailored, in formal or informal learning settings. However Terras and Ramsay (2012) argue that for positive learning outcomes to emerge from use that it is imperative researchers delve into user attitudes and behaviours (Kim et al, 2017). Al-Emran et al. (2018) in their systematic review of the TAM in m-learning contexts argue that in information services research circles empirical studies into the determinants of m-learning acceptance is an ongoing and critical issue. Pimmer et al. (2016) agree with this and Crompton and Burke (2018) call for more systematic knowledge regarding the use of mobile technologies in higher education.

2.6 The Impact of Technology Changes on Education

Post-primary and HE establishments are an information communication technological work in progress with an increased and ever growing flexibility and choice for both students, educators and support staff. 21st century teaching and learning in HE has become more personalised, learner-centred, interactive and collaborative. Over the past forty years, along with the development and use of the Internet, there has been a growth of networked learning opportunities with communication and interaction at the core (Jones and Healing, 2010). And the support and use of technology in teaching and learning has evolved and advanced year on year (Cakir, 2013). According to Boulton and Hramiak (2014) changes in technology in the educational sector worldwide are occurring at an unprecedented speed with technology such as the smart phone regarded as one of the tools that can be used to enhance learning (Evans, 2014). So it is imperative that that future studies investigating user acceptance of technology should include other variables to adapt with current trends and ongoing changes in organisations (Venkatesh and Davis (2000).

One of the key objectives of education is to provide students with the required skills, knowledge and attitudes to participate and successfully contribute to society (Mifsud, 2002). Mobile technologies in conjunction with for example access to the Internet (Thomas et al., 2014), Web 2.0 technologies and ongoing innovations have introduced new ways of thinking irrevocably changing the way students learn and interact (Jones and Healing, 2010; Song, 2007) and can potentially support learning across many subjects (Al-Emran et al., 2018). This has prompted educators, academics, and practitioners such as learning technologists to create educational applications and learning strategies using mobile technologies in for example collaborative and self-directed learning activities (Hoi, 2020). Although it is argued in literature, that there is a gap in empirical research on the impact handheld devices have on m-learning in educational contexts (Baig, 2006; Lorenzo, 2013; Sheng et al., 2005) and Kim et al, (2017) point to research indicating the limitations of using the mobile device in learning.

Educause (2016) report that students view technology not only as a vehicle of engagement in learning and an enricher of the learning experience but as key to academic achievement. Various web-based multimedia tools, learning resources and social networking platforms have been developed and utilised in education to enhance

student engagement (Hange, 2014) which has organically led to student calls for m-learning integration across education (Şad and Göktas 2014). Mobile technologies can provide easy access to online resources, applications such as online simulations, applets, wikis, blogs, all of which allow students to build, collaborate and communicate information (Moran et al., 2010). Kruger and Bester's (2014) study found that lecturers agreed that tablet use not only helped improve the quality of teaching and learning but aided transformative teaching practices in the classroom. Although, it is vital that educational institutions must recognise the increasing relevance and effects of technology and the widening of customised opportunities for teaching and learning (OECD, 2010); however, mobile learning use in formal education is arguably in the pilot stage, still to fully flourish and showcase its potential benefits for society as a whole (Kobus, 2013). Al-Emran (2018) level an important reminder that understanding the end user (which includes students) acceptance of m-learning is vital to success and delivery of quality teaching and learning.

2.6.1 Use of handheld technologies in post-primary education

Mobile devices can support a learner-centred environment where the user has interminable opportunity to dissect and understand content, communicate interactively and collaborate with peers and tutors (Gikas and Grant, 2013; Rosman, 2008). Mobile learning literature details the varied benefits for users including increased access, interactivity and personalised learning opportunities. Ahmed and Parsons (2013) argue that the interaction and engagement opportunities offered by mobile technologies at post-primary level are changing the face of education and the traditional classroom.
There is a growing amount of empirical evidence demonstrating the importance and effectiveness of digital learning for children at school.

The tablet computer as a learning device is increasingly trialled in schools across the world to explore benefits for learning purposes (Clarke et al., 2013) to personalise learning opportunities using applications which offer a variety of activities and access to the Cloud for sharing of resources (Geer et al., 2017). Schools are also using technology such as games and interactive software to engage, communicate and improve knowledge and skills across different subject areas. For example Wong and Hsu's (2014-2016) study used collaborative game-based learning to support Chinese character learning. In November 2013, mathematics software, aligned with the National Curriculum, was introduced across 124 UK schools integrating ICT into mathematic

lessons, introducing key mathematical concepts using dynamic representations and simulations (Hoyles et al., 2013). More than 20 Scottish primary and post-primary schools have adopted game-based learning alongside a powerful pedagogy to create engaging, digital learning environments for the development of student digital, collaboration and problem-solving skills (Groff, 2013).

The emergence of the smartphone with on-demand services alongside cloud computing mean that users can now access information and communicate anytime, anywhere inside and outside of formal learning settings (Price et al., 2009; Looi, 2010). Alongside applications such as MS Office 365, devices are increasingly used across all fields including education enabling electronic collaboration (Maican et al., 2019) which can reduce distance and time barriers, opening up opportunities to enrich student interaction and learning (Chang et al., 2011). While this provides the learner access to open, instantaneous resources and information, communication and collaboration potential with peers and teachers; however, the potential barriers to learning which may arise as a result are also highlighted in literature. This includes the risk of the inherently disruptive nature of the mobile device in conjunction with access to social and communication tools digitally distracting the student and potentially infringing student learning (Greener and Wakefield, 2015; Verhoeven et al., 2016).

In order for mobile learning to exist, the essential elements of mobile technology including both hardware and networking applications play an important role. Thus the limitations of mobile device use outside of formal learning settings can also arise in terms of limited or unreliable network and broadband access which can be a major constraint causing various challenges and accessibility issues for the mobile learner (Srivastava, 2012). Without an effective network and broadband facilities, the teacher/lecturer and/or the user cannot transfer information from one place to another (Nayebi, et al., 2012) reducing the potential for learning via the mobile device. The use of applications on different operating systems can also cause challenges in the creation of content for mobile learning. It can be argued that the ongoing advancement in software applications for mobile telephones alongside increased student ownership of smartphone technologies and introduction of touchscreens and gestural imput, educators can create smartphone content for learning using Tool Book (Dhaheri and Ezziane, 2015) which may help alleviate this issue.

While mobile learning has provided a platform through which users can technically study anywhere and at any time, technical issues can also be a problematic both inside and outside of formal learning settings causing significant challenges for teaching staff in second and third level education and could potentially hinder the learning process. It must also be noted that EU law (EU, 2016) and UK Public Sector Bodies Accessibility Regulations (Cabinet Office, 2018) state that all digital content created for teaching must be accessible and be easily navigated and understood by a wide range of users such as students who have any disability or accessibility requirements. The development of accessible web content by educational institutions needs to include content with appropriate technical and structural settings, site operability and compatibility with current and future tools (W3, 2018) which may present technical, time and financial implications which must also be considered.

Ng and Nicholas (2013) argue that there is a need for a model of sustainability for handheld device use in schools, which addresses the reconciliation of formal learning with mobile and informal learning. With focus on post-primary students it is also argued that such ease and flexibility of access to mobile technologies can lead to excessive use potentially compromising the health and safety of users (Sarrab et al., 2012) and present potential safeguarding issues for those using mobile technologies under the age of 16 years such as access to inappropriate web material and communication, for example, grooming, bullying or age-inappropriate content (Subashini and Kavitha, 2011). And Lai and Hong (2015) again reinforce the importance of understanding user attitudes and intention to use technology in education and suggest there is a lack of UK-based research investigating student attitudes, to mobile technology use at post-primary level for learning, communication, socialising and interaction both inside and outside of formal learning contexts.

2.6.2 Use of the mobile device at HE level

HE establishments are by their very nature reluctant to change; however, a new age of information, technology and student expectation have led to a revisit of the undergraduate student experience offering innovative ways of delivering content through the vehicle of learning, communication and information technologies (Garrison and Hanuka, 2014). Computers and the Internet have transformed how HE institutions can provide students with online digital educational services. There has been much technological change at HE level from the movement towards a new breed of university

course using computer conferencing in the 1980s to educational networked programs which came to the fore in the 1990s. The use of digital tools in pedagogy is becoming increasingly important at HE level (Hung et al., 2010; Wake et al., 2007). Most UK universities, as far back as 2004, were using some sort of technology to develop forms of e-learning (Donnelly and O'Rourke, 2007) and now rapid advancements in technology alongside widespread use of mobile technologies, mobile learning, year on year, is gathering momentum (Hsieh and Tsai, 2017).

Higher education is regarded as an ideal location to embed mobile learning, in part due to the fact that the majority of adults own more than one mobile device; however, mobile learning has yet to become a conventional method of learning (Kim et al., 2017; Crompton and Burke, 2018). Many institutions are utilising VLEs to track student use and interactions with resources (Anagnostopoulou and Parmar, 2010) and are progressing towards a wholly wireless campus, alongside an incline in mobile technology use within an increasingly competitive HE market (Amemado, 2014). Kennedy and Dunn's (2018) large scale qualitative study also illuminates that TEL in third level education has been positively adopted by institutions. The newest genre emerged in 2012 in the form of MOOCs (Amemado, 2014). MOOCs emerged because of a desire to extend beyond the traditional education delivery methods (Tossell et al., 2015) and enable the accessibility of a large variety of resources to engage millions of learners (Gaskell and Mills, 2014; Sharples et al., 2015). And although MOOCs are considered beneficial and desirable by educators, adoption of MOOCs has not been as popular as expected (Long and Sian, 2019).

Brand et al.'s (2011) design based research (DBR) (Brown, 1992; Collins, 1990) using the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) variables found that the use of the iPad had a positive impact on student attitude to mobile learning and on student results. However, it must be noted that Nguyen et al.'s (2015) review of research investigating the use of the iPad in HE found that current research is still in its infancy and while HE is eager to integrate technology and explore perceptions of use there is a need for further larger scale and longitudinal studies. So while mobile technologies and digital technologies are providing support, help and have been shown to enhance teaching and learning in education (Hauge, 2014) and arguably have the potential to revolutionise HE (Jones et al., 2004); however, there are empirical studies arguing that mobile technologies have little or no effect on student learning

performance (Kin et al., 2017; Park et al., 2010; Volk et al., 2017) or can positively contribute to student learning retention across formal or informal environments (Dunn and Kennedy, 2019; Sandberg et al., 2011). Mobile learning is still at an early stage of development (Sánchez-Prieto et al., 2019) and the successful integration of mobile learning to facilitate and support conventional learning is a challenge that must be faced by educational institutions to successfully compete in 21st century society.

2.7 Challenges faced by HE institutions

TEL has become crucial to the provision of teaching and learning and online tools and services in the UK HE sector (Walker et al., 2016). Jackson and Songer (2000) argue that the increased use and influence of technology does not guarantee effective use by learners in educational settings. Learning cannot be streamlined to occur purely through digital and mobile technologies but effective and successful mobile learning activities should be integrated with other learning activities (Vavoula et al., 2006). HE institutions face the challenge of integrating a seamless flow between formal and informal learning through the vehicle of mobile technologies, other forms of networked interaction and new technologies that originated in social communication arenas (Campbell and Kwah, 2010; Lim et al., 2010).

Learning environments have changed dramatically along with learners who have evolved from passive to interactive, collaborative learners (Taylor, 2007). The use of the mobile device is still in the primal stages at HE level (Gikas and Grant, 2013) and there is a lack of specific pedagogical guidelines on the use of technologies such as the tablet PC to improve student-learning opportunities (Nguyen et al., 2015). Corbeil and Valdes-Corbeil (2007) advise that educators adapt traditional styles of teaching and learning and embrace mobile technologies. Looi et al. (2010) and Pegrum et al. (2013) advocate a change in pedagogy from teacher-centred to student-centred because of the mobility and functionality of handheld devices which allow for active participation in the learning process. While a number of useful, quantitative and mixed method studies exist exploring student perspectives, use and experiences with digital technologies (Beckman et al., 2014; Wai et al., 2018), there is a need for further evidence that can be used as a guide to assist the effective integration of digital technologies into education (Beckman et al., 2014; Cheon et al., 2012).

ICT can only be successfully utilised for educational purposes if effectively integrated with both strengths and weaknesses addressed to evaluate the potential benefits for teaching and learning contexts (Motiwalla, 2007; Song, 2007). It is crucial that the potential and limitations of mobile devices are understood and considered in order to assess potential benefits for educational institutions. It is also important that obstacles to the successful integration of digital technologies in education are acknowledged and addressed (Hauge, 2014). Cloud-based m-learning enables information sharing in conjunction with collaborative, flexible and constructivist learning and although it has not reached its full potential in schools, use is increasing and gaining momentum (Chang et al., 2017). Chang et al. (2017) completed a randomised control trial experiment (RCT) (Oakley, 1998) in a Taiwanese university investigating the effects of cloud-based m-learning on engineering design students' creative performance and found a significant positive impact on creative design and the creative process through utilisation of collaboration and constructive learning opportunities.

Students are demanding flexible, quality and accessible learning opportunities at HE level (Amemado, 2015). According to Burden et al., (2012) users are becoming increasingly dependent on mobile, connected wireless devices which is changing the dynamics of learning both socially and institutionally at a rapid pace. The successful integration of technology is largely dependent on user acceptance (Davis, 1993) and this is in the context of a HE arena where student expectations of quality access to supportive learning resources and materials is continually increasing (Conole et al., 2006). Students integrate networked and digital technologies into everyday life so educational institutions need to maximise and develop the effective use of wireless technologies (Jones and Healing, 2010). The strategic role that technology must play in the governance of HE institutions emphasises the key role it has assumed and will continue to play in the continuing advancement and success of academic institutions. There has been a steady rise in the use of ICT and handheld devices inside and outside of formal learning; however, student use of technology for learning outside of formal education remains under-researched (Thorpe et al., 2012).

Every year across UK universities, students from a variety of academic, socio-economic and cultural backgrounds begin their academic career in HE, which can be a time of confusion and a journey into the unknown (Ramsden, 1992). The numbers making this transition between 1960 and 1990 increased by 800 percent (Hamley and MacBlain,

2010). The transition from post-primary to HE level can be a difficult period for undergraduate students, not only adjusting to new demands academically but also socially with many living away from home for the first time which presents new challenges (Gray et al., 2013). This can often result in student dropout and under achievement because of an unsatisfactory student and learning experience (Lowe and Cooke, 2003). There is a need for more research to increase understanding in the area of student technology participation so that university administrators and technology service units can tailor technology to suits its students (Margaryan et al., 2010).

Students in HE have an expectation of increased access and use of mobile technologies for learning (Fuller and Joynes, 2015) and the prominence of Web 2.0 technologies have changed expectations of the undergraduate student body who now demand a more student-centred environment than ever before (Barnes and Tynan, 2007). Gikas and Grant (2013) argue there is great potential to expand the third level student learning experience by combining mobile technologies with social media. Amemdao (2014) highlights the importance of multifaceted flexible technologies, which allow for asynchronous or synchronous communication, moulding active learners who collaborate, engage, reflect and articulate during academic studies. The growing emergence and use of e-learning 2.0 tools challenge not only traditional learning pedagogies, but they can alter current user experiences and inevitably institutional cultures through potential to empower the user. There is a need for more empirical research investigating potential benefits and effectiveness of the non-prescribed use of mobile technologies across learning settings (Guy, 2010). However, this is still a new and evolving area where more research is required to investigate the potential impact on the student experience. The potential beneficial and effective use of evolving technologies is dependent on successful integration into current learning contexts within established pedagogical practices (Lim et al., 2010).

The growth in technology use at primary and post-primary level education will impact the HE sector by an ongoing rise in undergraduates starting university who have already used mobile technologies for learning purposes (Fuller and Joynes, 2015). HE establishments face the challenge of integrating technology into the student learning experience to promote student engagement and ultimately secure student academic success (Chen et al., 2010). Technology must now offer more than an enhancement to learning, it must serve learning in educational contexts (Bayne, 2014). There is a

requirement for more empirical research focusing on the benefits of technology regarding technology benefit for users and its role in supporting student success (Bayne, 2014; Castano-Munoz et al., 2014; Landry et al., 2006).

HE establishments aim to successfully cultivate and innovate education, embrace learning technologies and adapt in changing social, political and cultural environments (Laurillard, 2004). Vogel et al. (2009) argue it is essential that student-learning environments at HE level are flexible and mobile. The emergence of increasingly sophisticated mobile and wireless technologies have instigated a new direction in education directly impacting provision, integration, pedagogy and learning theories (Craig and Van Lom, 2009). Ball and Levy (2008) argue that staff acceptance of technology can cause issues and challenges for organisations in the implementation of technologies for teaching and learning. Teachers in the classroom setting must initiate and invest in the use of digital technologies to ensure successful integration to enable a meaningful and effective use of ICT in formal education (Perrotta, 2013). This means that training and support for teachers and tutors alike in the pedagogical use of technology to support teaching and learning cannot be ignored (Goodwin, 2012; Higgins et al., 2012).

2.8 The Mobile Device – a Technology to Support Learning

Every student will have a personal preference to the type of mobile device and application use and differing attitudes toward security and privacy so it is important that institutions identify efficient and effective support for 21st century students (Allison and Bowen, 2011). While there has been an increase in investigative research on student use of ICT (Burden et al., 2012; Clarke et al., 2013; Hosein et al., 2010; Lai and Hong, 2015; Yang, 2012), much of the recognised knowledge on younger peoples' use and attitudes to mobile devices originate from the US. Attewell and Hughes (2010) identify a need for collective research analysing student perceptions to the use of ICT across the educational sectors (school, lifelong and HE). Research into the area of teaching and learning with technology is key to providing a deeper understanding and aid the successful integration of mobile technologies in education (Goh and Kinshuk, 2000).

The majority of undergraduate students are accustomed to anytime, anywhere access to technology (Barnes and Tynan, 2007). Students view user convenience, control and the ability to connect with other students as some of the key benefits of technology use in education (Caruso and Kvavik, 2005). Technology can encourage interactivity and collaboration with others, so the user can learn through participation (Smart and Cappel, 2006). Educational institutions now must provide learners with collaboration, problem-solving and self-directed learning skills to succeed as a 21st century citizen and digital technologies has the means to engage learners with various types of multimedia content and activities for self-directed learning (Groff, 2013). Different learners use different technologies in varied ways and mobile learning is not about the delivery of content to a mobile device but the ability to effectively and successfully integrate and utilise new learning contexts and spaces (Attewell and Hughes, 2010).

Mobile devices can offer personalised learning opportunities through a range of varied functionality such as storing audio, video and text, geotags, social media tools and applications which can be successfully integrated into the learning environment with a variety of learning approaches (Keengwe and Bhargava, 2013). Wireless devices can provide the user with asynchronous access to not only learning opportunities, materials and institutional services but can also support the development of user digital literacy skills required for the workplace and enhance communication in the classroom (Price et al., 2007). Universities must now make strategic uses of ICT in the support of teaching and learning. An ECAR study of 10,000 students found that technology encourages engagement with tutors and other learners, enhancing learning experiences and promotion of self-directed learning (Brooks, 2016). Institutions must be reliably informed of technologies perceived usefulness and ease of use to enable effective and efficient integration into class and study activities and that the user has a strong intention to use them (Edmunds et al., 2012).

Krause (2005) highlights the importance of technology for student-centred learning through the creation of tailored resources and online learning communities. The handheld device such as the tablet can be utilised to engage, sustain student interest, support learning through for example task based learning and work collaboratively in problem-solving activities (Volk et al., 2017). Technology is used in education to change or enhance traditional face-to-face teaching and learning and to make instructional resources more efficient while meeting the needs of diverse learners allowing users to

be at the very centre of their own tailored learning environment (Vogel et al., 2009). Mobile learning allows for authentic personal learning experiences on the move, where learning is possible across contexts and environments (Gikas and Grant, 2013). Users of mobile devices are at the centre of a unique learning environment with access to information and communication specific to individual needs (Parsons and Rye, 2007; Vogel et al., 2009).

Digital technologies are changing the face of education particularly at HE level and how knowledge is constructed, transmitted and processed (Bergdahl et al., 2020; Gillen and Barton, 2007; Sharples, 2005). Mobile technologies can overcome the limitations of previous technologies though instantaneous communication and collaboration access to peers, teachers, tutors and course materials wherever and at any-time (Bannon and Thomas, 2015; Kobus et al., 2013; Motiwalla, 2007) and potentially help increase student interactions with course content (Kuo et al., 2014). Mobile devices can also provide flexible technology-enhanced approaches to education in, for example, collaborative learning communities via email, discussion forums, instant messaging (IM), blogs and Really Simple Syndication (RSS) (Cochrane, 2005).

The use of advanced computing and IT in education has been continuously increasing resulting in more confident and independent learners and an increase in the use of mobile devices by the student for learning (Sharples, 2007). However, Volk et al. (2017) also highlight studies using technology to enhance student achievement in the mathematics classroom that present little effect, mixed results and no effect on student performance. Research into the use of technology in specific fields is required to guide and support technology integration where it is most effective for the user (Liu et al., 2010). If the culture in post-primary and HE sectors integrates and promotes technology use then this has the potential to contribute to learning if controlled and used with guidance (Gubernick, 2014). In order to effectively engage technology for learning in the HE sector, the transitional attitudes to mobile devices of upper-sixth post-primary and first year undergraduates can provide vital data and knowledge required to facilitate the effective and successful implementation of mobile devices and technologies for teaching and learning.

2.9 Challenges for the Mobile Device and as a Tool for Learning

Sánchez-Prieto et al. (2019) suggest that two factors can create barriers to successful technology integration, the first is external which includes training and technical support. These include the battery life of the device (Dhaheri and Ezziane, 2015; Wong, 2012) because when a mobile telephone for example is used continuously its battery drains quickly. Older batteries tend to drain more quickly than new batteries but even a new battery will start draining quickly if it is used excessively, because the more a battery is charged the less life it has, so the more it is used, the faster it will drain (Traxler, 2014). The quality of the users mobile telephone (Lai et al., 2016) in for example, recording of sound or videos or the screen and key size could cause problems in the reading and transferring of information which may impact learning particularly outside of formal learning.

Other technical issues such as connectivity and the reliability of mobile networks have the potential to affect mobile learning inside and outside the formal classroom which if not reliable can potentially provide challenges and constraints for user learning (Srivastava, 2012). Suki and Suki's (2011a) case study identified negative attitudes to the use of mobile devices for learning such as cost limitations and device usability. Screen size also has limitations associated with mobile learning, although there has been limited research in the area of device screen size. Verhoeven et al. (2016) report that there is a greater possibility of understanding and learning when the screen size is larger than 2.28 inches. However, such issues become a major concern merely when the instructional designer treats mobile learning in comparison with desktop learning (SAIDE, 2008; Song, 2007). And Dhaheri and Ezziane (2015) note that these issues are being addressed by for example the increase in availability of quality cost-effective mobile devices and the availability of touchscreen and gestural input devices.

Time constraints, lack of student skills and VLE incompatibility have emerged as limitations from Boulton and Hramiak's (2014) predominantly qualitative and interpretive study on the use of blogs as a student engagement tool for pre-service teachers. The the lack of innovative use of devices such as the tablet when a more conservative approach is adopted can be due to time constraints and lack of training and professional development This leads in very neatly to Sánchez-Prieto et al. (2019) second factor,

namely internal, which refers to teacher perceptions of technology and teachers' beliefs about pedagogy, a resistance to change which in Kim et al's (2017) was found to be a predictor of intention to use technology. Scherer's (2020) study highlights that the technology integration in the classroom can present challenges for the teacher largely due to the rapid changes occurring in technology which may require training and knowledge updating. Teacher perceptions about the disruptive potential in the classroom which may distract and in turn affect student learning negatively is widely documented in mobile learning literature (Kim et al., 2019). A lack of strategy on how best to integrate mobile technologies in a pedagogically sound approach can affect teacher attitudes and accessibility for use in their teaching (Greener and Wakefield, 2015). Lam and Tong (2012) argue, based on their study findings that best practice, meaningful activities in conjunction with student guidance and instruction on use in the classroom can help alleviate teacher concerns and confidence in technology use for learning.

2.10 The Mobile Device – a Technology to Support Communication and Collaboration in Learning

Communication is not only central to teaching and learning but to education as a whole (Sharples, 2006). Communication aids the processing of differences and the understanding and the interpretation of experiences (Sharples, 2005). Communication services and electronic collaboration opportunities offered by the mobile device are at the very core of the importance of the mobile device (Dobbin et al., 2011). Maican et al. (2019) define collaboration as equal input and contribution into a project by building on each other's ideas. Face-to-face communication is not always the richest medium for communication effectiveness, which ultimately should lead to a change in user understanding during learning (Dennis and Valacich, 1999).

Campbell and Kwak (2010) hypothesised that mobile technologies are an add-on to, for example, traditional face-to-face communication increasing opportunity for contact with others, unconstrained by time or place. The new generation of learners use varied information communication and collaboration tools and platforms for a range of purposes including communication, active learning and socialising (Liu et al., 2010; Valtonen et al., 2009). Waycott et al.'s (2010) qualitative findings in their mixed method approach study highlight communication as a major reason as to why users choose mobile technologies for everyday activities.

Communication and interaction play a pivotal role in the learning process and wireless technologies have improved communication avenues because of the ease of availability, flexibility of function, convenience and potential to provide dynamic learning experiences through real-time collaboration (Baig et al., 2006). The very nature of mobile devices such as the ease of accessibility for the user provide a flexible and unique method of communication with access to information and materials. Communication opportunities offered by wireless learning tools have been widely adopted and accepted by the younger generation, offering endless potential for learning in all sectors of education (ECAR, 2005). Scott et al.'s (2017) mixed method sequential explanatory design approach investigating mobile device use by doctors and medical students in a clinical learning setting found communication a key feature of use.

Tossell et al.'s (2015) empirical research using a naturalistic approach found that over 65% of all applications launched on a smartphone by HE students identified as communication or social based such as SMS messaging and email. Handheld devices have the potential to change student communications, interactions and behaviours with peers and are essential in the provision of academic and administrative information (Motiwalla, 2007). Mobile technologies can support dialogue and other communications between teachers and students, playing an important role in the effective and efficient use of online technologies to enhance learning (Nesta, 2012). Gikas and Grant (2013) using a qualitative case-study approach (Merriam, 1998) highlight the importance of ease and accessibility of anytime connectivity with peers and tutors to student use of a mobile device for learning. Nguyen et al.'s (2015) systematic literature review of previous studies investigating iPad use in HE found evidence that users find the iPad useful for communication, such as receiving feedback from other students and tutors.

Communications online can increase interaction between student and teacher, self-confidence and a sense of autonomy over learning (Donnelly and O'Rourke, 2007). Liu et al.'s (2005) TAM study concluded that the most media rich presentation types generated increased levels of user perceived usefulness confirming the importance of media richness in the acceptance of e-learning. Electronic communication media such SMS, IM, and email along with the growing ownership of portable, handheld devices have increased and enhanced communication opportunities between students and others (Parsons and Ryu, 2007). There are empirical studies highlighting students'

positive attitudes towards the use of mobile devices and SMS for interaction and learning purposes (Motiwalla, 2007). Microblogging sites such as Twitter are regarded as useful for quick communication between students and tutors (Shah et al., 2016). Garcia et al.'s (2015) case study highlights that teachers regard blogs as a useful medium of communication for students. The user can communicate both inside and outside the normal and traditional classroom setting, sharing ideas and thoughts unbound by time and place restrictions in a less formal context. Lindsay's (2016) mixed method cross-sectional survey on pedagogical approaches using mobile technologies found that one of the most frequent approaches to m-learning activities involved communicating with other learners.

Reynolds et al. (2010) argue that employment of wireless technologies would help towards increasing the notion of collaborative communication and learning. Maican et al. (2019) argue that collaboration presents the solution to many education and research challenges. The theoretical notion of collaborative learning emphasises the fact that learning can be promoted by the means of social interaction and within the sphere of teaching and learning, the concept of collaborative learning has arisen by the means of digitally supported work of collaborative learning (Motiwalla, 2005). Kukulska-Hulme and Viberg (2018) define collaborative learning as learning through communication and working together to accomplish a task or problem-solve and their review of 1241 mobile collaborative language learning studies highlight the value of collaborations in learning. Handheld devices such as the smartphones can help support and enhance collaborative learning through the means of communication (Drennan and Moll, 2018; Torstein and Dye, 2007) such as small group collaborative tasks and networked micro-blogging. The UK government highlight that implementation of mobile computing across a collaborative environment of learning and development allows for the evolution of learning models that could potentially fulfil the needs of all users, both teachers and students (Fuller and Joynes, 2015).

2.11 Formal and Informal Learning - Inside and Outside the Classroom

The World Wide Web and wireless technologies alongside personal mobile devices work collectively to connect, inform and increase the possibility of interactive communication

anytime, anywhere (ECAR, 2005). In order to satisfy learner expectations regarding the learning environment, educational institutions must consider the importance of the mobile device (Cochrane, 2014). Mobile devices can be used to access learning materials, create learning content and are an effective communication platform accessible inside and outside of formal learning (Garcia et al., 2015). Mobile devices in conjunction with other technologies have the potential to facilitate seamless learning spaces between different settings; for example, between school and home (Jones et al., 2013; Looi et al., 2010) via flexible access to an array of digital resources (Cheon et al., 2012), opening up learning opportunities outside the classroom walls (Şad and Göktas 2014). Bergdahl et al. (2020) also highlight that the use of digital technologies outside the classroom can help provide social support, build connections with other students thus benefiting the student experience (Gray et al., 2013).

Students expect ease of accessibility and convenience of access to learning resources in conjunction with face-to-face traditional learning using mobile and wireless digital technologies (Chen et al., 2010). Waycott et al. (2010) highlighted the use of technologies to integrate personal and study contexts thus blurring the line between formal use inside and outside of educational institutions. Mobile wireless devices can be used seamlessly any time from any place between formal and informal learning contexts (Cuban, 2014). Handheld devices can increase learning opportunities for the learner as learners can access materials and information outside of the formal learning environment empowering learners in a more informal learning setting such as at home or on the train (Jones et al., 2013). Burden et al.'s (2012) evaluation report on the impact of the iPad on teaching and learning in Scottish primary schools found that use not only increases and expands technology access but also provides for regular access to a more diverse range of learning activities. This increased collaboration among students and teachers, which encouraged the formation of learning communities, blurred the lines between formal and informal learning.

Social networking technologies are an integral part of students' lives to communicate, interact and share information both inside and outside of formal learning settings (Looi et al., 2001). Technologies such as Web 2.0 in conjunction with mobile devices have introduced new possibilities in the support of teaching and learning via the vehicle of e-learning where users can not only contribute actively and share content but edit and read existing content (Lim et al., 2010). Groff (2013) argues that first order innovations such

as Web 2.0 technologies, already used by learners for activities outside of school, have the potential to enable collaboration, communication and interactivity in all learning environments. Mobile technologies and Web 2.0 can also support different forms of learning such as 'informal' and 'semi-formal' in different settings (Jones et al., 2013).

Mobile technologies as part of a networked environment offers varied ways to explore learning where teachers and students can participate in social practices interactively and collaboratively in the pursuit of information (Roschelle, 2003). Informal learning has the potential for greater flexibility than ever before (Parkin, 2011). Lindsay's (2016) study concurs with other researchers in that informal classroom learning is playing a greater role in classrooms across Europe. Crossover learning can take place in informal settings such as museums and afterschool clubs and Incidental (unplanned or unintentional) learning can occur during participation in an unrelated activity on a mobile device (Sharples et al., 2015) providing learners with authentic and engaging opportunities for learning. Mobile devices can offer potential for innovative informal learning opportunities outside of the traditional classroom setting (Sharples, 2007).

Informal learning can include activities such as browsing the world-wide web or learning in leisure activities where the student can use a mobile device to access resources or communicate with others in conjunction with formal learning activities (Gikas and Grant, 2013). Schuck et al. (2017) argue that informal learning can be further divided into two separate spaces, a 'Second' and 'Third' space where mobile technologies can extend and increase learning opportunities. The 'Second Space' is the occurrence of informal learning in, for example, museums while 'Third Space' learning can take place in more social settings such as in a café or can be a metaphor for the virtual learning space. Carroll et al.'s (2002) research of 16-22-year-olds using an appropriation of mobile telephones model (MPA), an extension of theory planned behaviour (TPB) (Ajzen, 1991), found that mobile devices blur the boundaries between learning, social and leisure activities. Valék and Sládek (2012) emphasise the importance of technology in the creation of both formal and informal social learning groups or communities where participants can share, collaborate and discuss information.

Attewell and Hughes (2010) highlight literature focusing on the lack of connection between the use of technology in schools for teaching and learning and students' use of technology socially and personally. Students are at ease with technology use outside of

the formal learning environment taking ownership of learning, blending virtual with face-to-face, formal and social collaborations and interactions. However, within the formal learning environment technology, often led by tutor requirements, can lead to a schism and disconnection between uses in the different contexts. Looi et al. (2010) argue that the gap between the use of mobile technology in formal and informal settings must be closed to formulate a connected learning environment where learning can occur individually or in a group across contexts.

Song (2007) called for more research analysing individual student attitudes to use of mobile devices in an unstructured and free manner across contexts for learning purposes. Tossell et al. (2015) highlight that there is still a research gap on how mobile devices are used naturally across classes, settings and time periods without a specific application. The ongoing emergence and impact of handheld and digital technologies alongside the current gap between learning experiences inside and outside of school means that it is imperative that the student is equally involved with other stakeholders in the development of new learning environments to enhance learning opportunities. Hosein et al. (2010) caution that there is a time and a place for living and learning technologies so an understanding of learner attitudes is important in the development of learning environments which incorporate the use of new and emerging mobile and digital technologies for effective learning.

2.11.1 The impact of 'Push and Pull' technologies

Mobile technologies can offer students the possibility to engage in learning outside the classroom and is a useful method to promote students' access and interaction with facilities beyond the boundaries of the educational institution (Drummond, 2007). Mobile technologies are increasingly useful as an informal learning platform in healthcare and education in the provision of alerts, guidance and language learning opportunities (Traxler, 2005). The blurring of boundaries between physical spaces, different types of knowledge, informal and formal learning contexts has increased and diversified how user experiences, interactions and communications can be integrated into learning opportunities. In the US, initiatives such as 'ActiveCampus', a project designed and used on a campus, attempted to connect the university student to campus life. This project consisted of a mobile computing application used in a facilitating role to sustain, complement and increase accessibility and communication within the campus community both on and off campus (Griswold et al., 2002).

Wireless devices such as the smartphone have increased the relevance and potential for push and pull technology. Mobile connectivity research contends that a mixture of push and pull instruments are required in content delivery to aid successful m-learning and benefit the student experience (Motiwalla, 2007). Context-aware mobile applications can respond to a users' location where users can find resources based on physical location or active maps that change according to the users' locations (Kadyte, 2003). Pull communication is user requested information such as email technologies (Brüstel and Preuss, 2012).

Push-based services are where the server pushes a message or information to the client without user request via, for example, a SMS message which can be used to interact and communicate with the user (Brüstel and Preuss, 2012). SMS messaging has great potential to offer the delivery of learning content (Song, 2007). Push messages can help welcome students and encourage participation in student life through welcome messages, informative video-files and useful information relating to academic and social life on campus (Drummond, 2007). THE University is currently implementing a cloud-based VLE that has push-based functionality so students can automatically receive personalised academic and social related notifications from university academic and support staff (THE University, 2018).

The use of wireless technology can push information out to students such as assignment due dates, timetabling and coursework information (Liaw, 2009). However, the use of push technologies is not unique to university; post-primary schools across NI are using SMS messaging to inform parents/guardians about closure dates on snow days and other school related information such as dates for the calendar. In addition, many schools are using push technologies such as Seesaw to disseminate homework or to share classwork, achievements or video snippets of drama with parents on a weekly basis. Even some nursery schools are communicating with parents throughout the day to update them on their child's development, eating habits or playtime.

Stone (2003) highlights successful UK initiatives where SMS messaging was used for revision support in a Merseyside post-primary school and in Kingston University to support first year undergraduate learning. The University of Pretoria successfully developed interactive and instructional SMS messaging for learning support purposes

including interactive multiple-choice quizzes, and questions with feedback (Saide, 2008). The use of context-aware mobile computing has been largely led by the museum and gallery sector in the provision of information for visitors on exhibitions based on the visitor's location (Naismith, 2006). The 'MOBILearn' project successfully trialled context-aware mobile technology using devices such as tablets or Personal Digital Assistants (PDAs)S at the Nottingham Castle Museum and Gallery in Nottingham, UK, which provided information and guidance depending on user's location, route and time at the location (Parsons, 2011). And 'MyArtSpace' used in three UK museums was developed to bridge school learning with learning in the museum using a mobile telephone linked to a personal web space (Vavoula et al., 2006).

Oliver and Georke (2008) urge caution in the use of location-based tracking technologies as the user may view this as an intruder and mechanism for control over personal and social life. Sharples (2007) agrees that children are opposed to the infringement of school on their personal life and it is essential that educators, parents and policy-makers not only understand new technologies and the interactions they afford but allow the correct balance when using these technologies in conjunction with formal education. There is a requirement for more research investigating student attitudes to the use of context-aware technologies and its potential to aid student learning by acting as a bridge to learning between formal and informal learning settings.

2.12 Digital Literacy Skills and the Mobile Device

The digital world is greatly transforming how we learn, communicate and socialise, so it is imperative that technology-rich learning environments are developed and embraced (Groff, 2013). Lai and Hong (2015) enquire whether the integration of mobile technologies and applications can potentially address the digital capability and proficiency levels of the current generation of technology users born after the year 1985. The current generation are not all confident users of new and emerging technologies and do not participate in the creation of personalised communications with others through Web 2.0 activities (Attewell and Hughes, 2010). Digital literacy can pose challenges for the user of Web 2.0 in learning contexts as students need adequate proficiency to effectively and efficiently use the tools (Bower, 2016; Terras and Ramsey, 2012). Valtonen's (2009) study using the theory of reasoned action and planned behaviour (Ajzen, 1991) of 337 Finnish high school students' readiness to adopt online learning

highlight students' lack of knowledge about online learning alongside using social media platforms and Web 2.0 technologies.

Technology has become such an integral dimension in society where digital literacy has become essential to education, teaching and learning (Mac Callum et al., 2014; Valék and Sládek, 2012), where policymakers and educationalists recognise the importance that digitally literate graduates with transferable skills can compete competitively and contribute positively in a technology driven economy (Choi et al., 2019; Pelgrum et al., 2013; Valék and Sládek, 2012). An alarming 50% of university students believe that their university degree course adequately prepares them for the digital workplace (Newman and Beetham, 2017). The use of mobile devices alongside integrated applications and platforms can provide the user with experience to help promote and develop digital literacy in formal learning and informal learning contexts such as libraries, at home and in online spaces (Meyers et al., 2013). The use of mobile, wireless and learning technologies in the development of student digital literacy skills requires an understanding of student attitudes to the use of emerging technologies in learning both inside and outside of the classroom.

Digital literacy is an increasingly important area for the 21st century student and HE establishments are facing increasing pressure to provide globally relevant high quality courses in conjunction with graduates with essential digital workplace skills (Daniel, 2015). Approximately 90% of all new jobs require proficient digital skills; however, some UK universities and colleges are failing to embed digital skills as part of the curriculum which can improve learner experience and staff professional development (Newman and Beetham, 2017). Lee's (2008) extended TAM study emphasises the importance of PR on user intention to use technologies highlighting the need for effective user support and training in the use of technologies.

OECD (2015) highlight the importance of students' ability to communicate and interact through this increasingly wide digital landscape as it will affect contributions as citizens to the social and economic aspects of society. Digital competence can be defined as the users' aptitude in the use of ICT to access, evaluate, and understand information and communication with others online using a variety of digital tools (Ferrari, 2012). Digitally literate students have a varied skillset such as problem–solving, reflective thinking, collaborative and technical skills that contribute to success in dynamic and changing

learning environments. Digital competence is one of eight key competences for lifelong learning according to the European Union (Ala-Mutka, 2011) and many countries are implementing strategies and programmes to increase digital competency of students in schools (Hatlevik, 2013). The Creative Learning Centres work collaboratively with schools across NI offering support and training in digital literacy through the creative use of media and technology to help increase student engagement and achievement and prepare for future working life (Future Classrooms, 2015). Strategy groups were also established by the Department of Education, NI as early as 1996 to prepare and expose students to new technologies.

Historically the concept of a digital divide originated as a gap between those with access to digital technologies and those without, a partition by race, gender and income in the use of technology (Bolt and Crawford, 2000). A subsequent digital divide emerged at the turn of this century between computer and internet use regarding range and quality of use, the information versus recreational divide (Wei and Hindman, 2010). Digital natives a term popularised by Prensky (2001), and other terms such as the net generation, generation Y and generation X were those used to describe the generation of digital technology users born after 1980; the technology-savvy student with flexible and mainly uninhibited access to information and communication technologies both inside and outside of the educational environment (Hosein et al., 2010; Lorenzo et al., 2007; Prensky, 2001). The term digital immigrants emerged with reference to those who encountered technology at a later age (Kennedy et al., 2010).

Over the past decade the existence of ‘digital natives’ versus ‘digital immigrants’ has been widely discredited in literature (Kirschner and De Bruyckere 2017; Lai and Hong, 2015). Kennedy et al.’s (2010) study did not find a large gap in technology knowledge between the termed ‘digitally savy’ (the student) and the ‘digital immigrants’ (the tutor) and Kruger and Bester (2014) argue that not all students entering HE have the same level of proficiency in technology use. Jones et al. (2010) argue that although this is a more technologically integrated society the so-called ‘net generation’ with a presumed high level of technological skill does not exist. There has been a number of reports highlighting that not all young people from the termed ‘net generation’ are proficient in the use of digital technologies (Attewell and Hughes, 2010). There is a lack of empirical evidence and theoretical approval demonstrating that the so-called ‘Net Generation’ have an enhanced understanding of technology for academic and information gathering

purposes (Bennett et al., 2007; Kennedy et al., 2010). In fact as a result of their study, within the Transmedia Literacy Project (European Union), Masanet et al. (2019) suggest a new term entitled 'digital apprentice' as they found that users presented different transmedia skills and at different levels of skills.

It is well documented that before entering third level education many students have used digital technologies regularly, particularly through the use of social networking technologies and IM (Lai and Hong, 2015). Lim et al. (2010) purport that although use of social networking sites are part of this generations daily routine, they have not yet successfully been proven to be useful for learning purposes. Many students also utilise a variety of applications and are at ease with the use of personal wireless devices; however, many are not familiar with software and applications used for teaching and learning (Lorenzo et al., 2007). UK HE institutions have integrated and employed ICT at varying levels (Caird and Lane, 2015). This can be due to a wariness of embracing the use of technology in the classroom (Liaw, 2007). It is vital that educational establishments support users in the acquisition of digital literacy not only to enhance the student experience but for their future careers (Lorenzo et al., 2007). It has become increasingly important that teachers and lecturers adopt and use in a pedagogically sound way, information and communication technologies to enhance digital skills essential in the 21st century workplace (Boulton and Hramiak, 2013).

Lorenzo's (2016) study found that deep learning can only occur using mobile technologies when learners possess digital literacy skills. However, if the student is hesitant to engage with new technologies, then this will have an impact on the development of student digital skills (Thompson, 2013) and Pechenkina and Aeschliman (2017) are suspicious of the existence of a breed of digital native learners with adequate and effective digital literacy skills. The empirical evidence gathered in this research study provides important data on upper-sixth and first year undergraduate student attitudes and understanding of digital skills related to the use of mobile device and technologies for learning.

2.13 Content Creation using Mobile Technologies

Information at its core has changed because its source and creation is no longer solely in the hands of the expert (Lorenzo et al., 2007). Web 2.0 technologies defined as a web

application that remove the obstacles between information creation and absorption allowing for open, personalised, dynamic communication and interactions over the World Wide Web between learners and others anytime, anywhere (Garcia et al., 2015; Lorenzo, Oblinger and Dziuban, 2007; Oliver and Goerke, 2008;). This has altered the very nature and fundamentals of information, where essentially, easily accessible digital information and content can be created by anyone (Lorenzo et al., 2007). Terras and Ramsey (2012) and Merchant (2012) argue that mobile Web 2.0 has the potential to narrow the gap between structured class-based formal and opportunistic non-class based informal learning and become a vital part of teaching and learning.

Web 2.0 technologies are readily available; these online technologies allow the user to produce, edit and collaborate with others (Bower, 2016). The emergence of media streams such as podcasting, video streaming and other applications such as wikis, blogs and social networking technologies have become increasingly used in educational contexts (Boulton and Hramiak, 2014). The array of multifunctional features such as electronic portfolio, easy to access and use of collaboration tools facilitate socialisation, ease of communication and empower learners to become active contributors to course content and the learning process (Amemado, 2014; Lim et al., 2010). Saeed and Sinnappan's (2010) study which utilised an extended TAM integrating MRT found that PMR had a significant and positive impact on user acceptance of Web 2.0 technologies.

Web 2.0 technologies have the potential to alter the direction of e-learning and are increasingly used for teaching and learning in HE (Lim et al., 2010). Thompson et al. (2014) emphasise the body of research that presents the potential social web technologies can offer student learning at HE level. Web 2.0 technology tools such as blogs have the potential to alter the way learning can occur (Garcia et al., 2015). They are being increasingly used to empower users and improve the learning experience where users can interact, collaborate and increase knowledge through the creation and editing of content material over the World Wide Web (Cakir, 2013; Gillen and Barton, 2007).

Living technologies such as Web 2.0 technologies used for informal communications via social networking sites and learning technologies can be utilised for learning. A relationship between the two is also possible, for example, the use of a blog for learning and personal use. Hosein et al. (2010) argue that greater use of Living Technologies at

third level can aid the transfer of skills required to make successful use out of learning technologies. A survey carried out by Gikas and Grant (2013) highlights the usefulness of social media tools, for example, Twitter used in conjunction with mobile devices can facilitate interactive discussion about course material and can occur at the same time as a live presentation or lecture. Social media growth in popularity in the last ten years can be argued to have framed this digital generation's use of technology with the majority of users under twenty years of age using social networking tools to communicate and interact with others (Katz et al., 2013). A variety of surveys and reports highlighting students' use of social software and Web 2.0 technologies for communication and sharing information have been emerging over the past ten years (Attewell and Hughes, 2010).

The term social media emerged in 2005 after the term Web 2.0 and allows students to interact and collaborate with each other and tutors through social networking, creation and publishing sites (Gikas and Grant, 2013). Evans (2014) argues that current students are more acquainted with social media above other recent technological developments. Social media introduced new directions in online information exchange among users through applications in the form of social networking sites such as Facebook, LinkedIn and Twitter. At the time of writing, Facebook had over 2 billion users and Twitter 328 million users. This also includes media sharing sites such as YouTube, Flickr and bookmarking tools that allow the creation and publication of content such as Wikis and blogs. Evans's (2014) study on the use of Twitter for enhancement of teaching and learning found that Twitter increased student engagement in the learning process. Microblogging in m-learning is one of the most recent social phenomenon of Web 2.0 technologies which enables the user to share information, increase interaction and communication supporting the learning process via tools such as Twitter and Yammer (Shah et al., 2016).

There is little doubt that the ongoing emergence of new technologies mean that students in HE now experience an interactive and dynamic learning environment where a variety of technologies can be used to support learning. Brand et al. (2011) argue that in order to make successful use of mobile technologies, whereby they improve the student experience, they must be used innovatively which requires further studies of user perceptions of use and intention to use for learning. Traxler (2018) argues that in the past ten years practice and policy communities nationally and internationally have

become prolific users and owners of handheld devices with an understanding of how useful and beneficial the potential is for teaching and learning; however, as a result the research community has been playing a diminishing role.

2.14 The Research Framework

2.14.1 Introduction to the adopted research model

It has been established in Chapter 1 and in the literature review that the use of mobile technologies in post-primary and university education is a wide and varied topic, difficult to define, and research into user attitudes and use of mobile technologies at second level education is limited (Bjerede and Bondi, 2012; Burden et al. 2010; Valtonen et al., 2009). HE establishments also face many challenges and are now working across a global market where the need to exploit IT for communication, teaching and learning, independent of place or time is growing. It is important that HE establishments learn about cross sector adoption and acceptance of technology, to aid successful implementation (Straub et al., 1997).

The re-examination of the literature helped in identifying prospects of mobile device use in learning at both post-primary and higher education by examining capabilities and limitations of mobile technologies. Thus, the research problem, which is to assess student attitudes and perceptions of mobile devices for learning and how these technologies are perceived as a tool to potentially support learning both inside and outside of formal education, was addressed under the factors determined by an extended technology acceptance model (TAM2). The conceptual framework developed for this study aims to facilitate readers' understanding as to how the research problem was addressed by reviewing the extant literature, but to also assist the researcher to interlink findings from the reconsideration of the literature with the on-ground findings.

Measuring user acceptance of technology is a way of determining the user intention toward using new technologies in their learning. This research study primarily utilises the significant contributions of the extended TAM2 (see Figure 2.1) which includes PR and PMR as external variables, to investigate and inform the relationship between user attitudes, satisfaction, and intention to use information technologies (Liu et al., 2005; Park, 2009). King et al.'s (2006) meta-analysis of the technology acceptance model (TAM) applied in various fields highlights the robustness and power of the model in the prediction of user intention to use technology. Media Richness Theory is also incorporated into the extended TAM, and described in literature as a valid and robust external variable for the investigation of student attitudes and intention to use mobile

technologies (Lan and Sie, 2010). Media richness has a key role in the determination of new and emerging media acceptance and use (Shim et al., 2007).

2.14.2 Theory and models – user acceptance of technology

Technology acceptance theories and models aim to convey the concept of how users may understand, accept and use new technology. The acceptance of technology has been shown to be a requirement for successful implementation of IT, thus determinants of user acceptance can contribute to enhancing design and use (Davis, 1989; Mathieson, 1991). User attitudes and perceptions and how these influence acceptance is a well-documented area of research (Davis et al., 1989; Venkatesh, 2003). There have been multiple explanatory frameworks proposed, tested and validated over the years to model the relationship between user acceptance of technology and its determinants (Hoi, 2020). These include, but are not limited to the Innovation Diffusion Theory (IDT) (Rogers, 1993), the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). These models have emerged from well-established psychological theories, including the Theory of Reasoned Action (Fishbein, 1979) and the Theory of Planned Behavior (Ajzen, 1991). Although Scherer and Teo (2019) in their editorial to a special section on TAM remind us that as a result of growing number of studies using models such as TAM and UTUAT, contradictory findings have emerged due to generalisability and comparability issues associated with the models.

The Theory of Reasoned Action (TRA) (Ajzen and Fishbein 1980; Fishbein and Ajzen, 1975), based on social psychology, originally proposed that user intention to perform a behaviour has a major influence on individual behaviour (Ball and Levy, 2008) and intentions are determined by users' attitudes and the subjective norm concerning the behaviour (Fishbein and Ajzen, 1975). Attitude consists of beliefs about the consequences of performing the behaviour compounded by user evaluation of the consequences and subjective norm is a combination of perceived expectations from others along with intention to comply with these perceived expectations (Fishbein and Ajzen, 1975). TRA has been utilized to explain and predict behavioural intentions across many general settings, not designed for a specific behaviour or technology (Momani and Jamous, 2017).

The Theory of Planned Behaviour (TPB), complemented TRA and was developed by Ajzen (1991) adds the construct of perceived behavioural control and argues that behavioural intentions are determined not only by user attitudes and subjective norms but also by perceived behavioural control (Ajzen, 1991, Valtonen et al., 2009). This means that in the cases whereby the person has an incomplete control over the behaviour the behavioural intention is not the exclusive determinant of behaviour. This theory extends TRA as it includes not only voluntary but also mandatory settings. In this study the TPB was embedded in items measuring the PR construct within the TAM2 model adopted by the researcher, this included perceived ability of resources, skills, opportunity for performing a given behaviour and perceived availability of support in intention to use mobile technologies (Lai et al., 2012).

The Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Vantakesh et al. (2003) integrated eight models of technology acceptance and was designed to increase understanding of the acceptance of technology and specifically designed to determine college administrators' perceptions before the implementation of a new technology. The model consists of four constructs to represent technology acceptance, performance expectancy, effort expectancy, and facilitating conditions (Lynch et al., 2009). The effects of these determinants are hypothesized to be moderated by respondents' gender, age, experience, and the voluntariness of technology use (Williams, Rana,& Dwivedi, 2015). Moran et al. (2010) used the UTAUT model to examine student acceptance of mobile computing devices including tablet computers. Van Raaij and Schepers (2006) argue that UTAUT is less parsimonious than, for example, TAM because it's high R^2 is only achieved when moderating key relationships with up to four variables, combined with problematic grouping and labelling of items and constructs because of the combination of a variety of disparate items to reflect a single psychometric construct.

2.14.3 The technology acceptance model (TAM)

Central to this research study is TAM (Davis, 1989; Davis et al., 1989), an influential extension of Fishbein and Ajzen's (1975) TRA (Park, 2009) used to predict behaviour. The TAM has gained considerable prominence and is arguably one of the most widely accepted and influential models of user acceptance in IT research (Davis et al., 1989; Gibson et al., 2008; Behrend et al., 2011), particularly as it is specifically designed to be applied to computer use and according to Davis et al. (1989) and Ventakesh (2000) is

transferable across time, contexts, samples and technologies. The models adaptableness, transparency, soundness and parsimony are also considered advantages to TAM (Al-Emran, 2018; Sánchez-Prieto et al., 2019). The TAM also offers a simple specification in structural equation modelling frameworks (Scherer et al., 2019). It has validity in the prediction of intention to use (IU) information technologies as it offers potential to explain variance IU and it is extendable to e-learning contexts and academic settings (Alenezi et al., 2010; Landry et al., 2006; Saadé et al., 2007; Szajna, 1996). The successful integration of technology in education does not occur automatically but is steered by acceptance of the technology, comprised of attitudes and beliefs such as perceived usefulness (PU) and perceived ease of use (PEOU) (Scherer et al., 2020).

The TAM comprises core variables of user motivation (i.e., PEOU, PU, and attitude (ATT) toward technology) and outcome variables (i.e., IU and technology use). TAM suggests that when a new technology is presented to the user, the user decides when and how they will use the technology based on a number of factors: PU which is defined as the extent to which a person believes that using a particular technology will enhance job performance or learning and PEOU is defined as the extent to which use of a system would be free from cognitive effort (Davis et al., 1989; Park, 2009).

Within the basic constructs of TAM, PU and PEOU constructs are the factors most commonly referred to and are considered key variables that directly or indirectly explain the outcomes (Marangunić and Granić, 2015). This reflects their influence in determining user acceptance of technology, and shows the importance of TAM as a simple, predictive, and robust tool to assess the acceptance of IT by users. PEU and PU, directly relate to another TAM core variable, ATT toward technology (Scherer et al., 2020). ATT can be defined as person's positive or negative assessment of an object/behaviour and refers to an individual's willingness to participate in a specific behaviour (Sánchez-Mena et al., 2017). These variables are often accompanied by external variables explaining variation in perceived usefulness and ease of use such as norms and computer self-efficacy (Cheon et al., 2012; Park, 2009; Park et al., 2012).

Of course the TAM has undergone various modifications and extensions over the last few 30 years including (TAM1, TAM2, TAM3, Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Venkatesh & Bala, 2008; Venkatesh and Davis, 2000; Venkatesh, Morris, Davis, & Davis, 2003; Teo, 2011; Teo et al., 2015). The extended technology acceptance model

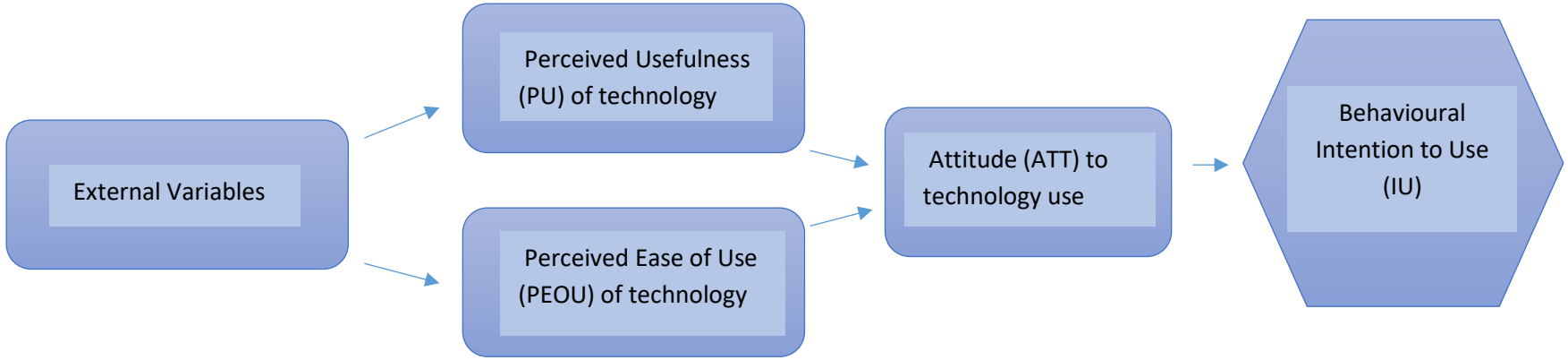
(TAM 2) (Venkatesh and Davis, 2000), extended from TAM, was developed in the IT field to explain PU and PEOU) incorporating constructs such as social influence and cognitive instrumental processes (Venkatesh and Bala, 2008). A further extended model TAM3, developed by Venkatesh and Bala (2008) posits three relationships that were not empirically tested in Venkatesh (2000) and Venkatesh and Davis (2000). These are that experience will moderate the relationships between PEOU and PU; computer anxiety and PEOU and PEOU and IU. Venkatesh and Davis (2000) found strong support for TAM2 and Venkatesh and Bala (2008) found support for TAM3 in longitudinal field studies conducted at different organisations and although this study had a longitudinal element in Phase II, a cross-sectional study was the only viable option for the researcher in Phase II.

TAM can provide the basis for tracing the impact of external variables on internal beliefs, attitudes and intentions which can deliver an understanding of what influences PU and PEU (Legris, et al., 2003). However, the limitations of TAM assume that there are no barriers to the use of IT (Mathieson et al., 2001). While the TAM model has been validated in past empirical research studies it has been argued in literature that PEOU and PU are unable to sufficiently capture all the required complex elements required in the prediction of user interactions with and in the acceptance of technology (Edmunds et al., 2012). PU and PEOU can be affected by external variables which can directly or indirectly affect learners' intentions (Venkatesh and Davis, 1996; Liu et al., 2010). Research is required to investigate determinants of PU to increase understanding, so interventions can be designed to increase user acceptance and use of IT (Venkatesh and Davis, 2000).

Empirical studies such as Park et al. (2012) declare confirmation of the acceptability of TAM in the explanation of mobile learning acceptance. However, the sheer number of studies investigating acceptance of technology has resulted in varied, often diverse findings. Scherer et al. (2020) list studies with opposite findings in the relationships between different variables and Scherer et al. (2019) argue that current research is yet to provide a comprehensive overview of the specific relations with the TAM, highlighting that in some research the hypothesised relationships are fully supported and confirmed while other empirical studies show either little or no significant relationship between variables and secondly that the role of different external variables in TAM and their effect on TAM core variable such as PU can produce varying results. It is also argued by

researchers such as Legris et al., (2003) that there is a need to extend the TAM model and integrate it into a wider model to increase its effectiveness and fully investigate user acceptance which has been done through the integration of other theories such as flow theory and other constructs such as concentration (Liu et al. 2005).

Figure 2.1 Technology Acceptance Model (TAM) (Davis et al., 1989)



2.15 The Research Model

2.15.1 An extended TAM – TAM2

Scherer et al. (2019) declare, based on their meta-analysis of TAM studies that the TAM is relevant to all potential users of a new technology because of its proven success in empirical studies in the prediction of user behaviour. TAM has consistently proven itself as a statistically reliable, valid and robust model, with foundations in social psychology theory which aids understanding and explanation of user behaviours in the implementation of IT (Mathesion et al., 2001; Sharma and Chandel, 2013). TAM has changed and tailored over time to suit different contexts and technologies and has been used to explain more than 40% of system usage (Legris et al., 2003). MacCallum et al. (2014) extended the TAM model and confirmed that digital literacy, ICT anxiety and teaching self-efficacy have an impact on a lecturer's intention to use mobile learning.

Although the potential of technology use to enhance teaching and learning is compelling and has become increasingly researched and investigated the actual acceptance or rejection of technology is essential to its success. Suki and Suki, (2011a) highlight the need for more research focusing on user perceptions of mobile device use in mobile learning. This researcher after much interrogation of literature conceptualized a theoretical framework that is representative of the TAM2 (Venkatesh and Davis (2000) as it is still considered an effective model to depict the path of technology acceptance (Park et al., 2012). The TAM2 contends that a user's election of a particular IT is determined by two cognitive beliefs and core constructs PEOU and PU which are claimed to be the main influences of technology acceptance (Chen et al., 2013; Elwood et al. 2006; Paiva et al., 2016; Teo, 2010) which in turn affect ATT and present a positive effect on behavioural intention to use and actual use of the technology (Davis et al., 1989; Lau and Woods, 2008; Liaw, 2008; Park, 2009; Liu et al., 2005; Roca et al., 2006).

Marangunić and Granić (2015) concluded that studies have continually identified new constructs that play major roles in influencing the core variables (PU and PEOU) of TAM and directly affect adoption and usage of technologies based on analysis of 85 scientific publications on TAM between 1986 and 2013. This study

recognises recent developments and therefore, together with the constructs PU, PEOU and ATT two external variables, PR and PMR were introduced with the aim of providing a robust framework that is consistent with investigation into user acceptance of the mobile digital device in learning (Behrend et al., 2011). This is to improve the ability of the model to predict student's adoption and usage behavior of the mobile device for learning purposes. The TAM has been the predominant model for researching technology acceptance and can be used to examine the influence of external variables on internal beliefs, attitudes and intention to use mobile devices (Elwood et al., 2006). External variables PR and PMR constructs are added to TAM to further explain the variation in PU and PEOU which highlights the fact that acceptance of technology is not a simplistic process, influenced by user attitudes and perceptions alongside contextual and situational factors (see Figure 2.2). The research will aim to explore the validity of an extension of the TAM based upon these additional external variables PMR and PR and whether they increase the predictive results of the extended TAM.

2.15.2 Perceived resources (PR)

PR is considered to be a key factor that could potentially hinder or support the use of mobile technologies and the impact on learning effectiveness (Lee, 2008). This empirical study extends TAM by adding the diagnostic instrument for measuring resource perception (PR) construct to the model which is operationally consistent with TAM's other constructs, to account for barriers to people's use of systems and has been previously tested in the field and found to influence behavioural intention (Mathieson et al., 2001). The PR items examine student perceptions of adequate resources that can facilitate or inhibit use of mobile devices both inside and outside of formal academic settings. PR are defined as the extent to which an individual believes they have the personal and organisational resources required to successfully utilise technology and can be successfully integrated with the original TAM model in the determination of barriers to use and is an area over which organisations may have some control (Mathieson et al., 2001).

Ajzen and Fishbein (1980) highlight the importance that new constructs should be congruent with existing ones. Legris et al. (2003) advocate inclusion of variables related to human and social processes. PR have been identified and explored in other empirical studies across different contexts. These include: Self-efficacy

(Grandon et al., 2005); Previous experience (Liu et al., 2010); Knowledge/time (Mawhinney and Lederer, 1990); Support from staff/others (Conrath and Mignen, 1990); Cost (Jen et al., 2013; Reimann and Warren, 1985) and Accessibility (Djamasbi et al., 2006). It is proposed by the researcher that positive or negative access to resources can affect user perceptions of mobile ease of device use and can affect intention to use.

In order to be compatible with TAM's other constructs, all items included in the questionnaire are task-specific without ambiguity at the same level of abstraction as other TAM constructs (Mathesion, 2001). Reflective measures investigating perception of availability of resources were developed for the questionnaire. The PR variable will investigate whether factors such as support from others and access to support materials, cost of mobile technologies or general control over the device can influence users' perceptions and attitudes towards perceived usefulness and ease of use. This will enable the researcher to identify exactly what users believe to be critical in forming overall perceptions of resource availability in the use of mobile devices.

2.15.3 Perceived media Richness (PMR)

Traditional style classroom based learning can offer effective forms of communication because it is face-to-face where body language and gestures are prevalent; however, this can also mean less interaction and contribution from some sections of the student population. Mobile technologies and learning is continually evolving alongside the emergence of new technologies that are decreasing in size but increasing in functionality. Literature has presented empirical findings that mobile learning provides benefits such as instant feedback, improves efficiency in learning and bridges the gap between learning inside and outside of the classroom (Lai, 2019). The introduction of the external variable PMR in this study allowed for the measurement of student attitudes to the PMR of mobile device use in learning and assess the relationship with the TAMs core variables including PU, PEOU, ATT and IU.

Mobile technology capability for storing audio, video and text files integrated with the learning environment can reach learners with different learning styles by making materials available anytime, anywhere in different formats such as podcast or audio-recordings (Keengwe and Bhargarva, 2014). Mobile devices used in

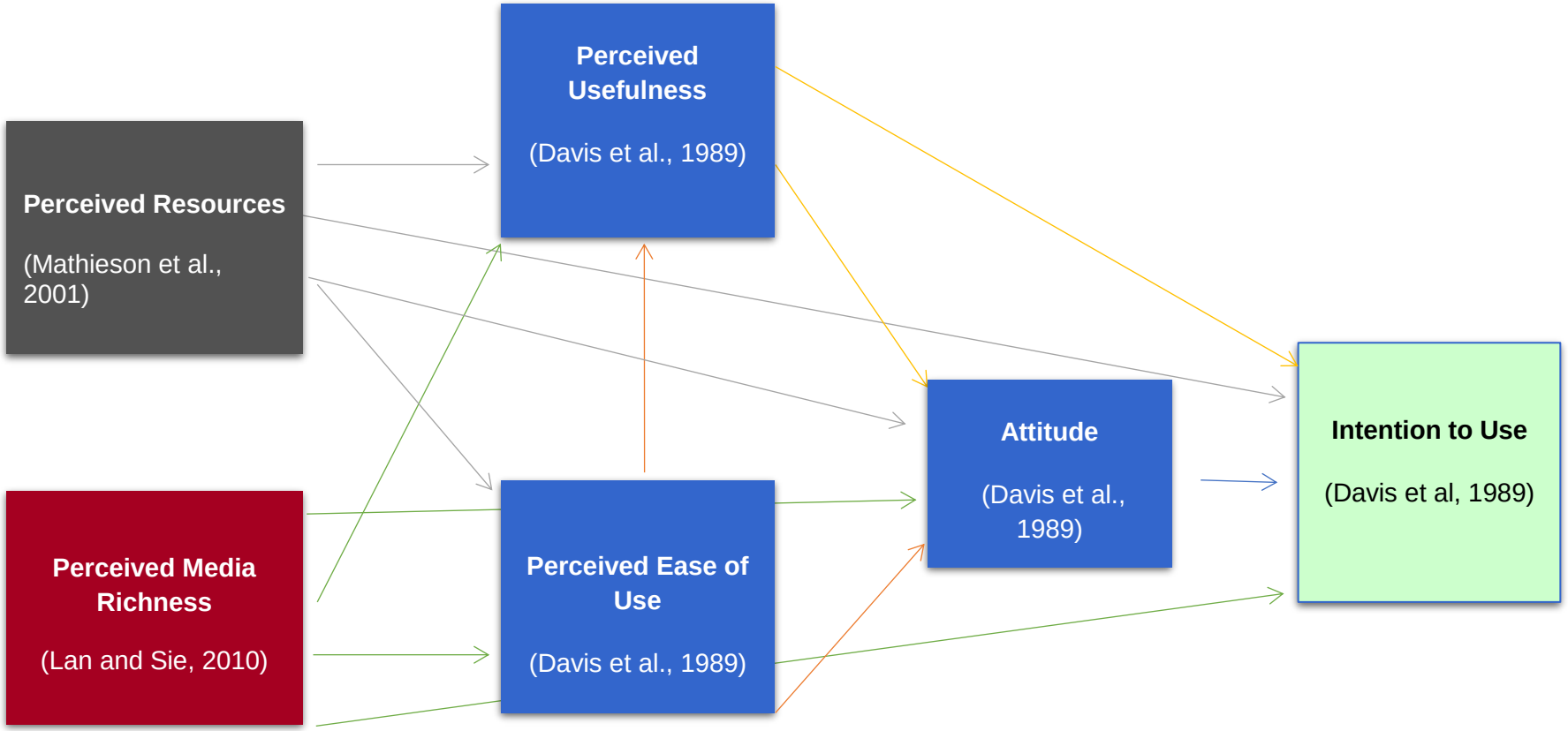
conjunction with other platforms can be used to support the learner, increase interactivity and collaboration in classroom settings (Dawabi et al., 2003). Kuo et al.'s (2014) research found that the embedding of rich media such as interactive video increased opportunity for learner interactions and satisfaction in online learning contexts. Ventakesh and Davis (2000) argue that TAM needs to be extended in empirical studies to include other theoretical constructs such as choice, available technology, congruent with existing ones (Ajzen and Fishbein, 1980). Huntington and Worrell (2013) argue that PMR is an important variable to consider in TAM studies of digital media and ICTs. Based upon the researcher's review of the literature for this study including the key search 'Media Richness Theory', there is relatively little research on the support of learning as it has previously been adopted in organisational and management information system research (Lan and Sie, 2010).

Ventakesh and Davis (2000) argue that future research needs to extend TAM to include other theoretical constructs such as choice, available technology and media richness. It must also be congruent with the TAM in the pursuit of valid and robust results. MRT (Daft and Lengel, 1984; 1986) which originated from Information Processing and Social Presence Theory is based on the concept that the aim of any form of communication is the deliverance of a clear and coherent message, moderation of shared meaning, the ability to change understanding and reduce uncertainty (El-Shinnawy, 1997; Lan and Sie, 2010; Robert and Dennis, 2005; Shahkat, 2011; Sun and Cheng, 2007). MRT ranks various media, based on the ability to reduce equivocality of the message and some can deliver this message superior to that of others (Kuyath and Winter, 2006). The four suggested criteria for media richness includes immediacy of feedback, the capacity for personal focus, the potential to transmit multiple cues and the potential for variety of language (Daft and Lengel, 1986; Sun and Cheng, 2007). Anandarajan et al. (2010) in their field survey define PMR as the extent to which a user has the belief that a specific communication medium has the capability to convey information based on its characteristics.

It has been argued that MRT has had an empirically mixed reception (Dennis and Kinney, 1998; Dennis and Valacich, 1999; Campbell and K, 2008). It is vital that user attitudes towards media richness of devices be investigated in the study of PU and PEOU (Lan and Sie, 2010; Liu et al., 2009). Liu et al. (2005) argue that the impact of media richness on users' e-learning acceptance is vital and that media

rich presentation interfaces can produce higher levels of PU. The focus of this study is student attitudes to the use of wireless mobile technologies which have the potential to transmit various combinations of text, graphics, audio and video (Lan and Sie, 2010). Campbell and Kwak (2008) emphasis the usefulness of MRT as a framework to investigate the implications of communication technologies. This research study will investigate whether user the PMR of mobile devices affect intention to use a mobile, wireless device.

Figure 2.2 Extended Technology Acceptance Model



2.16 Research Questions

The goal of this mixed method research project is to investigate post-primary and first year undergraduate student attitudes and perceptions of mobile wireless technologies for learning both inside and outside of formal learning environments. The research objective is to investigate whether student perceptions of the usefulness of mobile technologies affect intention to use mobile devices both at post-primary level (age 17-18 years) and first year undergraduate level. The findings of this research study will aim to inform and provide other third level educational institutions with an insight into student attitudes and intention to use mobile devices for learning. THE University, who participated in this study can utilise the research to inform policy and practice for the support and successful integration of mobile devices for learning, student engagement and the provision of services for undergraduate students' technology needs and expectations throughout the course of their studies (Ng, 2012).

The research study was designed to be completed in two phases over two consecutive years. The creation and delivery of the data collection instruments have been designed through the lens of the extended TAM2 which includes PR and PMR. Phase I consisted of the distribution of a quantitative-based data collection instrument, a paper-based questionnaire. This was followed up and consolidated by focus group data, using a qualitative approach to gain deeper insights into student opinions and attitudes. Phase II consisted of paper-based and follow-up electronic surveys at two time points in the students' first year of undergraduate study.

The data from the collection methods utilised during Phases I and II aims to address the following key questions, which are vital to the overarching objective of this study:

- Is there a relationship between students' perceptions of Resources, Usefulness, Ease of Use, Attitude and Use of a mobile device?

- Is there a relationship between students' perceptions of Media Richness, Usefulness, Ease of Use, Attitude and Use of a mobile device?

- Is there a relationship between students' perceptions of Usefulness, Ease of Use, Attitude and Use of a mobile device?

CHAPTER 3 METHODOLOGY

3.1 Introduction

The theoretical stance not only moulds and directs the type of theory used in a research study (Creswell et al., 2011) but it also provides a framework for the data collection phase of research. The researcher has outlined the research questions and research objectives in chapter 2. The purpose of this chapter is to initially present the research hypothesis and how this is informed by the research model and objectives, followed by the philosophical assumptions underpinning this research with a discussion on pragmatism, the philosophical approach adopted in this study in relation to other philosophies. The research then expounds the research strategy, including the mixed method research methodologies adopted; introduces the research instruments that have been developed and utilised in the pursuit of the research project goals which includes quantitative and qualitative based research instruments. Descriptions of the instrument's administration, population, sampling methods and size are also detailed. To conclude, the ethical considerations applied to this study will be provided along with appropriate reliability and validity evaluation discussed.

3.2 Research Hypothesis

The research model adopted in this empirical study (see Figure 2.2 - an extended TAM including PR and PMR) and the research objective help inform the hypotheses being tested. The validity testing of these proposed hypotheses form the foundations of the emerging theoretical models in each phase of the study:

Perceived Usefulness and Perceived Ease of Use

PU refers to the users' subjective probability that using a specific application system will increase his or her job performance (Davis, 1989). PEOU refers to the extent to which a user believes the system will be free from effort consistently shown to be robust predictors of technology adoption intention (Lai et al., 2012; Lai and Chang, 2011; Mathieson and Chin, 2001; Szajna, 1994). Therefore it is hypothesised that:

H1: Perceived Usefulness is positively related to Intention to Use

H2: Perceived Usefulness is positively related to Attitude

H3: Perceived Ease of Use is positively related to Intention to Use

H4: Perceived Ease of Use is positively related to Perceived Usefulness

H5: Perceived Ease of Use is positively related to Attitude

Attitude

ATT to technology use is deemed to influence a user's intention to use technology (Alenezi et al., 2010; Park et al., 2012) and although the role of ATT is not considered in later adjustments to the model (Venkatesh and Davis, 2000) and studies such as Teo's (209) found that ATT did not contribute to total variance in technology use by preservice teachers he still advocated that future research should examine the ATT construct alongside various aspects of the users environment so it was deemed appropriate to include ATT in this research model. Therefore it is hypothesised that:

H6: Attitude is positively related to Intention to Use

Perceived Resources

TAM has previously been criticized for missing important variant sources ignoring potential barriers preventing the use technology such as cost, functionality, accessibility and this requires more research (Lee, 2008). Therefore PR is included as an external construct to extend the model, it is hypothesised that:

H7: Perceived Resources is positively related to Perceived Ease of Use

H8: Perceived Resources is positively related to Perceived Usefulness

H9: Perceived Resources is positively related to Attitude

H10: Perceived Resources is positively related to Intention to Use

Perceived Media Richness

MRT posits that fitness of the media and communication task characteristics affect communication efficiency between users. MRT was introduced as an external

construct in this study as it has been previously found to be a reliable predictor influencing intention to use technology (Lai and Chang, 2011; Lan and Sie, 2010) and because of the various and continual development of feature and functionality capabilities offered via mobile devices. Therefore it is hypothesised that:

H11: Perceived Media Richness is positively related to Perceived Ease of Use

H12: Perceived Media Richness is positively related to Perceived Usefulness

H13: Perceived Media Richness is positively related to Attitude

H14: Perceived Media Richness is positively related to Intention to Use

3.3 Background to the Inquiry

Research provides for the most effective approach to the discovery of knowledge through a combination of reason and experiences and is argues to be the superior approach in the discovery of truth. The goal of research should be to improve knowledge using a research approach and design fit for purpose (Halkier, 2010) alongside 'beneficial aims and results' (Hostetler, 2005). Philosophy has been a key factor in the development and refinement of research methodology and it is essential that the researcher is knowledgeable of issues, implications of the methodology and methods adopted in the research project as they inform and refine how data is collected, the origin, how it is interpreted and how it will answer the research questions (Bettis and Gregson, 2001; MacKenzie and Knipe, 2006). While there is no one agreed set of 'commandments' outlying how to conduct research, Bettis and Gregson (2001) argue that the use of multiple paradigms will ultimately benefit the quality and aid rejuvenation in social sciences and educational research. Whereas Purists argue that fundamentally different research paradigms adopt different ontology, epistemology, theory and methods during the research process (Brannen, 1992; Firestone, 1987).

The philosophical assumptions or worldview adopted by a researcher, guide and shape the approach to a study helping to not only clarify the research design (Creswell, 2011; Gray, 2018; Lincoln and Guba, 2005) but also dictate the main research questions, methodology and methods utilised during a study (Almpanis,

2016). Guba and Lincoln (1994) define a paradigm as the 'worldview that guides the investigation'. The assumptions that form the foundations of the major paradigms can be divided broadly into the ontological and epistemological. Ontology focuses on the nature of and what constitutes reality where realism suggests that a discoverable reality exists, independent of the researcher and relativism propose that realities exist in the form of multiple mental constructions, dependent on the various worldviews of humans (Bettis and Gregson, 2001). Epistemology analyses the nature of the relationship between the inquirer and the knowable, attempting to comprehend what it means to know. An objective ontological stance contends that an objective reality exists whereas constructivism purports that multiple contradictory but equally valid worldviews can co-exist. In contrast to constructivism, subjectivism argues that subjects construct meaning within collective unconsciousness.

Positivism has a strong historical significance in research and has guided educational research for many years (Bettis and Gregson, 2001). Positivism originated out of the French Enlightenment; the concept was first coined by the French philosopher Comte, in the middle of the 19th century. Comte advocated the application of the tools and logic of the natural sciences, observation and reason to study and understand behaviour and society (Cohen et al., 2011; Mackenzie and Knipe, 2006). The applied quantitative methodology is used to express the assumptions of the positivist paradigm in the collection and analysis of data in an objective value free manner and was formed based on a critique of research that favoured experimental, correlational and survey methods (Firestone, 1987; Gage, 1989). Although positivism has been heavily criticised and is argued to be inadequate to fully study the full range of human experiences, it has been hugely influential and still affects use of experiment and statistics in educational and social research (Bettis and Gregson, 2001).

Educational research witnessed the emergence of post-positivism at the turn of the 20th century and knowledge developed through this lens is based on observation and measurement of objective reality (Creswell, 2014). While sharing many similarities ontologically, epistemologically and methodologically with positivist protagonists, many argued for a change in the methods utilised, some using quantitative exclusively while other used qualitative methods only (Bettis and

Gregson, 2001). Dewey (1938), while a strong proponent of the scientific approach, began to question positivism and the ontological view of fixed truths.

It was during the 1970s and 1980s that a reformist movement, the interpretivist paradigm began to gain momentum and the use of a qualitative methodology as the framework for educational research studies became increasingly significant. This approach emerged from Husserl's phenomenology and other German philosophers' studies of interpretative understanding in the form of hermeneutics (Mackenzie and Knipe, 2006). The interpretative model focuses on the social construction of reality, that teaching and learning is too complex to be studied by scientific method and that human beings are inextricably linked to intentions, aims and objectives that give them meaning, rather than reality predetermining a subjects' perception (Gage, 1989).

This paradigm holds the worldview that meanings are constructed by humans as they engage with the world, influenced by social and historical perspectives and human sciences aim to understand the meaning behind the human action and experience (Almpanis, 2016, Cohen and Manion, 1994; Schwandt, 2000). Qualitative research methodology has origins in distinct epistemological and ontological perspectives that are in sharp contrast with the positivistic approach informing quantitative research. Criticisms of the interpretative paradigm include findings which lack reliability due to its inherent subjectivity and lack of scientific procedures of verification (Almpanis, 2016).

3.3.1 The competing paradigms debate

There has previously been a well-documented conflict between what Gage (1989) described as these competing paradigms originating from wars between the various academic disciplines, which according to (Hammersley, 2007) has had unfortunate consequences resulting in the questioning of the quality of educational research. Paradigm wars are argued to be divisive for research and focus only on negative aspects of each paradigm causing problems for educational research (Hammersley, 2007). The ongoing dispute among qualitative and quantitative research cultures where purists on both sides focus on the negative aspects of each paradigm and argue that methods are inextricably embedded in

epistemological and ontological ties which cannot be mixed. While quantitative based approaches have been criticised for the artificial nature of research instruments applied to participants (Bryman, 2001). Equally, much concern and criticism has been directed towards the quality and trustworthiness of qualitative methods due to suggested lack of robustness, relevance and usefulness of data gathering instruments (Oakley, 1999; Spencer et al., 2003).

While quantitative and qualitative methodologies invoke different paradigms and epistemologies, choosing one way of describing the world cannot capture richness present in non-technical everyday understanding of experience (Pring, 2000). Johnson and Onwuegbuzie (2004) refute the one or other method approach to research and argue that quantitative researchers should be free to use qualitative methods. Indeed Pring (2000) argues that using one method of describing the world cannot capture the essence and richness present in the understanding of everyday experiences. Researchers are continually attempting to achieve the goal of providing enough evidence that can be accepted by contemporaries as objective proof and a blurring of paradigms in order to interconnect viewpoints, using different perspectives in the pursuit of theoretically sound and trustworthy research has the potential to further contribute to achieve this (Lincoln and Guba, 2000).

3.3.2 'Mixed Method' research design and the emergence of the pragmatism

Mackenzie and Knipe (2006) argue that none of the philosophical paradigms explicitly condemn or stipulate the use of one specific methodological approach to the collection of data. Indeed Lincoln and Gub (2003) argue that various paradigms can interbreed and that elements from different paradigms can be mixed successfully. Although, it is argued that the complexity of a research question can never be fully apprehended, a one or other approach to educational research is not a compulsory approach and the use of multi-methods is a viable alternative with the potential of improving findings from both quantitative and qualitative methods and the delivery of quality educational research (Bergman, 2011; Hostetler, 2005). A blending of paradigms began to emerge by the year 2000 in the form of a mixed method approach which is viewed as a valid addition to qualitative and quantitative research (Johnson et al., 2004).

The use of a mixed-method approach can help mould a researcher to be more knowledgeable and critical towards research as they assess the possibilities and limitations of each research technique (Almpanis, 2016). The use of multiple methods in data collection provides evidence of study credibility and reliability of results (Ary et al, 2010) allowing for the maximisation of the strengths of both quantitative and qualitative approaches allowing the research results to be generalised for future studies and analysis (Hesse-Biber, 2010). The mixed methods approach incorporates elements from both qualitative and quantitative research methodologies providing a more rounded understanding of the research problem (Creswell, 2014). Critics of the mixed methods or combined methods approach in social science research argue that protagonists of the combined methods fail to adopt a clear philosophical or theoretical stance and the methodology adopted is based on the quantitative versus the qualitative debate (Nudzor, 2009).

The mixed methods and mixed models debate lead to the emergence of a third set of beliefs, also known as the third paradigm, Pragmatism. Pragmatism, as a philosophical approach originated with Charles Sanders Peirce (1839-1914) and early proponents include William James (1842-1910) and John Dewey (1859-1952) (Aune, 1970). The pragmatism paradigm focuses on addressing the research problem rather than being restricted to one approach. In addressing the research problem with what works, pragmatism is pluralistic and may combine different paradigms and methods (Creswell et al., 2011). The root of the word pragmatism originates from the Greek word meaning ‘work’. Pragmatism reintroduces discovery into the enquiry process and it is argued that it can sidestep the issue of reality and truth, accepting that singular and multiply realities exist that are open to empirical enquiry and that ultimately research is imperfect and fallible (Putnam, 1995). And due to the fact that all measurement is deemed fallible, pragmatists argue that there is a need for multiple measures and observations, each of which present different types of error and there is a need to use triangulation across multiple error-full sources with the aim of gaining a better understanding of what is happening in reality

3.3.3 Location of this research

This research study focused on student perceptions of the use of mobile device for learning with a view to understanding user intention to use mobile devices both inside and outside formal learning. A pragmatic approach was adopted by the researcher, which is recognised as the philosophical underpinning for mixed methods paradigm focusing on a specific situation using different approaches to exert knowledge about the situation, deemed as the most appropriate for the question and applied consistently, unambiguously and duplicable by others (Gray, 2016; Oakley, 1999). Gage (1989) advocates for the co-existence and collaboration of paradigm in order to not only endure but to assist in the production of quality educational research.

Pragmatism provides a third alternative to the researcher in this study that enabled the utilisation of pluralistic approaches to derive knowledge about the research problem with the introduction of quantitative and qualitative approaches in order to address the research question. This enabled the researcher to re-introduce discovery into the inquiry process in a way that sidesteps issue of reality and truth and accepts there are singular (positivist) and multiple (interpretivist) realities. The pragmatic paradigm centrally positions the research problem and applies all approaches to understanding the research problem with a focus on solving problems in the real-world.

3.4 Design of the Research Inquiry

The paradigm and methodology work hand in hand to form the foundations of the research study influencing the way knowledge is studied and interpreted. This research is concerned with finding the determinants of mobile technology acceptance, and understanding how different factors relate to student perception and acceptance of mobile technologies for learning both inside and outside of school and university. The researcher uses the theoretical framework, in this case, the core constructs of the TAM2, PU, PEOU and ATT extended to include external constructs PR and PMR to guide the design which will help determine variables to measure and investigate correlational statistical relationships between variables. Theory guides all aspects of this research from the formulation of questions for the

paper-based, electronic questionnaires and the focus group sessions to the operation of the methods, dissemination and discussion of the findings.

The study comprised of a Phase I and Phase II to indicate and highlight the two distinct educational level settings and participants, upper-sixth post-primary level and first year undergraduate university level students respectively. A sequential explanatory design was employed where the quantitative component in Phase I was used to initially investigate user attitudes to mobile devices. In quantitative research a research design is initially developed, followed by the formulation of research questions, the testing of hypotheses based on previous theories and the production of research findings which verify or do not verify theory and generalisation of findings to contexts beyond the current study, where appropriate (Hartas, 2010). A questionnaire data collection instrument (see Appendix 1) was designed, based on an extended TAM and was completed by 581 upper-sixth class students at fifteen post-primary level schools across NI. This explored attitudes to mobile devices and the types of technologies adopted by students.

Subsequently, six focus group sessions (Appendix 2) were conducted with consenting students from five of the post-primary schools who participated in Phase I of the inquiry. The aim of this qualitative phase was to further explore student attitudes and perceptions of mobile device use for learning both in school and at home. The sessions explored student positive and negative attitudes and experiences with devices and intended or actual use of these technologies. The researcher further explored PU, PEOU and the perceived barriers to the use of mobile technologies.

It was also planned by the researcher to use the same research approach and instruments in Phase II of this inquiry; however, this was not possible due to a number of issues. Firstly, the university's ethics committee deemed that the completion of the paper-based questionnaire during THE University's IT induction sessions would place too much of a time constraint on the students. This was due to the fact the researcher required time to distribute the written information sheets, as well as articulate verbal information, and ensure voluntary participants had read and understood the information provided. Thus, the researcher had to edit and remove items from the original instrument used during Phase I of the project as the

IT induction sessions was the researcher's only opportunity to have direct contact with 1st year undergraduate students at the beginning of term.

Secondly, focus groups had to be omitted from Phase II due to concerns from the researcher's senior management that these could compromise the students' academic studies. Therefore, a compromise was agreed that the questionnaire would be distributed at three stages of the academic year as it was agreed by the researcher's manager that the data gathered would be of benefit to the area providing data on student daily use of mobile devices in the access of information and learning materials. A paper-based questionnaire (see Appendix 3) was distributed at the beginning of the academic year (Part A - end September/beginning October 2014) and 1,162 were completed by the first year undergraduate students. Two follow-up electronic surveys (see Appendix 3) were distributed to students who had participated and provided an email address in Part A, at the end of semester one and two (Part B and C) and were completed by 209 students in total.

In Phase II, as previously discussed, the researcher had to cut down the number of validated items to 36 in the measurement of the proposed research model variables. Initial analysis of internal consistency and reliability in Phase II (A, B and C) revealed acceptable levels to high alpha reliability and scale correlations were statistically significant at the $p<0.01$ or $p<0.05$ levels. Convergent and discriminant validity analysis also produced statistically significant results. Finally, a series of regression provided powerful insights into the interrelationships among variables in the dataset. This enabled the researcher to compare and contrast the evidence across Phase I and Phase II. Although, as clarified, focus group research data were not collected in Phase II due to reasons out of the researcher's control; the researcher was given permission to distribute two further questionnaires. This introduced a longitudinal element to Phase II and produced further data from 1st year undergraduate students at the end of their first year in higher education mirroring Phase I data collected at the end of upper-sixth in 2nd level education. This also enabled the researcher to compare findings and attitudes between students at the end of two distinct levels of education, pre-university and current 3rd level students.

3.4.1 Quantitative method

Quantitative research methods evolved in the 1960s to include surveys which have since provided an opportunity for educational research to locate itself in organic settings and move beyond the limitations that earlier experimental research posed to educational research designs. The survey method is generally utilised by researchers to gather data at a specific time-point with the aim of providing an explanation of current conditions or an exploration of relationships (Cohen et al., 2011). The quantitative non-experimental survey designs utilised in this study presented a correlation design where the correlation statistic is used to measure and describe the relationship between variables and sets of scores (Creswell, 2014).

In Phase I and Phase II, a questionnaire was deemed to be the most appropriate data collection method to collect user attitudes and perceptions of the large sample set in this inquiry which included post-primary students and a large number of university students in THE University. The first section of the survey collected student demographic data and it alsointerrogated the type of mobile device utilised by students and mobile device use inside and outside of the formal learning environment. In the second section the survey instrument for this study, exploratory in nature, was developed using validated items from previous research as a means of assessing the theoretical constructs of the extended TAM2 model for intention to use mobile devices for learning and to test hypotheses from relationship and pattern exploration through correlation and factor analysis (Cohen et al., 2011). A seven-point Likert-type scale with anchors from “Strongly agree” to “Strongly disagree” was used. Likert items are common response formats used in attitude scales, which offer multiple response categories.

The basic assumption behind attitude scales is the possibility to uncover a person’s internal state of beliefs or perceptions by asking them a series of statements (Reid, 2007). The measurement of student attitudes is challenging such as the determination of validity and reliability of the utilised instrument. It is also recommended in literature that in order to draw valid conclusions collected via self-array tools in the measurement of attitude for example it is important to choose the most appropriate analyses for the task (Lovelace and Brickman, 2013). Davis

(1989) argues that measurement scale validity must be constructed from the beginning of the research.

In my study a step-by-step process was used to develop multi-item scales with high reliability and validity. Validated items from past literature were initially researched to generate items for each construct included in the proposed model. A pilot study was then conducted after initial development of the questionnaire to test item appropriateness so that these could be adapted or removed. The reliability and validity of the scales that emerged from this study were consistent with prior research. At this stage a post-primary school teacher also reviewed the questionnaire and provided feedback on item wording, and consistency. Additionally, the questionnaire's validity was evaluated by the researchers' supervisor and a Higher Education senior manager with substantial experience in the mobile technology usage behaviour of students for learning and communication.

The items that best fit the definitions of the constructs were retained and finally the Cronbach's Alpha was used to finalise the number of items to generate for each scale and all data produced a co-efficient score of 0.7 or greater suggesting an acceptable to high level of reliability to the data collected (Elwood, et al., 2006). Based on the demographic data collected It must also be noted, based on demographic data, that all respondents included in each phase of this study had previously used a mobile device for learning inside and/or outside of formal learning. This suggests that the measured attitudes and beliefs were developed based on direct behavioural experiences with the attitude object (Davis, 1993).

3.4.2 Qualitative method

The data gathered from the quantitative component fed into a second qualitative component. Qualitative research is concerned with the opinions and experiences of individuals producing subjective data. Focus group sessions were deemed to be the most appropriate method of data collection because they provided an opportunity for voluntary participants to openly provide detailed opinions, providing the researcher with a more in-depth understanding of people's attitudes and experiences (Brown, 2010; Ennis and Chen, 2012; Spencer et al., 2003). Focus

groups allowed the researcher to introduce points for discussion and following participant interactions produced large amounts of data within a short time frame.

The data derived from the focus groups were analysed in an attempt to get a deeper understanding of the reasons behind the student attitudes and perceptions towards mobile devices. The use of a mixed method approach in this research study was an attempt to draw the main strengths from the two methodologies (Bryman, 2001; Johnson and Onwuegbuzie, 2004). Quality qualitative research studies have the potential to evolve during a study (Brown, 2010). The data gathered from focus groups provided the researcher an opportunity to establish, focus on emerging themes and provided a platform to look at motivations behind why and how results appeared in the survey data.

3.4.3 Triangulation of methods

Triangulation means using more than one method in the study of social phenomena and was originally linked to measurement of concepts for increased confidence in reliability and validity of findings which meant that it was closely associated with quantitative-based research methods (Bryman, 2001). In order to increase the trustworthiness of the data and enhance the credibility of the research findings, the researcher looks for an intersection in the collected data from all methods utilised in a study (Hesse-Biber, 2010).

Methodological triangulation referring both to mixing quantitative and qualitative approaches of research and data triangulation and the use of multiple data sources on the same objects of the study was utilised in this research (Cohen et al., 2011). Li and Ni (2000) advocate that students are key players whose attitudes and perceptions must be addressed in the process of integrating technology in education. The quantitative and qualitative investigation presented in this research aim was to gain a better understanding of student attitudes and perspectives on the use of mobile technologies for learning and intention to use mobile technologies in HE.

By examining student perspectives about the role of mobile technologies in everyday life and study, the researcher was able to investigate whether there is a

schism between those used outside versus those used inside education settings. The research also aimed to gain an insight into what students perceive to be the role that mobile technologies play in supporting learning and teaching activities and how they are utilised for communication and interaction with peers and teachers. In turn it will also investigate the perceived benefits and limitations of using mobile technologies for educational purposes from the learners' perspective.

The use of triangulation in this study aims to provide the researcher with a greater and a more comprehensive understanding of the complex area of human behaviour. In Phase I the researcher integrated qualitative methods in the form of focus group sessions into the research to expand on data already gathered via the survey method in the form of a self-administered questionnaire.

3.5 Sample Population

In a research study, the population is the group of individuals with which the researcher aims to generalise findings obtained for the sample (Hartas, 2010). This research inquiry was carried out over two phases so two populations are involved in the data collection process of the study. Once identified, a sample of the population was selected by the researcher, which is a subgroup of the population intended for study.

3.5.1 Target population

The target population in Phase I was upper-sixth level students (students in final year) at post-primary level (2012-2013) across the five Education Boards in NI. At the time of writing, there were 217 post-primary level schools with an approximate total of 13,660 students enrolled in upper-sixth level (Department for Education Northern Ireland (DENI), 2013) (see Appendix 4).

Grammar and integrated schools were initially targeted by the researcher due to the fact that these schools are the main suppliers of undergraduate students to HE establishments in NI. In the academic year 2013/2014, 70% of students from grammar schools and 21% from non-grammar schools entered HE (DE, 2014). ICT specialist schools were also identified and all the non-grammar schools in this

category were invited to participate due to their level of ICT usage and ICT specialism in the past. ICT Mark Schools in NI were identified and invited to participate, again because of their accreditation for ICT use across all subjects. These post-primary establishments are feeder schools for THE University as the vast majority (over 90%) of all students at NI HE providers came from NI.

In Phase II, the target population was first year undergraduate students enrolled in academic year 2013/2014 in a HE institution. In the academic year, 2013/2014 there were a total of 56,395 students enrolled in HE establishment in NI.

3.6 Sampling Methods

The sampling methods employed by the researcher in an enquiry is essential to secure the validity of a study and whether the results of the study can legitimately be generalised to a larger population (Black, 1999). In Phase I and II of this study, a non-probabilistic purposive sampling technique was employed. Purposive sampling is a technique that involves the selection of participants which represent the desired population. This involves the conscious selection of certain subjects in order to access those on which the study is based and who are knowledgeable about the research issue based on their perceptions and experiences (Cohen et al., 2011).

In Phase I, the target population of upper-sixth level post-primary level students was initially stratified into separate categories in order to produce a more representative sample (Butcher, 1965). The categories included: school management type, single sex/coeducational school type and grammar/secondary, ICT Mark and ICT Specialist post-primary schools. An extensive Microsoft (MS) Excel workbook was designed using data provided by the DENI and the Education and Library Boards (Belfast, North-Eastern, South-Eastern, Southern and Western) (EA) (2011/2012). This included data on the school type, management type, school size, school principal and contact details (see Appendix 4). In January 2013, invitation letters and consent forms (see Appendix 5) were sent to all grammar and integrated school principals in NI. The MS Excel workbook was used as a management tool to log response rates and logistical elements related to the data collection process. Due to a low response rate from grammar schools in two

of the Education Board areas, further invitation letters were sent to secondary schools.

When the questionnaire had been completed, a reminder email was issued to participating schools (February/March 2013) about the focus group sessions. The researcher experienced difficulty arranging sessions as this was a busy period for upper-sixth level students preparing for examinations. In total, five of the fifteen post-primary schools agreed to provide students for a period of 30-40 minutes (student timetable permitting). In total, six focus group sessions, with eight participating pupils in each session took place.

In Phase II, purposive sampling was considered the most appropriate because the researcher, had access to the target population, during the New Student Induction weeks in September/October 2013. Permission was obtained from management to distribute paper-based questionnaires during the New Student Induction sessions. The population was again stratified into degree course type and participant gender. A representative sample across THE University's faculty groupings was gathered. In the accompanying information letter (see Appendix 6) participants were informed if a contact email/student number was declared on the paper-based questionnaire then the researcher would follow-up with two further electronic questionnaires. In January 2014, an electronic-based questionnaire was sent to students and the second follow-up survey, in April 2014 (end of the academic year), before the beginning of the examination period.

3.7 Sample Size

The minimum sample depends on the type of research involved and quantitative researchers select as many research participants as possible in an effort to minimise the difference between the sample estimate and true population score, commonly known as the sampling error.

In Phase I (January 2013), a total of 137 invitation to participate letters were sent to the principal of every grammar (78), integrated (20), ICT Mark (8) ICT specialist (3) post-primary schools and 28 secondary schools in NI. The invitation letters detailed an overview of the research project and logistics involved in the data

collection process. There was a low response rate from schools in two of the Education and Library Board geographical areas. In an effort to encourage the schools in these areas to participate, invitation letters were reissued in February 2013; however, this proved unsuccessful.

Initially, 18 post-primary level schools agreed to participate in the research. One school withdrew due to time constraints and student assignment completion deadlines (an integrated, mixed sex school). Another withdrew due to an unexpected school inspection (a grammar, mixed sex school). In total, 16 post-primary level schools agreed to participate and one of the schools (a secondary, single-sex school) agreed to participate in Phase I. There were 713 questionnaires distributed to the participating schools and a sample of 581 questionnaires were collected from the population. The sample included nine grammar, two secondary (ICT Specialist), one secondary (ICT Mark), two secondary, one integrated school and a total of ten mixed-sex and five single-sex (girls) schools.

In the Phase I qualitative data collection process, the four participating schools provided a random selection of 40 students (who had completed the questionnaire) over five focus group sessions.

In Phase II (A), over 2,000 paper-based questionnaires were distributed and 1,162 were completed during the New Student Induction week. In Phase II (B and C), a follow up electronic-based questionnaire was distributed to 260 consenting students and produced a total of 209 completed questionnaires.

3.8 Data Collection

This section details the two research instruments utilised in the study. The purpose, context, development for use and the overall appropriateness will be discussed.

Table 4.1 Timeline - Data Collection Instruments

	N (Schools)	N (Pupils)	Uni. (Oct. '13)	Uni. (Jan. '14)	Uni. (Apr. '14)
Pilot (Jan '13)	1	85			
Phase I (Mar. '13)	16	579			
Phase II A			1,162		
Phase II B				95	
Phase II C					95
Focus Groups (Apr '13)	4 (Schools - 5 sessions in total)	40			

3.8.1 Instrument development (Questionnaire)

The survey was developed and utilised as a data collection instrument in Phase I and Phase II of this research project. The aim of the instrument was to measure upper-sixth level students (about to leave post-primary education) and 1st year undergraduate (at the beginning of university studies) attitude to mobile device use for learning. The use of a survey instrument provided the researcher with the best opportunity to introduce a longitudinal element to the data collection process in Phase II of the study. The questionnaire was distributed three times over the course of the academic year; on the second and third occasions an electronic version was used. The aim of this was to gauge student opinion and perceptions to the use of mobile devices over the course of the participants' first year of undergraduate studies. This allowed the research to compare and contrast student

attitudes at three distinct times of the academic year and investigate changes in attitude.

The data collection instrument consisted of an introductory section which was used to gather demographic data including gender, type of mobile device accessed and applications/tools/platform accessed via a mobile device. In order to measure the six latent variables hypothesised in the research model, the researcher divided the main body of the instrument into six parts (Parts I-VI). The latent variables were measured using multiple items. The constructs measured in the research instrument were based on previous empirical research and studies which had employed TAM. The research model also extended TAM2 to include variables PR and PMR. These external factors were integrated into TAM2 by the researcher to provide a better understanding of what influences PU and PEOU (Legris et al., 2003).

In Phase I, 69 items were introduced to measure the latent variables and were primarily items validated from prior research (Ajzen and Fishbein, 1980; Edmunds et al., 2012; Lee, 2008; Liu et al., 2010; Mathieson et al., 2001; Saadé et al., 2007; van Raaij and Schepers; Yoon and Kim, 2007). PR was measured based on 15 items; PU on 11 items; PEOU on 8 items; ATT on 8 items, IU on 5 items and PMR on 22 items. A 7-point Likert scale measure ranging from 1 (strongly agree) to 7 (strongly disagree) was used to rate all items included in this research instrument. In Phase II, anticipating time constraints during the data collection process, the researcher had to delete some of the items included in the Phase I questionnaire. PR was measured based on 3 items; PU on 4 items; PEOU on 7 items; ATT on 6 items, IU on 3 items and PMR on 12 items, a total of 35 items using a 7-point Likert scale.

3.8.2 Development of instrument scale

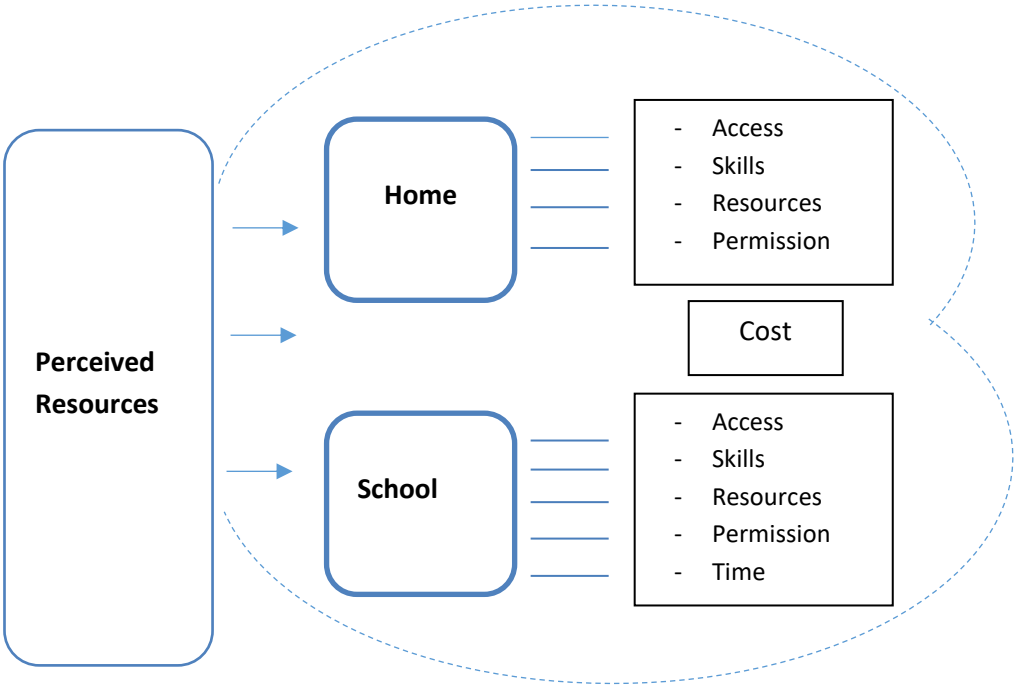
Stevens (1946) defines scales of measurement as the assignment of numerals to objects or event, according to rules. The theoretical model which is measured in the questionnaire consists of constructs or latent variables. A construct is an attribute which is expressed in a general manner such as Intention to Use (mobile technologies) and a variable is an attribute expressed in a specific manner. When

the participant responds to a survey question or a variable, the researcher then assigns a score to the response and this score or variable equals a value. The research studied measures utilised in technology acceptance and media richness literature (Lai and Chang, 2010; Raaij and Schepers, 2006;).

A Likert-type scale was utilised within the questionnaire to enable the researcher to functionalise the underlying construct/attribute that is not directly measurable and to ensure valid and reliable research design (Pallant, 2013). Past research also informed the number of response steps assigned to the scale (Yoon and Kim, 2007) and all scales were modified to suit mobile learning. Participants were asked to rate each of the survey items on a Likert-scale from 1 to 7. The Likert-type response scale was able to provide the researcher with a wider range of scores increasing possibilities for statistical analyses. This enabled the researcher to interconnect measurement with student attitudes, quantity and quality (Chang, 2008). The pilot survey trialled the understanding of the Likert scale to measure items in the questionnaire.

Part I – PR (Do I have resources required to use a handheld/mobile device?)
PR was introduced as a construct to extend TAM for determining use of mobile technologies in an effort to measure user attitude and perceptions of access to resources (time, skills to make effective use of mobile devices, support resources and the cost of mobile technologies) in and outside of school (see Figure 3.1). This enabled the researcher to measure the relationship between the PR construct with PEOU, PU and IU. The items were created based on research literature with modifications to fit the specific context of mobile technology use (Mathesion et al., 2001). In total, fifteen items were developed and included in Part I of the questionnaire to measure student attitudes to PR and investigate the impact on PEOU, PU, ATT and IU.

Figure 3.1 PR Construct (Item breakdown)



Part II – PU - How useful do I find handheld devices?

Part III – PEU - How easy do I find mobile device use?

Part IV – ATT – My attitude to handheld devices for learning at home or at school/university

Part V – IU - My intention to use mobile technologies for learning at school/university

The modified TAM latent variables (Parts II-V, as listed above) were measured in the questionnaire using scale items adapted from Davis (Davis, 1989 and Davis et al, 1989).

Part VI – PMR - How effectively can I communicate using a handheld/mobile device?

There is a stated need for further research that focuses on the influence of different types of media on intention to use technology (Liu et al., 2009). According to Lan and Sie (2010) there is a need for studies incorporating MRT to investigate technology acceptance in support for learning as it has been previously used in organisational and management information system research. Media Richness

Theory provides a useful framework to look at implications of communication technology (Campbell and Kwak, 2008).

The scale items included allowed the researcher to measure the relationship between the PMR construct with PEOU, PU, ATT and IU. The introduced items were created based on media richness literature (Balaji, 2010; Dennis and Kinney, 1998; Lan and Sie, 2010; Lee et al., 2007; Liu et al., 2009). Media richness must be measured based on the ability of media to moderate and communicate shared meaning, understandings and reduce uncertainty (Sun and Cheng, 2007).

3.8.2 Focus groups

The aim of focus group interviews was to elicit views of group members while also noting group interaction (Ary et al., 2010). The rationale for utilising this method was to triangulate the data with the quantitative data collected in Phase I. It illuminated the varied and numerous contextual and circumstantial factors which affect student perspectives and use of mobile technologies both in and out of learning contexts. Through the course of each focus group, the researcher aimed to empower the student participants to voice opinions in their own words through interactions within the group (Cohen et al., 2011).

Four out of the fifteen schools who participated in the quantitative data collection agreed to participate in focus group sessions. Two of the participating schools were single sex, two were in the co-educational category, three grammar and one secondary level schools. The sessions were arranged between March and April with a representative random sample of six to eight students, male and female, studying a variety of subject areas attending each of the six focus group sessions.

Before the initial focus group session, the researcher developed a semi-structured question framework or aide-memoir (see Appendix 9) which was used as a guide during each focus group session. This was based on the theoretical approach adopted in the research model (extended TAM2) and was used to formulate the items measuring variables in data collection instruments (already completed by these post-primary students). The only deviation from this may have been if a follow-on question arose from a particular participant answer. The aide-memoir

enabled the researcher to subtly direct or help instigate topics for discussion. The interviewer allowed for a certain level of flexible question order and phrasing to create a comfortable atmosphere in order to encourage the group to voice opinions (Cohen, 2011).

3.8.3 Pilot Test of research instrument

The research instrument (see Appendix 7) was piloted at a single sex, girls' post-primary school where 100 questionnaires were distributed and 85 were completed by participants. Results and feedback from the pilot study were analysed and allowed the researcher to make any essential adjustments to the survey design, the response scale and items used to measure constructs.

The researcher distributed the pilot questionnaire in the schools' study hall during free periods between timetabled classes throughout the school day. This enabled the researcher to distribute the questionnaire to new groups of students. When distributing the questionnaire, the researcher asked each student to log the start and completion time. The researcher also asked for voluntary feedback on the data collection instrument. The feedback focus included the effectiveness of the questionnaire tool regarding trustworthiness and reliability. The respondents provided comments on any difficulties incurred during completion and suggestions for improvement. This also allowed for exploration of question appropriateness and effectiveness for research purpose.

The researcher carried out reliability analysis on the pilot data utilising Cronbach's alpha coefficient test, correlation between items measuring the constructs was analysed using the Pearson correlation matrix and an exploratory factor analysis was completed (see Appendix 8). The researcher used results from the questionnaire analysis to edit and re-word or to remove items from the research instrument. In Part I, the researcher removed one of the items and reworded and reordered the remaining items. In Part II, the researcher changed the layout of the items to a more logical order. The researcher added an item to Part III and amended the question layout. In Part IV, the wording of one item was changed, along with the order of items. All items in Part V remained the same. Finally, in Part

VI, an item was removed, question layout was adjusted and the researcher changed item wording of the data collection instrument.

3.8.4 Phase I – Administering the research instrument

Two of the schools requested that the researcher deliver and administer the questionnaire. The remaining participating schools requested postal or hand delivery of surveys so the school could administer the questionnaire at a convenient time. The completed questionnaires were collected by the researcher or returned by post.

Self-administered questionnaire – with researcher present

Questionnaires were distributed to students at morning assembly in the school assembly hall. This ensured that there was an adequate time frame (30/40 minutes) to speak with students, distribute, complete and collect the questionnaires. The researcher introduced the questionnaire and provided a short background and overview of the research (prior to this each student had received a research information letter and completed student and parent consent forms) (see Appendix 10). Students were reminded that in order to complete the questionnaire, student and parent consent forms should have been already completed along with a reminder of the right to withdraw from the study at any time. The researcher remained in the assembly hall throughout completion of the questionnaires.

Self-administered questionnaire – without researcher present

Questionnaires were posted out to the post-primary schools' contact staff member. The researcher also provided the school with a courtesy telephone call regarding questionnaire arrival and answered any further queries regarding the research inquiry. Once questionnaires had been completed, seven schools returned the questionnaire to the researcher via post. The remaining questionnaires were hand delivered and collected once completed.

Administering focus group sessions

The researcher was invited to attend each of the participating schools for an arranged time and date. Four of the focus group sessions were held in a small meeting room equipped with a table and chairs and the remaining session was held in a classroom setting. Before each session, the researcher positioned participant table and chairs.

A digital recorder was set in the middle of the table to record participants' responses to allow for full transcription during the data analysis phase. Prior to each focus group session, the researcher prepared printed labels for each participant (for example Student 1) in order to secure participant anonymity and these were placed at each setting around the table. The researcher referred to participants via an anonymous code during the focus group and throughout the transcription analysis (see Appendix 9). The focus group participants were also asked to apply the anonymous identification code to fellow students.

The researcher gave a brief introduction and a clear explanation of the agenda and focus of the session. The participants were informed that all conversations would be digitally recorded which the researcher would transcribe in full at a later date. Each participant was assured of anonymity and to aid this the researcher asked the student to refer to the number on the assigned label when referring to themselves or other participants during the session.

It is important that due care is taken with focus group facilitation and management (Cohen et al., 2011). The researcher, while chairing the meeting and introducing questions and topics for discussion, also aimed to balance this instruction with an atmosphere where the participants felt able to engage and interact with peers throughout. This proved successful as all planned areas and topics were discussed by the participants during each focus group session.

3.8.5 Phase II - Administering the research instrument

In Phase II, three questionnaires (Part A, B and C) in total were distributed over the course of the academic year to first year undergraduate students.

(Part A) – Self-completion questionnaire 1

The self-completion paper-based questionnaire utilised during Phase II (A), were distributed in October 2013, at the beginning of New Student IT induction sessions at THE University. The researcher had to compile an edited version of the questionnaire distributed during Phase I of the research study due to time restrictions for questionnaire distribution and completion (a maximum of ten minutes) at the start of the induction session. Also a number of the original items were not relevant or appropriate for the HE level student.

The questionnaire was distributed to 2,000 first year undergraduate students over a two-week period. The majority of these sessions were held in a room in the Library of THE University. The questionnaire was distributed with an accompanying information letter (Appendix 6). The letters detailed information about the research project, confidentiality assurance, researcher contact details and permission to contact the student with further questionnaires (Phase B and C) upon participant provision of a student email address or student number. The researcher presented a brief introduction and background to the research and advised that questionnaire completion was voluntary and an assurance of the right to withdraw at any time.

(Part B) Self-completion electronic questionnaire 2

In Phase II (B) an electronic based questionnaire was designed and created using Quest Back software and distributed at the end of January, before the start of Semester two. Quest Back software enabled the researcher to enter the questions which were then formatted by the software into an online questionnaire. The researcher utilised the same items measuring the six variables in the Phase II (A) questionnaire. Also a demographic question used in the Phase I was again introduced to this questionnaire. In order not to conflict with student examinations, it was decided that the survey should not be forwarded to students until after the January examination period.

The researcher emailed the electronic questionnaire to all students (400) who had previously voluntarily submitted an email address/student number in Phase II (A). The software tracked all questionnaire responses and provided data analysis tools, accessible at any stage of the data collection process. The Quest Back software

also allowed the researcher to automatically send two follow up reminder emails to students who had not completed the questionnaire within a two-week period.

(Part C) Self-completion electronic questionnaire 3

In Phase II (C), an identical questionnaire to that utilised in Phase II (Part B) was again distributed using Quest Back software in April 2014 along with an accompanying letter. It was agreed by the ethical committee that the survey required distribution before the examination period in mid-May 2014.

3.9 Ethical Considerations

Ethics is a complex area with no universal laws on right or wrong as issues may differ according to context and institution (Papademas, 2004). Ethical issues and the protection of participants must be applied and given precedence over method in all areas of research design, application and data representation (Razi, 2006). A code of ethical practice was established based on literature and in accordance with THE University ethical procedures. All ethical principles have been adhered to by the researcher throughout the research process with participant and data confidentiality rigidly observed throughout the research project. Ethical Scrutiny and Approval forms (see Appendix 11) were submitted and approved by the School Ethics Committee for each data collection instrument distributed during the research process. Ethics committees assess on similar ethical principles such as informed consent, confidentially and anonymity of participants, prevention of harm and researcher integrity (Wiles et al., 2008).

In advance of the data collection process in schools, the researcher completed an AccessNI check and complied with THE University's Safeguarding Children and Vulnerable Adults Policy throughout the process. The pilot data were gathered in one school over the period of one day and a member of staff from the school accompanied the researcher throughout the data collection process. All data gathered in the process of the pilot study was accessible by the researcher and study supervisor only. Anonymous codes were listed by the researcher on each questionnaire before distribution. Feedback provided by participants was voluntary

and confidential. All data were securely stored following successful completion and dissemination of the research. The researcher and the researchers' supervisor were the only persons with access to the data used for research purposes.

In Phase I, the majority of participants were under eighteen years of age so initially an information letter and voluntary consent form was issued to each school principal with the invitation to participate in the project. A sample of the student and parent/guardian consent and information letter was also enclosed. Surveys were not distributed to participant schools until student and parent/guardian consent forms had been completed. Participant or school names were not used in the data, research or published work to ensure the protection of participant privacy and preservation of participant and school anonymity. All participating schools and participants were issued with an identification number to be recorded in all data, recoding and published work. Focus group participants were provided with anonymous labels which were used during interviews, research dissemination and published work. Participants were informed that each focus session was digitally recorded by the researcher.

In Phase II (A), before distribution of the questionnaire, the researcher introduced and provided a brief summary of the research project and remained present during questionnaire completion to answer questions. A more detailed summary was provided in an information letter attached to the questionnaire. The researcher and information letter also highlighted that participation was voluntary, all data would be treated confidentially and participant right to withdraw from the research at any time. Consenting participants were also asked to list their university email address/student number so that the researcher could forward an electronic questionnaire both at the end of semester one and the end of semester two, Phase II (B and C). Participant or the participant university name were not used in the data, research or published work.

During the research all questionnaire hard copies and digital recordings of interviews were stored in a secure locked cabinet in the researcher's office. All electronic data collected (including student emails and questionnaires completed in Phase II (B and C) were stored on a secure password protected computer connected to a university server. These confidential data were accessible only by

the researcher and the dissertation supervisor for research purposes. All paper based and electronic data will be securely stored in the School of Social Sciences, Education and Social Work for five years post research completion.

Incentives were not provided to individual pupil participants during any phase of this research project. However, in an effort to show reciprocation for time and effort employed by the school and participants, a research briefing report was provided to each participating school. The suggestion of investigating mobile device use and student attitudes to these originated from discussions between the researcher and a senior manager who emphasised the need for research as THE University were investing in new technologies and focusing on mobile learning development for teaching and learning. The researcher provided a research report on both the post-primary and university student findings to the senior manager. Participants' rights to privacy including a right to non-participation or withdrawal at any time without giving a reason during the research process was emphasised during each phase of the research.

3.10 Validity and Reliability

3.10.1 Introduction

Furlong and Oancea (2005) emphasise the importance of quality research and the need for a relationship between research, policy and practice. Research should be assessed for quality on its own merits; however, the issue of validity and reliability cannot be dismissed (Spencer et al., 2003). External and internal reliability must be considered where the degree to which a study can be replicated and equally that there is a connection between researchers' observations and theoretical ideas (Le Compte and Goetz, 1982). Throughout this research process, a key objective is the production of quality systematic research, which will contribute to theoretical knowledge and address the need for research to contribute to practical solutions with careful attention paid to validity and reliability (Cohen et al., 2011).

3.10.2 Research trustworthiness

Trustworthiness is essential the production of quality educational research and fundamental to judgement of quality. The fundamental differences between the various philosophical and methodology approaches to research are widely acknowledged. Positivist protagonists argue that the application of method ensures rigour while interpretivists view informed consent as synonymous with research validity; however, the importance of research trustworthiness is shared (Furlong and Oancea, 2005). The use of a mixed method approach in this study allowed the researcher to apply both scientific rigour and informed consent throughout the data collection process.

The researcher considered the research contribution to knowledge in advance of the data collection process and conducted in-depth research on associated theoretical models in an effort to ensure a depth of knowledge and understanding to identify gaps in knowledge in the area of mobile technologies (Furlong and Oancea, 2005). The research design was explicitly planned based on philosophical premises, checked for consistency and coherence with regards to methodology and aims, data collection, data consistency with the topic and contribution to knowledge (Ghesquiere et al., 2004).

Data triangulation through the use of both quantitative and qualitative data were used in this inquiry to explain in greater depth student attitudes towards mobile technologies and enhance both external and internal validity and reliability of the data (Kelliher, 2005). In Phase I, the survey data results were used alongside theory to aid the development of topics for discussion during the focus group sessions. This helped the researcher to add to the validity of the inferences being made from the data and increase validity and reliability of inquiry outcomes (Polit and Hungler, 1999).

3.10.3 Pilot Test – Item face and content validity

The pilot testing process of the investigation was used to test the face and content validity of the questions used in the inquiry and afterwards the researcher used the feedback to reword ambiguous or misleading questions. A Cronbach's Alpha test was carried out to test the internal reliability of the scale items and a Pearson

Correlation coefficient test was used to examine item correlation. A factor analysis enabled the researcher to examine reliabilities of various constructs in the model. The research supervisor was also consulted and provided guidance, comments and feedback on item clarity, quality and appropriateness to the topic. This iterative process resulted in the rewording and modification of some questions for clarity purposes and improvements in question layout design.

3.10.4 Sampling

The collection of data representative of a population is the common aim of survey research where the data are used to generalise findings from a sample representing a population within the limits of random error (Bartlett et al., 2001). The unit of analysis was the individual student and the target population, upper-sixth, post-primary level in Phase I when at the time of data collection (DoE, 2016) figures document that 42% (9,557) of pupils out of a total of 23,001 leaving post-primary education in NI entered HE (includes UK and Ireland universities) broken down as 70% from grammar and 21% from non-grammar institutions. In Phase II, it is documented that 9,470 (NI resident students) entered HE institutions in NI as first year undergraduate full-time students (HESA, 2013). In quantitative research the suitability of a sample determines the meaningfulness and generalisability of the results; in this study, the researcher planned the most appropriate sampling method for the target population, utilised an appropriate data collection instrument and applied appropriate statistical analysis of the data (Cohen et al., 2011). Stratified purposive sampling was utilised in the study to increase representativeness and generalisability of data (Teddlie and Yu, 2007).

In Phase one data was stratified by management type, gender (single sex and co-educational schools) and based on EA figures. It should be noted that a single-sex boys' school, although invited did not participate in the study. Phase II was stratified by gender, university school and faculty. In order to guarantee a high response rate in Phase I, students were asked to complete the questionnaire in class or study sessions where the researcher was present (dependent on school requirements). This phase produced 579 valid questionnaires for analysis. In Phase II (Part A), students were asked to complete the questionnaire during the 'IT Induction' session which produced 1,162 valid responses. The follow-up

electronic surveys in Phase II (Part B and C) which included email reminders sent via Quest Bac software produced a total of 209 responses; however, 19 responses were deemed unusable as these included responses from participants who had completed the survey for Part B or for Part C and not for both. This resulted in a total of 190 valid responses from the same sample eligible for analysis. A high response rate was obtained to increase population generalisability and a wider representation of the population and to avoid, for example, gender and socio-economic biases.

Sampling is very important to the production of quality data from focus group sessions (Cohen et al., 2011). Four of the schools who completed the quantitative phase of the study agreed to participate in focus group sessions, a total of five sessions took place. The schools explained that this was a very busy period for the upper-sixth students so could not all allocate the required time for a focus group session. Fowler (2009) advocates between six to eight people per focus group session and in accordance eight participants attended each focus group session in this inquiry. However, the audit trail completed by the researcher during the process provided a data source with clear, detailed and in-depth descriptions of the data for replicability in future studies. The issue of subjectivity is prevalent in qualitative data; the researcher made a mindful attempt to remain objective throughout all focus group sessions, without leading participants and allow for free expressions of viewpoints (Bott, 2010).

To address sampling error, the researcher analysed standard deviations, frequency distributions and sampling distributions of the sample mean and the standard error for all data collected in each phase of the research project.

3.10.5 Internal reliability

Reliability and validity are the key corner stones of a measurement instrument (Tavakol and Dennick, 2011). The reliability of a scale indicates how free it is from random error as random error decreases the reliability of a scale (Pallant, 2013). Initial internal reliability was assessed on all collected data using Cronbach's Alpha to check for errors and inconsistencies (Cronbach, 1984; Tavakol and Dennick, 2011). When items are created to form a scale, then internal consistency is

essential in that the items should all measure the same thing and should correlate with one another (Bland and Altman, 1997). A detailed reliability analysis was performed on the complete data set where a minimum acceptable reliability co-efficient of 0.7 for latent variables was deemed acceptable. The reliabilities of the scales were determined through an iterative process. In Phase I, all alpha co-efficient scored 0.7 and greater. In Phase II (A), it was discovered that if one item in the Resources scale was removed, then the reliability would increase to an acceptable level above 0.7. In Phase II (B and C), all alpha co-efficients scored 0.7 and greater.

In order to assess construct validity, a Pearson product-moment correlation coefficient analysis was employed to measure linear relationships in the model and to establish if convergent validity was supported by the constructs. This established the direction and strength of relationships between variables. The correlation coefficient test was re-run after factor analysis to examine the variables of the hypothesised relationship.

The correlation matrix and exploratory factor analysis using the principal components method with Varimax rotation was employed to examine discriminant validity. This allowed the researcher to explore underlying constructs and dimensions of the model and grouping of items into a set of factors. Items were removed if there was a lack of theoretical and mathematical evidence that they belonged to one of the dimensions. Items were removed one at a time based on the following (Acton and Millar, 2009; Field, 2009). The Kaiser-Meyer-Olkin measure of sampling adequacy was considered with a value at least of 0.60 and the Bartlett test of sphericity was significant for each part of the research indicating that factor analysis was appropriate. Commonalities among items were examined and items with commonalities less than 0.3 were removed and the factor analysis was re-run. The matrix of loadings and items with a loading less than 0.3 were removed. In order to choose the number of factors an item eigenvalue of greater than 1 was utilised and the scree plot was also consulted alongside constructs cited in the hypothesised research model.

Finally, a series of regression analyses was run on all the data to test relationships in the model, the statistical significance of the proposed or emerging models and

its predictability (Ndubisi and Chukwunonso, 2004). This was also used to identify how different factors affect user Intention to Use mobile technologies for learning both inside and outside of school.

CHAPTER 4 ANALYSIS AND FINDINGS

4.1 Introduction

Chapter 3 has dealt with the methodology and explained in detail the parameters which guided this study. Chapter 4 will analyse and discuss the results obtained through the data collection. In this study, an extended technology acceptance model (TAM) which incorporated external variables PR and PMR constructs was used to establish the presence of a relationship between multiple sets of variables and to identify the important factors associated with the research problem.

The chapter presents the scale descriptive statistics which includes gender, type of mobile devices accessed by respondents and types of applications, platforms and resources accessed using a mobile device. The frequency and/or percentage to describe nominal or categorical scales are analysed for each phase of the study. The researcher groups items together from a theoretical aspect based on TAM2, and tests this by conducting a reliability analysis, which provides a benchmark for determining whether or not the items group together. Reliability and validity analysis was used by the researcher to confirm decisions and exploratory factor analysis to explore underlying constructs and model dimensions and to assess items grouping together into a set of factors or sub-factors. Pearson's r correlation, and multiple regression analysis, are used to test hypotheses, answer research questions and establish reliability and validity. Finally a summary of the triangulation of the findings of each phase of this study is discussed at the end of this chapter.

Data analysis was completed after each phase of the research project. The findings are divided into three sections:

- Phase I
- Phase II (A)
- Phase II (B and C)

4.2 Data Screening

All questionnaire data were inspected for missing data through both descriptive and visual means. Data were also inspected for outliers to check adherence to statistical assumptions and for skewness and kurtosis (see Appendix 12).

4.2.1 Missing data

The researcher allocated the value '9' to items with missing data. This was used to record missing data in Statistical Package for the Social Sciences (SPSS) for data analysis purposes and is recommended practice in the recording of missing data (Acton et al., 2009).

4.2.2 Phase I

In total, 581 completed surveys were returned to the researcher and 579 were included in analysis. The PR section was completed by all respondents but contained three missing responses. The PU section contained four missing responses and PEOU contained eight missing responses. The ATT section contained five missing responses and IU contained one missing response. Finally the PMR contained three missing responses. This resulted in a total of twenty-four missing items. The researcher made the decision to reject two cases from analysis due to the number of missing items. The full breakdown is available in Appendix 12.

4.2.3 Phase II Part A, Part B and C

In Phase II (A), 1,162 questionnaire were completed by participants. Across all cases there was a total of 17 missing items (see Appendix 12); therefore, a decision was made not to discard any cases from analysis.

In Phase II (B and C), all items across all cases were completed in each of the 190 questionnaires therefore none were discarded from analysis.

4.3 Phase I - Descriptive Statistics

In Phase I, the sample respondents derived from the target population (upper-sixth post-primary level students) provided demographic information including gender, mobile devices accessed and online resources or platforms accessed using a handheld device (see full breakdown in Appendix 13).

4.3.1 Gender

Gender demographic data were gathered for 579 participants. The breakdown is summarised in Table 4.2. The female representative sample was 26.5% more than the male representative sample which is representative of the participating schools in the study as five single–sex girls' schools along with ten mixed sex schools participated.

Table 4.2 Gender Demographic

Gender	Frequency	Percentage
Male	213	36.7%
Female	366	63.2%

*N = 579

4.3.2 Student access to a mobile device at school

The majority of post-primary students (88%) did not have formal permission (see Table 4.3) to use a mobile device in school. Focus group sessions highlighted that specific teachers allowed informal use of handheld devices in class to complete coursework or search for information.

Table 4.3 Access to Mobile Device at School

Response	Frequency	Percentage
Yes	60	10.4%
No	510	88.4%

*N = 570

4.3.3 Type of device accessible on daily basis at school/home

Participants were asked to indicate the type of mobile device accessed at school or home from a choice of eight and an 'Other' option (see Appendix 13). Although 88% of respondents listed that use of a mobile device was prohibited in school all respondents accessed at least one type of mobile device in school. The most highly accessed device was the smartphone (68%) and an Internet connected telephone (58%). Notably 42% more students have access to a tablet computer at home (out of school) in comparison to school use. The laptop is accessed at home (out of school) by 92% of respondents, whereas at school it is accessed by only 36% of respondents.

4.3.4 Use of a mobile/handheld device to access online learning resources, communication tools, social networking platforms

A total of 81.60% of respondents had previously used a mobile device to access information, resources, communication and social networking tools (see Appendix 13).

Communication Tools and Platforms

Platforms such as email (93.3%) and SMS messaging (86.2%) were the most highly accessed communication tools via a mobile device. Just over 70% had used Chat tools and/or IM and 91.1% of students had used a device to access social networking platforms. Web 2.0 technologies such as wikis and blogs were most

significantly accessed outside of school with over 40% having previously used mobile telephones (Smart/Internet connected) and 29% had used a PDA to access the tools.

Online Information and resources

Significant numbers of respondents had accessed online static information (69.5%) and newsfeeds (74.9%); however, under half of participants (40.8%) had accessed a digital library using a mobile device. The increasing importance of cloud-based technologies is evident as 25.8% had used mobile technologies to save or share documents via for example ‘Drop box’.

Learning Platforms and Resources

The findings indicated that significantly less participants used a mobile device to retrieve learning resources via, for example, a VLE or have access synchronised/synchronised learning materials inside or outside of school. For example, 6% of users had previously used a smartphone to access synchronised video class.

4.4 Phase I - Reliability and Internal Consistency Analysis of Measurement Instrument

When a Likert-type scale is used in a data collection instrument, then it is essential to calculate Cronbach's alpha coefficient for internal consistency and reliability (Gliem and Gliem, 2003). Lee Cronbach (1951) developed this as a measurement of internal consistency and inter-relatedness of items in a scale measuring the extent to which items measure the same construct (latent) (Tavakol and Dennick, 2011). If items in a test are correlated to each other, the value of alpha increases (Bland and Altman, 1997).

Cronbach's alpha coefficient test was run on all 579 self-completion questionnaires. The reliability tests were conducted for all six constructs measured in the questionnaire (see Appendix 14). All alpha co-efficient scored 0.7 or greater ranging from acceptable to high internal consistency. Table 4.4 summarises results of the reliability analysis for the constructs in the study.

Table 4.4 Results of Reliability Analysis (N=579)

Construct	No. of Items	Cronbach's Alpha
PR	15	.780
PU	10	.933
PEOU	8	.700
ATT	8	.761
IU	5	.910
PMR	22	.866

4.5 Phase I – Validity Analysis

Construct validity can be broadly described as the degree to which the construct measures the concept it is aiming to measure (Bagozzi et al., 1991).

4.5.1 Convergent validity

Pearson's Product-Moment Correlation (r) coefficient aims to determine if a relationship exists between two variables, the direction and strength of the relationship (Field, 2009). Pearson correlation was tested initially on the data to establish if convergent validity was supported by the constructs. All variables displayed a significant result at the $p<0.01$ or $p<0.05$ level and a significance level of .000 indicating that the probability of the correlation not being statistically significant was very low. The correlation among the majority of items measuring the PR construct presented lower levels of convergent validity in comparison to correlation scores measuring the other items in the study (see Appendix 15). Correlation of constructs was examined after factor analysis.

4.5.2 Discriminant validity

The correlation matrix approach and factor analysis were applied to examine discriminant validity. The measurement of internal consistency and a high alpha result does not imply that the scale in question is unidimensional; factor analysis was used as a method to check the dimensionality of a scale (Gliem and Gliem, 2003). In dimension reduction, a principal component analysis along with varimax rotation method was performed on each construct to measure, evaluate and compare variables and analyse what the factor structure fallout of this scale was to enable interpretation of factor structure.

The researcher also used this to verify the underlying foundations of the sets of variables making up each construct, initially presented in the research model (Elwood et al., 2006). It reduces variables into a smaller amount of more manageable components or factors (Field, 2009). This allows the researcher to look at patterns behind correlation in the variables, the simplification of relationships between variables and identification of common components between groups of variables underlying their relationship (Acton and Miller, 2009).

This process was assisted by the use of parallel analysis in the scree plot results alongside the Eigenvalues and percentage of variance explained (Liaw et al., 2007). A component was retained for factor extraction with an item eigenvalue greater than 1 and the percentage of variance greater than 6.7%.

In the initial factor analysis, item communalities were examined and any items with communalities less than .3 that did not fit well within the factor solution were removed (PR - items one and seven; ATT – item two and eight; PMR - items nine, 13 and 15 and 18 respectively). Factor analysis was re-run. The Kaiser-Meyer-Olkin measure of sampling adequacy of .937 and Bartlett's test of Sphericity is significant at .000. Factors with loadings on the rotated component matrix of less than .40 were omitted to improve clarity and interpretation as loadings of 0.4 or above, are considered to demonstrate acceptable convergent validity (Chesney, 2006). The constructs are unidimensional and factorially distinct and all items used to operationalise constructs load onto a single factor.

This resulted in the emergence of seven dominant factors accounting for 56% of the total variance explained (see Appendix 16). It must be noted that the ATT construct was merged into IU. After rotation the following factors emerged:

1. PU (Items one-nine) and integrating PEOU (Items six and seven)
2. IU (Items one to five) and incorporating ATT (Items three to six)
3. MR (Flexibility for Communication) (Items fourteen, sixteen, seventeen, nineteen and twenty-twenty-two)
4. MR (Access to information) (Items one-six)
5. PEOU (Items one to three and eight)
6. PR (School-based) (Items eleven to fifteen)
7. PR (Home-based) (Item two, four and ten).

A further Cronbach's Alpha coefficient test was conducted on the seven components to assess the reliability of a multiple-item variable. All components measured above the widely argued minimum level for the alpha coefficient of >.70. (Tavakol and Dennick, 2011) and are listed in Table 4.5. A full breakdown is listed in Appendix 16.

Table 4.5 Results of Reliability Analysis (N=579)

Component	No. of Items	Cronbach's Alpha
PU	11	.921
IU	9	.938
PMR (Flexibility for Communication)	7	.863
PMR (Access to Information)	6	.849
PEOU	4	.842
PR (School-based)	5	.769
PR (Home-based)	3	.730

4.6 Scale Descriptive Statistics

Descriptive statistics were obtained after the reliability and validity of the scales were verified. It excludes items removed after the reliability and validity analysis. Appendix 17 presents descriptive statistics and frequency tables for scale items measuring each of the emergent constructs. These were analysed and inspected before proceeding to the next phase of statistical analyses.

4.7 Research Model Evaluation

Seven constructs emerged from the data analysis and the ATT construct became merged into IU (see Figure 4.1 depicting amended extended TAM). The next step in model evaluation was testing the relationships hypothesised in the original research model alongside the newly emergent constructs.

4.7.1 Bivariate relationship

A Pearson product-moment correlation coefficient analysis was run to measure linear relationships in the model and examine correlations between the variables of the hypothesised relationship, which was followed by linear regression analysis. Appendix 18 details full result breakdown.

H1 states that PU is positively related to IU. Analysis produced a correlation coefficient of .785, significant at $p<0.01$ which suggests a strong positive linear relationship exists suggesting that H1 is supported.

H2 states that PU is positively related to ATT. This is unsupported because items measuring ATT were integrated into the IU construct.

H3 states that PEOU will have a positive effect on IU. A weaker positive correlation coefficient of .360 emerged, significant at $p<0.01$, suggesting that H3 is statistically acceptable and supported.

H4 states that PEOU will have a positive effect on PU with a correlation coefficient of .358, significant at $p<0.01$, suggesting that H4 is supported.

H5 states that PEOU will have a positive effect on ATT towards using mobile technologies (see H2).

H6 states that ATT is positively related to IU (see H2).

H7 states that PR is positively related to PEOU. The factor analysis produced two PR component items measuring: School-based and Home-based. School-based produced a correlation coefficient of .133, significant at $p<0.01$ which suggests a weak positive relationship. Home-based produced a positive correlation of .359, significant at $p<0.01$ which suggests a moderate relationship. This suggests that H7 is supported.

H8 states that PR is positively related to PU. School-based produced a positive correlation coefficient of .333, significant at $p<0.01$ suggesting a weak significant relationship. Home-based produced a stronger positive correlation of .516 significant at $p<0.01$ suggesting that H8 is supported.

H9 states that PR is positively related to ATT (see H2).

H10 states that PR is positively related to IU. School-based demonstrated a coefficient of .133, significant at $p<0.01$ which suggests a weak positive relationship. Home-based and IU presented at .461, significant at $p<0.01$, suggesting a moderate significant positive relationship and that H10 is supported.

H11 states that PMR is positively related to PEOU. The factor analysis produced two PMR components items measuring Flexibility for Communication and Access to Information. Data analysis found a moderate positive relationship between the variables measuring at .368 and .398 (respectively), significant at the $p<0.01$ level, suggesting that H11 is supported.

H12 states that PMR is positively related to PU. Flexibility for Communication produced a positive correlation of .567 and Access to Information produced a significant correlation of .579, significant at the $p<0.01$ level. This suggests that H12 is supported.

H13 states that PMR is positively related to ATT (see H2).

H14 states that PMR is positively related to IU. Flexibility for Communication produced a positive correlation of .571 and Access to Information produced a correlation of .567 significant at the $p<0.01$ level suggesting that H14 is supported.

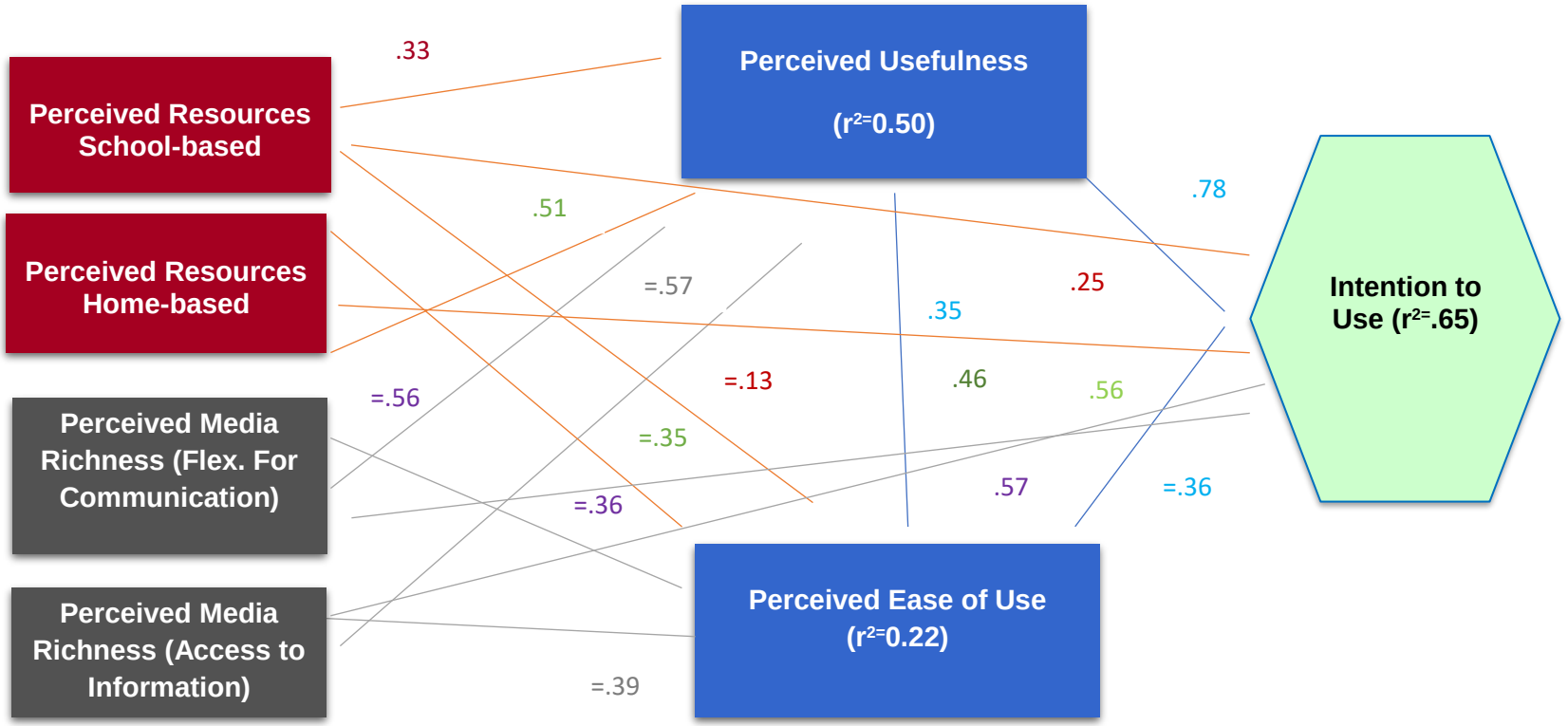
4.7.2 Regression analysis

A series of regression analyses was also run on the data to test relationships in the model and the predictability of the research model (Ndubisi and Chukwunonso, 2004). This is derived by calculating the percentage of total variance evaluating the relationship between a dependent variable and independent variables (Hossain and Prybutok, 2008). It allows more powerful insights into the interrelationship among variables in a dataset.

For the emergent model, the researcher examined path coefficients, p-values, t-values and variance (r^2 values) for each dependent variable that can be explained by the path model. A graphical representation of the structural model presented in Figure 4.1 displays standardised regression coefficients and the p-values represent their respective significance levels and r^2 values. Appendix 19 lists full breakdown of analyses.

All coefficient values are positive, indicating that as the value of the latent variable increases then the value of the dependent latent variable increases (see Figure 4.1). It is proposed that 50% of variance in PU, 22% in PEUO and 65% in IU mobile devices are explained by the emergent model. Alongside analysis of the bivariate relationships among model variables, and after regression analysis of the emergent model, it is reasonable to claim that the model has strong explanatory power and results support the tested hypothesis.

Figure 4.1 Revised Model after Factor Analysis (with Standardised Beta Coefficient)



Path coefficient significant at P<.01 level

4.8 Phase II (Part A) – Descriptive Statistics

In Phase II, the sample population is first year undergraduate students at 'THE University'. In total, 1,162 questionnaires were completed by consenting participants. The sample completed demographic information including gender, degree course and the type of mobile technology devices accessed (see Appendix 20).

4.8.1 Gender

Gender demographic data were gathered from 1,160 respondents (see Table 4.6). The female representative sample was 32.9% higher than the male representative sample which reports similar sample proportions to data gathered in Phase I of the research study (63.2% female and 36.7% male respectively).

Table 4.6 Gender Demographic

Gender	Frequency	Percentage
Male	389	33.5%
Female	771	66.4%

*N=1,160

4.8.2 Degree course

Participants were asked to state degree course and the data collected were representative of each of THE University faculties – Arts, Humanities and Social Sciences (40%); Engineering and Physical Sciences and Medicine (20%); Health and Life Sciences (40%).

4.8.3 Handheld/mobile devices accessed on a daily basis on and off-campus

The mobile telephone and the laptop were the most highly accessed devices. Notably, 9.5% of participants' listed access to a mobile device without an Internet connection while

31.8% had access to a tablet computer, 28.1% a personal digital assistant and 19.8% an eReader.

4.9 Reliability Analysis of Measurement Instrument

Cronbach's Alpha coefficient test was conducted on all six constructs measured in the questionnaire. Cronbach's alpha was run on the three items measuring the PR construct and with item three removed; a coefficient of .283 emerged which is not considered an acceptable score of scale reliability (Field, 2009). The remaining two items and the PR construct had to be removed from further analysis. Items measuring constructs PU, PEOU, ATT and IU measured greater than 0.7 ranging from acceptable to a high internal consistency (see Appendix 21 for the full breakdown).

4.10 Correlation among Scale Items

Pearson's Product-Moment Correlation (r) coefficient was initially tested on the data in Phase II (A) to establish the significant levels of the extended TAM constructs. PEOU item 4 was removed due to statistically insignificant results and all remaining variables displayed a significant result at the $p<0.01$ level (see Appendix 21).

4.11 Factor Analysis

The factor analysis produced a Kaiser-Meyer-Olkin measure of sampling adequacy of .904 and Bartlett's test of Sphericity was significant at .000 with a six factor fallout (see Appendix 22). The six factors accounted for 75% of the total variance explained:

1. PMR (Task importance) (MR items four, five, seven, nine, ten and PEUO item four)
2. PU (Items one-four and MR items one-three and six)
3. PEOU (Items one, two, three, five, seven and ATT item one)
4. PMR (Flexibility for Communication) (MR items eight, eleven, twelve and PEOU item six)
5. ATT (Items two-six)
6. IU (Items one-three)

A further Cronbach's Alpha coefficient test was conducted on the six components and are listed in Table 4.7 and a full breakdown is available in Appendix 22.

Table 4.7 Results of Reliability Analysis (N=1162)

Component	No. of Items	Cronbach's Alpha
MR (Task Importance)	6	.988
PU	10	.927
PEOU	8	.832
MR (Flexibility for Communication)	4	.993
ATT	5	.776
IU	3	.822

4.12 Scale Descriptive Statistics

Descriptive statistics were obtained after the reliability and validity of the scales were verified and excluded items removed after this analysis. Appendix 23 presents scale descriptive statistics including minimum and maximum scores, means, standard deviations, kurtosis and skewness and frequency tables for each scale item.

4.13 Research Model Evaluation

PR originally hypothesised in the original research model was not statistically viable and as a result items were removed from further analysis. The other construct, external to TAM, in the original hypothesised mode was PMR. PMR emerged as a statistically significant factor; however, it was divided into two separate constructs:

- Media Richness (Task Importance)
- Media Richness (Flexibility for Communication).

4.13.1 Bivariate correlation

A Pearson product-moment correlation coefficient analysis is summarised in this section, a full breakdown of results is available in Appendix 24.

H1 states that PU is positively related to IU. Analysis produced a correlation coefficient of .460, significant at $p<0.01$ which suggests a moderate positive linear relationship exists and that H1 is supported.

H2 states that PU is positively related to ATT towards using mobile devices. A positive correlation coefficient of .576, significant at $p<0.01$ suggesting that H2 is supported.

H3 states that PEOU will have a positive effect on IU. A positive correlation coefficient of .362 emerged, significant at $p<0.01$ suggesting that H3 is supported.

H4 states that PEOU will have a positive effect on PU. This produced a positive correlation coefficient of .442, significant at $p<0.01$ suggesting that correlation is statistically moderate and H4 is supported.

H5 states that PEOU will have a positive effect on ATT towards using mobile technologies. This produced a weak positive correlation coefficient of .315, significant at $p<0.01$ suggesting that H5 is supported.

H6 states that ATT is positively related to IU. This produced a positive correlation coefficient of.433, significant at $p<0.01$ suggesting that H6 is supported.

H7 states that PR is positively related to PEOU. PR did not produce a statistically acceptable alpha result so was removed from the analysis.

H8 states that PR is positively related to PU (as above).

H9 states that PR is positively related to ATT (as above).

H10 states that PR is positively related to IU (as above).

H11 states that PMR is positively related to PEOU. The factor analysis produced two PMR component items measuring Task Importance and Flexibility for Communication which produced a correlation coefficient of .023, suggesting a very weak positive correlation and .334 respectively, a stronger positive relationship between the variables, both significant at $p<0.01$ suggesting that H11 is supported.

H12 states that PMR is positively related to PU. Task Importance found a weak positive relationship between the variables measuring at .070, significant at $p<0.01$ level and Flexibility for Communication measured at .558, suggesting a moderate relationship, significant at $p<0.01$ level supporting H12.

H13 states that PMR is positively related to ATT. Task Importance found a weak positive relationship between the variables measuring at .076 and Flexibility for Communication measured at .528, suggesting a moderate relationship, both significant at the $p<0.01$ level suggesting H13 is supported.

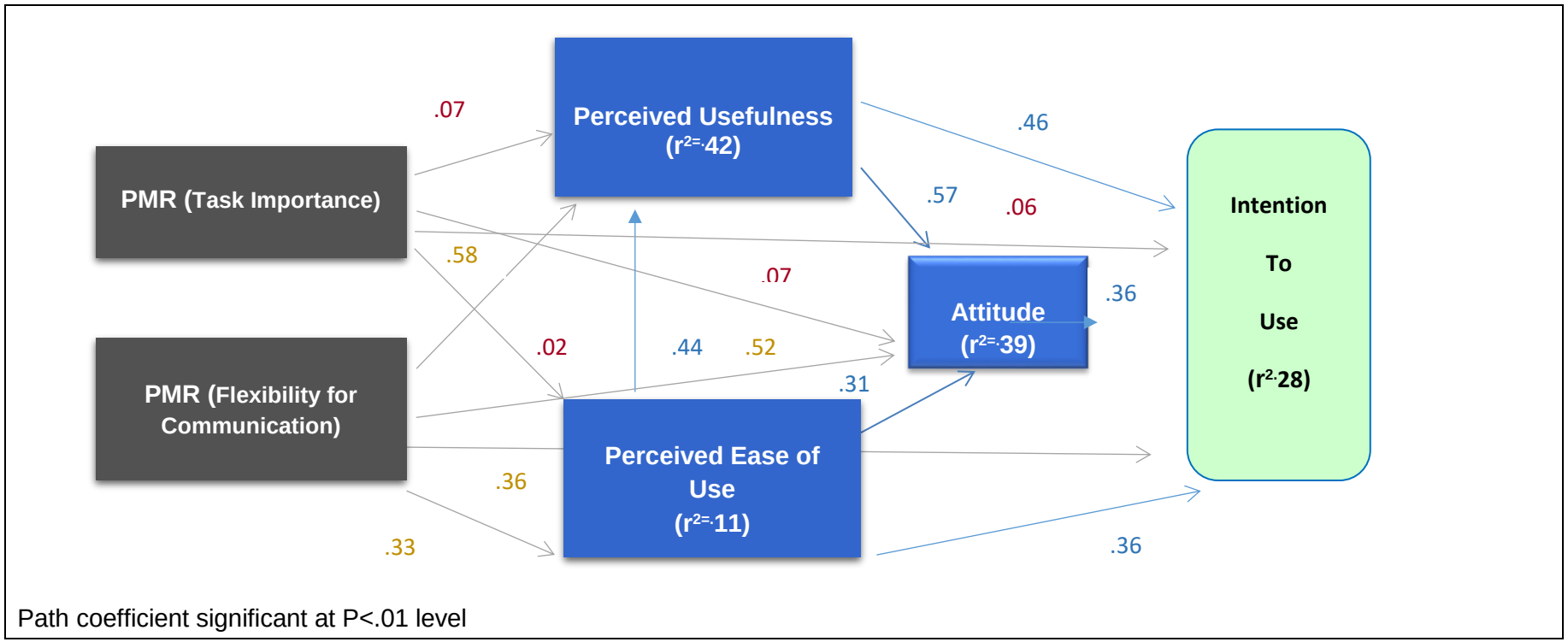
H14 states that PMR is positively related to IU. Task Importance found a weak positive relationship between the variables measuring at .060, significant at the $p<0.05$ level and MR Flexibility for Communication produced a stronger correlation of .365 significant at the $p<0.01$ level suggesting H14 is supported.

4.13.2 Regression analysis

A regression analysis was conducted to test each hypothesis. The results of the complete analysis of the structural model, including path coefficients, path significance and variance explained (r^2 values) for each dependent variable that can be explained by the path model are presented in Appendix 25. A graphical representation of the structural model is presented in Figure 4.2 which displays standardised regression coefficients and the p-values represent their respective significance levels and r^2 values. All coefficient values are positive, indicating that as the value of the latent variable increases then the value of the dependent latent variable increases.

The proposed amended model explains 42% of variance in PU, 11% of variance in PEOU, 39% in ATT and 28% in IU. Alongside analysis of the bivariate relationships among model variables, and after regression analysis of the emergent model, it is reasonable to claim that the model can offer explanatory power and results support the tested hypothesis.

Figure 4.2 Revised Model after Factor Analysis (with Standardised Beta Coefficient)



4.14 Phase II (Part B and C) - Descriptive Statistics

Phase II (B and C) of the study was completed by the first year undergraduate students at the end of semester one and two. A total of 260 questionnaires were electronically distributed and 190 responses were returned and analysed (see Appendix 26 for breakdown of demographic data).

4.14.1 Gender

The female representative sample was significantly larger at 67% more than the male representative sample as shown in Table 4.8.

Table 4.8 Gender

Gender	Frequency	Percentage
Male	31	16.3%
Female	159	83.7%

*N=190

4.14.2 Access to handheld/mobile devices

Appendix 26 presents a full breakdown of types of mobile devices accessed. The laptop along with mobile telephone devices are the highest accessed devices. Handheld devices such as the tablet computer (46.3%), the personal digital assistant (13.3%) and the eReader (17.6%) also present significant access figures among respondents.

4.14.3 Use of a mobile device to access resources, tools and social media applications.

The use of mobile technologies to access communication tools and platforms produced particularly high results such as email (79.3%) and IM (45.2%). Accessing social networking platforms and blog tools also produced significant results at 48.5% and 47.3% respectively. Devices were used to access information (47.9%) and online resources such as a digital library (40.8%). The results also highlighted that mobile technologies were highly utilised in the retrieval of specific learning resources, for example, a VLE (43.1%) (see Appendix 26).

4.15 Reliability Analysis of Measurement Instrument

Cronbach's Alpha reliability tests were conducted for all six constructs measured in the hypothesised model (see Figure 1.3). The items measuring PR produced a result of .629 before the removal of item three. Two items (11 and 12) were removed from PEUO to raise the alpha value from .492. Two items (16 and 20) were removed from ATT. Table 4.9 summarises the results. Appendix 27 illustrates full results of the reliability analysis.

Table 4.9 Results of Reliability Analysis (N=190)

Construct	No. of Items	Cronbach's Alpha
PR	2	.748
PU	4	.895
PEOU	5	.847
ATT	4	.823
IU	3	.778
PMR	16	.839

4.16 Correlation among Items Measuring Variables

All scale correlations were significant at the $p<0.01$ level. All items produced positive correlations with at least one other item, significant at the $p<0.01$ or $p<0.05$ level and a significance level of .000 indicating that the probability of the correlation not being statistically significant is very low. Correlation among items 29, 35 and 37 did not produce significant positive or negative correlations with any other items and a probability of statistical insignificance so were removed from the analysis (see Appendix 28). Correlation was again examined after factor analysis was carried out on the data.

4.17 Factor Analysis

A factor analysis was conducted based on eigenvalues and a six factor solution emerged:

1. PEUO (Items eight, nine, ten, fourteen, fifteen and two items originally measuring PMR).
2. PU (Items five, six, seven; item three originally measuring PEOU and items twenty-four to twenty seven originally measuring PMR).
3. ATT (Items fifteen, seventeen, eighteen and nineteen).
4. IU
5. PMR (Flexibility for Communication) (Items twenty-eight, thirty-one, thirty-four, thirty-six and thirty-eight).
6. PR (Items one and two).

The Kaiser-Meyer-Olkin measure of sampling adequacy of .896 and Bartlett's test of sphericity was significant at the .000 level. The six factors accounted for 71% of the total variance explained. A further Cronbach's Alpha coefficient test was conducted on the six components which emerged from factor analysis and these are listed in Table 4.10 (see Appendix 29).

Table 4.10 Results of Reliability Analysis

Component	No. of Items	Cronbach's Alpha
PEOU	7	.872
PU	8	.921
ATT	4	.853
IU	3	.818
MR(Flexibility for Communication)	5	.833
PR	2	.816

4.18 Scale Descriptive Statistics

Descriptive statistics were obtained after the reliability and validity of the scales were verified and excluded removed items. Appendix 30 presents frequency tables and descriptive statistics for each scale.

4.19 Bivariate Relationships

All variables reported positive correlate bivariate relationships, significant at the $p<0.01$ level. A full breakdown of bivariate relationships are available in Appendix 31.

H1 states that PU is positively related to IU. This produced a strong positive correlation coefficient of .707 suggesting that H1 is supported.

H2 states that PU is positively related to ATT towards using mobile devices. This produced a strong positive correlation coefficient of .624 suggesting that H1 is supported.

H3 states that PEOU will have a positive effect on IU. A moderately strong correlation coefficient of .440 emerged suggesting that H3 is supported.

H4 states that PEOU will have a positive effect on PU and a resulting strong correlation coefficient of .636 indicates that H4 is supported.

H5 states that PEOU will have a significant effect on ATT. This produced a moderately positive correlation of .534 suggesting that H5 is supported.

H6 states that ATT is positively related to IU. This produced a positive correlation of .435 suggesting that H6 is supported.

H7 states that PR is positively related to POEU. This produced a weaker but significant positive correlation of .359 suggesting that H7 is supported.

H8 states that PR is positively related to PU. This produced a weaker but significant positive correlation of .256 suggesting that H7 is supported.

H9 states that PR is positively related to ATT, with a very weak correlation of .165; however, it is significant at $p<0.01$ suggesting that H9 is supported.

H10 states that PR is positively related to Intention to Use, with a weak correlation of .324; however, it is significant at $p<0.01$ suggesting that H10 is supported.

H11 states that PMR is positively related to PEOU. A positive moderately strong correlation of .590 suggests that H11 is supported.

H12 posits that PMR has a positive effect on PU. This produced a strong correlation of .665 suggesting that H12 is supported.

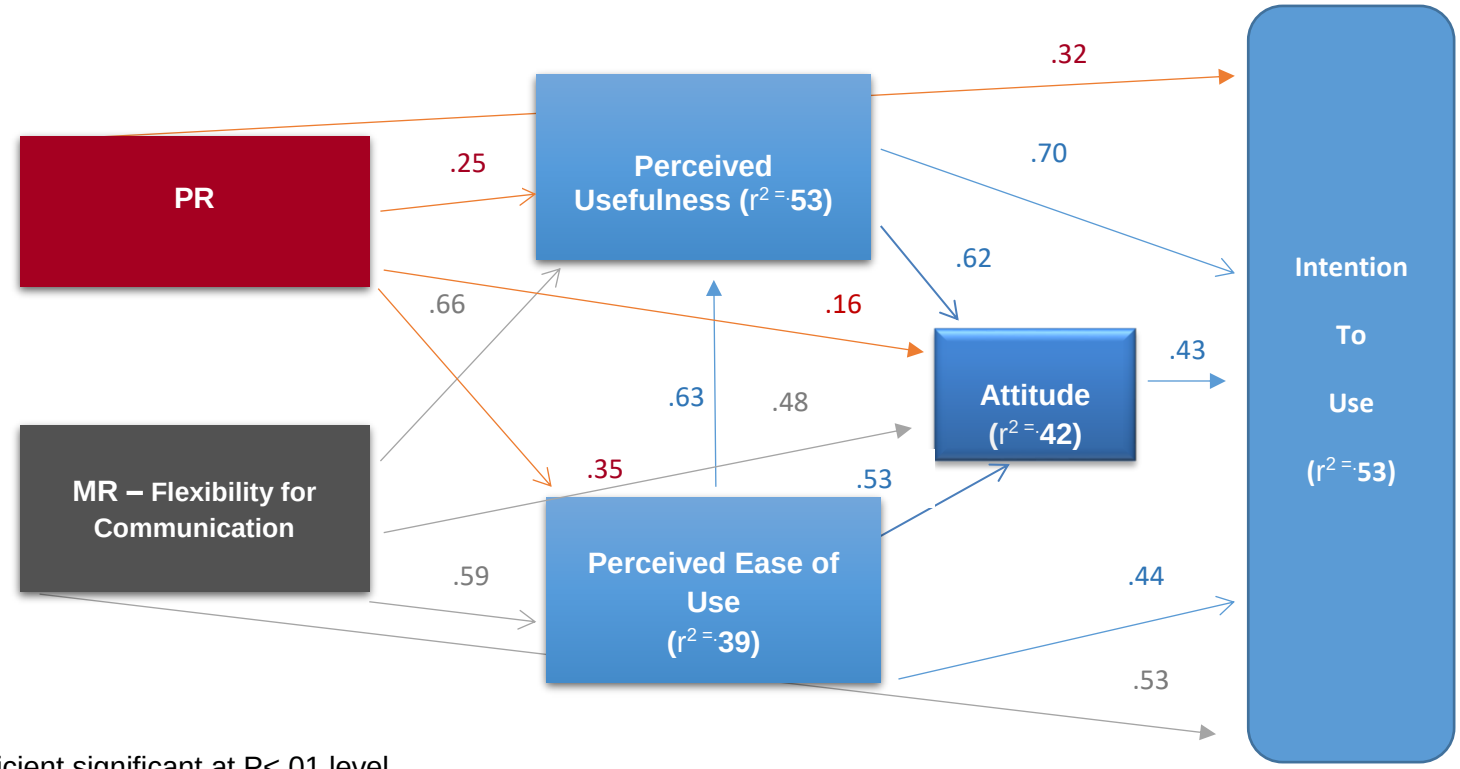
H13 posits that PMR is positively related to ATT. A moderately strong correlation of .489 emerged suggesting H13 is supported.

H14 states that PMR is positively related to IU. This produced a moderately strong correlation of .532 suggesting that H14 is supported.

4.20 Regression Analysis

A regression analysis was again conducted to test each hypothesis. The results of the complete analysis of the emergent structural model are presented in Appendix 32. Figure 4.3 displays structural model standardised regression coefficients, and the p-values represent their respective significance levels and r^2 values. All coefficient values are positive, indicating that as the value of the latent variable increases then the value of the dependent latent variable increases. The proposed amended model explains 53% of variance in PU, 39% of variance in PEOU, 42% in ATT and 53% percent in IU. It is reasonable to claim that the model can offer explanatory power and results support the tested hypothesis.

Figure 4.3 Model after Factor Analysis (with Standardised Beta Coefficient)



Path coefficient significant at P<.01 level

4.21 Qualitative Data Analysis

This section analyses and discusses data emerging from focus group sessions. In preparation for the sessions, questions and guiding topics for discussion were designed and guided through the lens of the extended TAM2 with the inclusion of constructs PR and PMR. The researcher applied a deductive approach to data analyses relying heavily on the study's research questions to direct and guide the groupings and analysis of the data collected.

4.21.1 Focus group sessions

The focus group sessions were audio-recorded, transcribed verbatim, coded and analysed using thematic analysis (Onwuegbuzie et al., 2014). The approach consisted of six stages: familiarisation with the raw data, code development, finding, reviewing, defining, specifying and describing themes in the research report. A qualitative analysis tool, NVIVO, was initially considered and used to assist with the coding of the data into themes and subcategories. However, the researcher reverted to coding by hand as the researcher concluded that this would enable better familiarisation with the data. The data were then analysed using open-coding into a large number of categories to reveal connections and reflect both the research questions and the emerging themes.

The researcher attached conceptual labels to every line in the transcripts to capture what had been said and observed (see Appendix 33). Codebooks were developed (see the sample in Appendix 33) using MS Excel where each variable measuring each of the constructs based on the technology acceptance model were defined and labelled and assigned numbers for each of the possible responses on the scale. This enabled the researcher to further simplify, abstract and transform the transcriptions, identifying emerging themes from the responses. Patterns in the data were then developed and collapsed into categories and finally overarching themes evolved.

4.21.2 Analysis – 'Thematic Approach'

In the interests of clarity, a thematic approach has been used to present the findings which have been divided into three sections with the emergence of subsequent subthemes.

- Theme one: The importance of the mobile telephone. The mobile telephone dominated discussions in each of the five focus group sessions and was referred to as the primary mobile device.

- Theme two: PU and PEOU of the mobile device as a communication tool (learning and social purposes) at post-primary level and a necessity to learning at HE level. A sub-theme emerged with the clear distinction between use of mobile technologies inside and outside of school.

- Theme three: The perceived issues/problems associated with use of mobile devices for learning and other purposes.

Quotations used within each theme indicate verbatim remarks by the participants, and pseudonyms are used to denote the participants and institutions.

4.22 Theme One - Importance of the Mobile Telephone

The importance of the mobile telephone above other available mobile technologies was apparent throughout. The researcher gently stressed the term 'mobile devices' during discussions but the majority of participants continuously referred to mobile devices as a 'phone' and one respondent commenting *"if I could choose any phone then it would definitely be an Apple iPhone" [Student 1: G1].* Participants emphasised the fact that *"the phone is the handiest" [Student 1: G5] for easy access* to information from a range of sources *"……because everything is … in one place, cause … you can listen to music, … go on the internet, … text ….". [Student 3: G5].* Mobile devices such as the laptop and tablet computer were also noted as important for accessing learning materials and resources; however, the flexibility and importance of mobile telephones was continuously emphasised with one participant commenting that:

"sometimes I can't be bothered with the laptop so just use the phone" [Student 2: G5].

4.22.1 Cost of mobile technologies

The cost of mobile technologies emerged as a subtheme in discussions focusing on the importance of the mobile telephone. A segregation in attitudes about the perceived cost in owning a mobile telephone became apparent. Over half of participants (56%) agree that the cost of mobile devices was a barrier to use;

"Yeah cost if you want something good, actually good, you can get a rubbish one cheap" [Student 7: G3].

Participants also differentiated the cost of a mobile telephone from the cost of other types of devices such as;

"an iPad and laptop computer yeah but I dunno about a phone,……but like an iMac is like 1000 pounds so like is very very dear, so" [Student 1: G2].

A significant 37% of participants felt that the cost of a mobile telephone did not impact access;

" … there's all the contracts and things where it's 10 pound a month and stuff. …… if you are prepared to be in a contract for it then, you know then cost isn't really an issue [Student 5: G5].

4.23 Theme Two - Use Inside and Outside of Formal Learning

Two distinct contexts of mobile device use emerged from the data; inside and outside of school which overarched perceived uses of mobile devices

4.23.1 Outside of school (for learning purposes)

(i) Access learning resources and materials

The majority of participants (81%) had previously used mobile technologies outside of school to tailor and personalise learning opportunities in the support of school learning for example *"if ….. stuck on a question" [Student 2: G2]* or compiling *"research for schoolwork at home" [Student 5: G3].* Students also used a mobile device to access materials or content or to reinforce school-based learning such as *"youTube for videos if you don't understand something" [Student 3: G3].*

Participants also listed and specified the use of mobile devices to access a broad spectrum of subject related content such as *"… French like translating …".* [Student 2: G2], *"the periodic table"* [Student 5: G2] and *" … an online Spanish Dictionary"* [Student 8: G4]. With another student commenting that it was useful for *"…writing an essay for … sociology and if I didn't know the term of something then I probably could look it up" [Student 1: G4].*

The use of the mobile device to access past examination papers and marking schemes was highlighted as an area of importance to the participants with one participant commenting that *"…the only thing I would use it for to access past papers and stuff" [Student 5: G2]*.

(ii) Access general information and resources on the World Wide Web

The ability to connect to the World Wide Web to access general information and resources emerged as an implicit benefit associated with the use of mobile technologies outside of formal learning. The participants in Group 2 identified browsing *"the BBC sport website* [Student 4] and *"Browsing clothes"* [Student 1]. The majority of participants agreed mobile devices increased ease, flexibility and convenient access to resources and information via the World Wide Web with one participant commenting;

"I just think for the Internet in general because everything is just right there, …. I like generally have a good connection on my phone so anything that I want to know or find out I can just search it and it just makes a lot of things easier" [Student4: G3].

(iii) Perceived usefulness and ease of use as a communication tool –social and learning purposes

The perceived most useful function of a mobile device was its role as a communication tool using communication applications and platforms. The words 'communication' or 'communicating' were used twenty-one times during discussions highlighting the importance of communication accessibility for users. The two key functions utilised on a mobile device are *"just texting and phone mostly"* [Student 8: G3] for *"staying in touch"* [Student 2: G1]. Social communication with friends and peers via social networking sites also emerged as a dominate function because of its easy accessibility and flexibility such as *"…texting but Facebook and WhatsApp as well" [Student 4: G3]* and *"… the social aspects of it like Facebook, texting, calling" [Student 1: G4].*

The use of mobile devices for learning-based communications with teachers and peers was also identified in all focus group sessions. While the majority of the participants preferred face-to-face contact with teachers, a number of participants highlighted the versatility and flexibility afforded via communication platforms on mobile devices such as:

> *"Email like teachers one hundred percent cause you can like read what they are saying think about it and reply and you can take as much time as you want to reply instead of feeling pressured into doing it quicker than that. Because I would say yes I understand even when I don't".* [Student 7: G3]

Students also identified the use of devices in collaborative learning with other students;

> *"It's good for FaceTime. I remember I FaceTimed a guy the whole day before an exam and we were just bouncing questions off each other*". [Student 7: G3]

and for collaborative learning with a number of peers simultaneously;

> *"I think like Group chat, you can do it with say a couple of people in your class and say you had a problem with something you can like Group chat it and then if somebody didn't know the answer then somebody else will"* [Student 3: G5].

Mobile devices could also afford students flexible communication with teachers about schoolwork outside of school hours; *"I would email teachers work and stuff and they would check it and send it back"* [Student 2: G3].

4.23.2 Use in a formal learning environment

(i) School Policy restrictions on mobile device use – effect on use as a viable learning tool

The majority of participants in each of the focus groups highlighted that *"you are not supposed to have mobile phones turned on during school*" [Student 3: G1]. Participants described teaching methods utilised as traditional teacher-led and that the use of mobile devices inside the classroom was in the majority prohibited. Participants commented that *"don't think students really get to use the Internet but teachers do …….. and can access the Internet to show you things.* [Student 2: G2].

However, four of the focus groups described that although *"school Policy [prohibits use of mobile devices] … you can use it in private study*" [Student 7: G3] or during free periods. One participant highlighted the importance of the availability of school-based mobile devices (laptops in this case) to access learning resources and materials on the school ssvirtual learning environment during study periods because *"I would never go onto the VLE on my phone, I don't even have WIFI at home …. so if I am gonna go onto it I am more likely to go onto the school laptop because our computer is very old … I find it easy to use and all that kind of thing .."* [Student 5: G5].

Group two participants specifically discussed school policy restrictions and commented that *"it would be better if the restrictions weren't as much on the Internet, is something I would like as well, some sites aren't even that bad and I can't get on them"* [Student 7: G2]. This significantly reduces the usefulness of mobile technology as a learning tool, one participant highlighted this with an example; *" I think another thing if you want to access stuff in school there are so many restrictions that you can't basically look at anything, we were doing in English this poem and it's from like the 18t century and because there is the word rape in it you can't access anything on it on school internet"* [Student 2: G2].

(ii) Teacher specific permission to use a mobile device

Another exception to the rule that emerged during the sessions was that specific teachers such as *"Science we are allowed to bring out laptops to do our work to help us …".* [Student 7: G4] in the classroom for learning purposes such as browsing for resources. While another participant highlighted that *"Yeah I do in politics but that's just because I can do easily. Yeah if I want to look up something instead of logging into the computer I can just look*

up my mobile phone" although another participant added that this was *"probably because you are the only person in your politics class!"* [Student 5].

(iii) Intention to use mobile devices for learning at HE level

Data emerging from the focus group sessions highlighted that school and classroom restrictions on mobile device use at post-primary level did not affect student intention to use mobile devices in further education or at HE level. Mobile technologies were viewed as a useful, important and essential tool for learning with one participant commenting that *"I would definitely think about buying a laptop before I go to Uni because it seems like something that would be really useful …" [Student 2: G2]*. Mobile devices were for example, viewed as an important, essential tool in the access of synchronous and asynchronous online learning resources or digital recordings of lectures, anytime from anywhere;

"Yeah I think it would be good cause the course says online learning so I think you could go on and that helps revise for your course so I think it would be useful" [Student 7: G4]. Another participants notes that "… they (University) *put a lot more emphasis on the IT things that they have there when go out and visit and they are showing off about the number of different things that they have and … when I went to talks and things the lecturer said that they would film their lectures then put them up online ……." [Student 4: G2].*

4.24 Theme Three: Perceived Issues Associated with use of Mobile Device for Learning Purposes

(i) Device functionality

Issues surrounding the functionality of mobile devices was raised by participants including the limitations offered by screen size and keypad size; "*It's probably a bit too small as well like size wise …*" [Student 6: G1] and slow internet connection speeds as it "sometimes it takes ages to load" [Student 8: G4]. However, issues with device functionality was recognised as potentially device-specific related and "*probably just to do with the phone*" [Student 5: Group 2].

Participants also highlighted issues with regards to access and editing of documents for learning with certain types of mobile device such as the "…… *iPad that we use and you know you can't open documents for school and stuff, it's crap"* [Student 2: Group 5]. The lack

of sufficient school infrastructures to support a utilitarian wireless connection was another suggested problem regarding mobile device use in school with one participant commenting that *"… the internet in school there's no Wifi it would be like 3G in the sense that it would take very long to load"* [Student 3: G5].

(ii) Incompatibility of learning style and the mobile device

Teacher-led learning alongside student learning styles highlighted an issue for mobile device use in formal learning contexts where, for example, paper-based materials were considered essential to learning particularly during examination revision periods where a participant commented that *"I wouldn't use it for direct revision I would just write everything down "on a piece of paper .."*. However, the participant found a device useful *"… if I wanted to know something I would email my teacher or text someone. Or look at past papers" [Student 6: G5]. Another participants echoed this attitude;*

"……. I prefer to have, if I am revising past papers and stuff I am fine with looking at the computer and writing down the answers but when it comes to revising and going through notes and stuff like that there I prefer to have the actual notes and be able to highlight them physically" [Student 1: G3].

The completion of coursework was also highlighted as an area where mobile devices were not considered utilisable;

"If I was doing coursework I would always go to the main computer" [Student 5: G1].

(iii) Potential distraction to learning

While the majority of participants agreed that a mobile device could provide easy and flexible access to various tools, resource and platforms, it was not considered an essential learning tool and had the potential to distract the user from learning:

"Yeah I think it is flexible, I think it is a good tool for learning although it also hinders it, you know if you spend all your time on your phone, you know instead of actually looking at your books. Is an aid but it's not an necessity …" [Student 1: G1].

The mobile device was also regarded as *".. too much of a distraction when doing coursework – if a text comes through" [Student 4: G1].* Outside of schools participants illuminated that parents were wary of device use for study and that *"some peoples mum and dad are funny about them having their phone when there are revising cause it can distract them"* [Student 2] and *"….anytime my mum sees me with the laptop she thinks I am not*

revising but I am actually using it for something" [Student 5]. Participants accepted and agreed with parental restrictions on the use of mobile technologies during, for example, revision for examinations due to its potential for study disruption with one participant communicating that *"….. if you are trying to revise then a mobile device is probably the worst thing you can have. I try and set it away from myself" [Student 1: G4].*

4.25 Data Triangulation

The perceptions of pre-university students (upper-sixth post-primary) and first year undergraduate students provide us with some interesting findings. The purpose of this study was to identify factors that affect the adoption of mobile devices for learning both inside and outside of formal learning contexts and to investigate the relationships among those factors. In this section, the researcher initially interrogated the models (Figures 4.1 and 4.2) emergent after factor analysis with standardised betas with path coefficients, which allowed the researcher to interpret the relationship between the variables and variance, detailing the relationship between the dependent and independent variables and then triangulating this with surveys and the focus group data.

In Phase I, the pre-university student data produced a model different to that of the proposed model. It is initially evident that PR emerged as two external constructs PR (School-based) and PR (Home-based) (Figure 4.1) whereas PR did not emerge as a statistically significant construct in Phase II (A) (Figure 4.2). It may be surmised that PR (School-based) and PR (Home-based) emerged as constructs in the Phase I research model due to the fact that these are considered additional beyond the classroom, and online resources are additional to non-teaching content because the majority (88%) are not allowed to use a device in school for learning purposes; thus, there are no formal strategies in place for integration in the learning curriculum. Whereas, at university, content and resources are all available online, for example, via the university VLE or utilisation of cloud-based applications in MS Office 365 such as OneDrive and collaborative apps such as Teams.

It also must be highlighted in Phase I (Figure 4.1) that the majority of variables in the emergent model indicate strong or medium-strong path coefficient relationships significant at $p<.01$ level, with only two of the variables producing weaker values, the relationship between PR (School-based) and PEOU and PR (School-based) with IU. This may be due to the fact that the majority of students do not have formal school permission to use a device for learning in school and are unsure if they have the time or support from either teacher or paper-based or electronic resources to support learning so the environment is not in place to associate school-based or home-based resources with either PEOU or IU.

The model emergent from pre-university student data is able to predict 65% of the variance of the IU mainly through PU and to a lesser extent (22%) through PEOU (Figure

4.1). The emergent external construct PMR (Access to Information) presented the strongest positive effect on intention to use mobile devices. This may be explained by the fact that users agree that mobile devices enable quick access to reliable and diverse types of information. The data emerging from the focus group sessions also indicate that the students value the benefits of easy access to information and resources through connection to the Internet and the World Wide Web. Participants also emphasised the usefulness of mobile technologies in the access of online learning materials to subsidise coursework and classroom-based learning. It provides students with the opportunity to support and reinforce learning through access to online subject-specific videos and access online examination papers and mark schemes.

The core TAM construct PU was also able to predict a significant 42% of the variance of IU in Phase II (A); however, PEOU's variance significantly reduced in the model to 11%. The ATT construct emerged in this model and presented a significant variance of 39% of IU and which may be suggested affected the variance of PEOU. The variance of IU of 28% may be explained by the fact the students have the expectation of mobile device use in third level education and this did indeed emerge during focus group sessions where participants suggested that mobile device ownerships and use would be a necessity at university level.

PMR also emerged as two constructs: PMR (Flexibility for Communication) which also emerged as an external variable in Phase I and PMR (Task Importance). PMR (Flexibility for Communication) and its importance to IU is also highlighted in the survey data as the majority of student participants strongly agreed the benefits regarding quick communication with others and agreed it facilitates the sharing of opinions effectively, openly and allows for communications that would not occur in face-to-face discussion. Users agree that devices aid quick communication allow for easy sharing of opinions with others using varied language and slightly disagree that there are issues that cannot be communicated using a handheld device. Interestingly, focus group participants indicated a preference for face-to-face contact with teachers, which supports survey findings where users indicated that the importance of a task would dictate mobile device use.

It is also notable that three of the constructs, PU, PEOU and PMR (Flexibility for communication), indicate strong or medium-strong path coefficient relationships significant at $p<.01$ level with ATT. Significantly, it emerged from survey data that

although users present a strong positive attitude to the use of the mobile device, they like to learn using a device and agree that a wireless device is fun to use in learning and can indeed make learning more interesting; however, it must be highlighted that users are unsure if the device can be a distraction to learning. Although ATT did not emerge as a construct in Phase I, the focus group attitude results echo Phase I survey data, such as the potential distraction mobile devices may cause to learning. Conversely, Kemp et al. (2019) note that the ATT construct can sometimes be incorporated into other constructs in the model as was the case of the model that emerged from Phase I survey data. It transpired that four of the items measuring the ATT construct were subsumed by the IU construct and all centred on the actual use of a device for learning. López-Bonilla and Laópez-Bonilla (2011) argue that ATT should be included in the TAM as it delivers better results.

Granić and Marangunić's (2019) systematic review of TAM empirical studies contend that PU is the strongest determinant for the adoption of technologies in education and each of the three emergent models in this study are also consistent with this, as PU presents the strongest relationship with IU and is also able to predict a significant 53% of the variance of IU. The model that emerged in Phase II (BC) (Figure 4.3) is the same as the proposed research model (Figure 4.1). Also, IU also rose here to 53%; this may be due to the fact that the undergraduate students' experience of using mobile devices in learning had an impact on attitudes to IU.

It must also be noted that PR emerged as a construct again in this model (Figure 4.3), as the construct did not emerge in the model from Phase II (A), university students at the beginning of the academic year and their third level studies. The survey data convey that students in Phase II (BC) felt that the perceived cost of mobile devices was an issue; however, students at the beginning of the academic year in Phase II did not consider cost an issue. This may suggest that users had to buy new technologies for use in learning in university, which perhaps exceeded user expectations in comparison to attitudes at the start of the academic year. It is also notable that the construct presents a medium-strong path coefficient with IU. It must be highlighted in Phase II BC (Figure 4.3) that the majority of variables in the emergent model indicate a strong or medium-strong path coefficient relationship significant at $p<.01$ level, the weakest being PR relationship with ATT measured at .16.

PMR (Flexibility for communication) again emerged as a construct as it did in other models (Figure 4.1) and (Figure 4.2), but with even stronger coefficient values, for example, the relationship with PU emerged as .66. It is interesting that students at the beginning of the academic year were unsure about receiving messages containing mixed media content; however, in this survey, students agree that they like feedback containing different media and agree that devices allow use of rich and varied language in communications.

The core variables of TAM PU and PEOU have been found on many occasions to affect user intention to use technology as is the case in this emergent model (Figure 4.3) (Granić and Marangunić, 2019). It is also significant that in this model PEOU statistical significance substantially increased in comparison to post-primary students and students entering 1st year undergraduate studies. The construct presents a significant 39% of the variance of IU, an increase of 28% in comparison to the variance in the model that emerged from data collected at the start of the UG year. Interestingly, PEOU presents a very strong effect on PU variable at .63, nearly .20 more than in the previous model (Figure 4.2).This may also be explained by the fact that students are actually utilising mobile devices for learning at university, so PEOU has become a more important variable in the PU and intention to use mobile devices for learning. In light of the original hypotheses associated with the TAM, this model confirms the importance of students' perceptions of PU and PEU and ATT for user intentions to use (Scherer et al., 2019).

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In Chapter 4, the research findings were explored and hypotheses tested in the analysis of the research model. The current chapter covers the discussion of these findings in the light of the conceptual framework and corresponding literature. This research study revolved around the concept of mobile learning and specifically student attitudes to the use of the mobile device in learning. The chapter initially presents a table to highlight the similarities and differences in the findings between each of the phases at the different periods of data collection and is then followed by a discussion of these findings. The emergent research models are then discussed based on the research questions and the aim is to provide research conclusions of the overall study so that the reader can get an overview of the research. Furthermore, the potential implications for stakeholders and limitations of this research project are presented. To conclude, the researcher highlights future research recommendations and includes a personal statement highlighting the value of this research project to empirical studies and research literature.

5.2 Summary of Research Findings under the Proposed Conceptual Framework

Initially this section presents a table detailing the comparative mean, standard deviation and variance for each of the items measuring the constructs in the proposed research model (Figure 2.2) along with a breakdown of the questions utilised in the Phase I and II surveys. An M value of ‘1’ is high, and in the questionnaire Likert scale of 1 to 7, ‘1’ was representative of strongly agree and ‘7’ of strongly disagree. This is followed by a discussion of these findings.

Table 5.2.1PR – Mean, Standard Deviation and Variance data

	**ITEMS ***See list of questions in table below														
Phase I	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***	***Q6***	***Q7***	***Q8***	***Q9***	***Q10***	***Q11***	***Q12***	***Q13***	***Q14***	***Q15***
Mean	1.06	1.96	2.69	1.65	4.64	3.56	4.62	4.37	4.81	2.36	4.10	4.57	2.94	4.04	4.79
St. Dev	.278	1.31	1.77	1.10	2.11	2.04	1.84	2.08	2.04	1.57	2.01	1.98	1.74	2.00	1.95
Variance	.077	1.72	3.15	1.21	4.45	4.19	3.39	4.34	4.18	2.48	4.06	3.923	3.03	4.03	3.83
Phase II A	***Q1***	***Q2***	***Q3***												
Mean	1.08	1.54	5.04												
St. Dev.	.407	.841	1.57												
Variance	0.16	0.70	2.47												
Phase II B C	***Q1***	***Q2***	***Q3***												
Mean	1.16	1.46	2.83												

St. Dev.	0.56	0.87	1.69												
Variance	0.32	0.75	2.8												

Item	Phase I – PR Questions
Q1	I have daily access to a mobile device of my own
Q2	I can use a handheld device for learning at home
Q3	I use a handheld/mobile device for learning (e.g. to access learning resources) at home
Q4	I have the skills I need to use mobile device for learning at home
Q5	If I need help in using a handheld/mobile device for learning at home I can ask my parents
Q6	If I need help in using a handheld device for learning I can ask other family members at home
Q7	The cost of mobile technologies impacts upon my access to a device
Q8	I can use a mobile device for learning at school
Q9	I use a mobile device for learning at school
Q10	I have the skills I need to use a handheld/mobile device for learning at school
Q11	I have the time to use a handheld/mobile device in school as part of my learning
Q12	I can ask someone at school e.g. a teacher/staff member for help in using a handheld/mobile device for learning purposes
Q13	I can ask e.g. another pupil for help in using a handheld/mobile device for learning purposes at school
Q14	There are online resources I can access at school if I need help in using a handheld/mobile device for learning
Q15	There are paper-based resources I can access at school if I need help in using a handheld/mobile device for learning

Item	Phase II (A, B and C)
Q1	I have daily access to personal mobile device

Q2	I have the skills i need to use a mobile device for learning
Q3	The cost of mob. tech impacts upon my access to a device

Table 5.2.2 PU Mean, Standard Dev. And Variance

	**ITEMS ***See list of questions in questions table									
Phase I	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***	***Q6***	***Q7***	***Q8***	***Q9***	***Q10***
Mean	2.5	2.8	2.5	2.2	2.2	2.8	3.6	3.5	3.6	3.5
St. Dev	1.5	1.4	1.5	1.3	1.3	1.6	1.7	1.7	1.7	1.8
Var.	2.2	2.21	2.24	1.88	1.8	2.6	3.0	2.8	3.1	3.3
Phase II A	**Q1**	**Q2**	**Q3**	**Q4**						
Mean	2.31	2.54	2.51	1.93						
St.Dev.	1.25	1.01	.07	.99						
Var.	1.56	1.69	1.57	1.32						
Phase II B C	**Q1**	**Q2**	**Q3**	**Q4**						
Mean	**2.31**	**2.54**	2.51	1.93						
St.Dev.	1.25	1.30	1.25	1.15						
Var	1.56	1.69	1.57	1.32						

Item	**Phase I PU Questions**
Q1	Using mob. dev. for learning enables me to complete tasks faster
Q2	Using mob. tech. enhances effectiveness as a learner
Q3	Using mob. technologies makes learning easier at home
Q4	Using a mobile dev. is a conv. way to access learning res. at home
Q5	Using a mob. dev. is a convenient way to access learning res. outside school hours
Q6	I find a handheld dev. convenient for my schoolwork
Q7	Using a mobile dev. improves my learning at school

Q8	Using mobile devices improves performance in schoolwork
Q9	I find mobile dev. useful for learning at school
Q10	Using mobile device is convenient way to access learning resources at school

Item	**Phase II (A, B and C) PU Questions**
Q1	Using mob. dev. for learning enables me to complete tasks faster
Q2	Using mob. tech. enhances my effectiveness as a learner
Q3	Using mob. tech. makes learning easier
Q4	Using a mob. Dev. is convenient way to access learning res.

Table 5.2.3 PEOU - Mean, Stand. Dev. and Variance

	**ITEMS ***See list of questions in questions table							
Phase I	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***	***Q6***	***Q7***	***Q8***
Mean	1.37	1.49	1.64	3.73	3.10	2.56	3.54	1.88
St. Dev	.657	.754	.926	1.81	1.67	1.44	1.72	1.04
Variance	.431	.568	.858	3.28	2.81	2.09	2.97	1.09
Phase II A	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	
Mean	1.86	1.95	4.12	3.14	2.64	2.18	1.94	
St. Dev.	.846	.970	1.06	1.60	1.39	1.07	1.04	
Variance	0.71	0.94	1.13	2.57	1.95	1.14	1.08	
Phase II B C	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	
Mean	1.56	1.86	1.95	4.12	3.14	2.64	2.18	
St. Dev.	0.84	0.97	1.06	1.60	1.39	1.07	1.04	
Variance	0.71	0.94	1.13	2.57	1.95	1.14	1.08	

Item	**Phase I PEOU Questions**
Q1	I find handheld devices easy to use
Q2	Learning to use a mobile device is easy for me
Q3	I find it easy to get a hh. dev. to do what I want it to do
Q4	Interacting with a handheld device is often frustrating
Q5	Interacting with a mob. dev. requires a lot of mental effort
Q6	I find mobile devices flexible to use for learning at home
Q7	I find handheld dev. flexible to use for learning at school
Q8	It is easy for me to become skilful at using mob. devices

Item	Phase II (A, B and C) PEOU Questions
Q1	I find mobile devices easy to use
Q2	Learning to use a mobile device is easy
Q3	I find it easy to get a mob. device to do what I want it to do
Q4	Interacting with a mobile device is often frustrating
Q5	Interacting with a mob. Dev. requires a lot of mental effort
Q6	I find mobile device flexible for learning
Q7	It is easy for me to become skilful at using mobile devices

Table 5.2.4 ATT - Mean, Stand. Dev. and Variance

	ITEMS * See list of questions in questions table							
Phase I	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***	***Q6***	***Q7***	***Q8***
Mean	1.79	3.51	2.87	2.86	2.98	2.92	4.77	4.57
St. Dev	1.02	2.85	1.54	1.55	1.63	1.52	1.83	2.19
Variance	1.04	8.12	2.40	2.40	2.68	2.31	3.35	4.81
Phase II A	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**		
Mean	1.94	3.26	2.96	3.30	3.14	4.95		
St. Dev.	.985	1.58	1.27	1.51	1.33	1.76		
Variance	0.96	2.50	1.61	2.28	1.79	301		
Phase II B	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**		
Mean	1.94	3.06	2.96	3.30	3.14	4.95		
St. Dev.	0.98	1.58	1.27	1.51	1.33	1.76		
Variance	0.96	2.50	1.61	2.28	1.79	3.10		

Item	**Phase I ATT Questions**
Q1	I have a favourable attitude toward using mobile devices
Q2	I do not like the idea of using a mob. Dev. for learning purposes at home
Q3	It is a good idea to use handheld devices for my schoolwork
Q4	Mobile/handheld devices make study/learning more interesting
Q5	I like studying/learning with handheld/mobile devices
Q6	Using handheld/mobile devices for learning is fun
Q7	Using mobile devices is a distraction to my learning at home

Q8	Using mobile devices is a distraction to my learning at school

Item	**Phase II (A, B and C) ATT Questions**
Q1	I have a favourable attitude toward using handheld/mobile devices
Q2	I do not like the idea of using a handheld/mobile device for learning purposes
Q3	Mobile/handheld devices make learning more interesting
Q4	I like to study or learn with a mobile devices
Q5	Using handheld/mobile devices for learning is fun
Q6	Using a mob. Dev. For learning is fun

Table 5.2.5 IU - Mean, Stand. Dev. and Variance

	**ITEMS ***See list of questions in questions table				
Phase I	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***
Mean	2.67	3.20	2.96	2.74	2.44
St. Dev	1.69	1.78	1.74	1.70	1.55
Variance	2.87	3.17	3.04	2.89	2.41
Phase II A	**Q1**	**Q2**	**Q3**		
Mean	2.20	2.42	2.06		
St. Dev.	1.19	1.37	1.22		
Variance	1.88	1.49	1.51		
Phase II B C	**Q1**	**Q2**	**Q3**		
Mean	2.20	2.42	2.06		
St. Dev.	1.19	1.37	1.22		
Variance	1.4	1.88	1.49		

Item	**Phase I IU Questions**
Q1	I intend to use handheld/mobile devices throughout the remainder of my studies
Q2	I intend to use mob dev. on a daily basis to help with my schoolwork/A(S) Level studies
Q3	I intend to use handheld/mobile devices on a weekly basis to help with my schoolwork/A(S) Level studies
Q4	I intend to use handheld/mobile devices in my studies at further/higher education on campus
Q5	I intend to use handheld/mobile devices throughout my studies at further/higher education off campus

Item	Phase II (A, B and C) IU Questions
Q1	I intend to use mob. dev. throughout remainder of my studies
Q2	I intend to use mobile devices in my University studies on campus
Q3	I intend to use mobile devices in my University studies off campus

Table 5.2.6 PMR Mean, Stand. Dev. and Variance

	**ITEMS ***See list of questions in table below																					
Phase I	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***	***Q6***	***Q7***	***Q8***	***Q9***	***Q10***	***Q11***	***Q12***	***Q13***	***Q14***	***Q15***	***Q16***	***Q17***	***Q18***	***Q19***	***Q20***	***Q21***	***Q22***
Mean	1.68	2.09	2.06	2.37	2.16	2.57	3.59	4.46	4.46	2.04	3.21	1.87	2.57	2.79	4.77	2.83	2.65	3.47	2.69	2.51	2.43	2.65
St. Dev	.965	1.08	1.18	1.49	1.23	1.66	1.96	1.95	1.65	1.29	1.70	1.20	1.46	1.66	1.71	1.54	1.51	1.74	1.46	1.37	1.46	1.47
Variance	.931	1.18	1.40	2.23	1.53	2.75	3.85	3.82	2.72	1.68	2.88	1.45	2.13	2.76	2.92	2.37	2.29	3.05	2.13	1.89	1.15	2.16
Phase IIA	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***	***Q6***	***Q7***	***Q8***	***Q9***	***Q10***	***Q11***	***Q12***										
Mean	2.29	2.52	1.73	4.08	4.11	1.53	4.12	2.64	4.14	4.29	2.63	2.58										
St. Dev.	1.23	1.27	.991	1.60	1.601	.812	1.60	1.60	1.60	1.58	1.06	1.06										
Variance	1.51	1.62	0.98	2.58	2.56	0.65	2.57	1.14	2.57	2.51	1.13	1.14										
Phase II BC	***Q1***	***Q2***	***Q3***	***Q4***	***Q5***	***Q6***	***Q7***	***Q8***	***Q9***	***Q10***	***Q11***	***Q12***										

Mean	2.29	2.52	1.73	4.08	4.11	1.53	4.12	2.64	4.14	4.29	2.63	2.58									
St. Dev.	1.23	1.27	0.99	1.60	1.60	0.81	1.60	1.06	1.60	1.58	1.06	1.06									
Variance	1.51	1.62	.98	2.58	2.56	0.65	2.57	1.14	2.57	2.51	1.13	1.14									

Item	Phase I - PMR Questions
Q1	Using a mobile device enables me to access information/content quickly
Q2	Using a hh. device enables me to access reliable information
Q3	Using a mob dev enables me to access rich content via e.g. digital library, wiki or online tutorials
Q4	Handheld devices enable me to access diverse types of content via e.g. Newsfeed or digital video/audio of classes
Q5	Mob. dev. enable me to choose information that I need for learning
Q6	I like to receive messages on a mob. Dev. which contain various types of media (e.g. image, sound) for schoolwork.
Q7	I can receive immediate feedback for schoolwork on a mob. dev.
Q8	I do receive immediate feedback for schoolwork on a mob. Device
Q9	Communication of messages/feedback containing various media such as sound or images can distract from the main message
Q10	Using a mobile/handheld device helps me exchange communications quickly
Q11	I can tailor my communication with others on schoolwork using e.g. discussion boards or document sharing using Dropbox on a mob.dev.
Q12	Mob. dev. allows me to communicate multiple types of information using e.g. Facebook or Twitter
Q13	The importance of a task would dictate whether I would use a handheld/mobile device to communicate my message to others
Q14	There are issues that I cannot communicate using a handheld/mobile device
Q15	Communications with my friends/other people using handheld/mobile devices help me to better understand the teachers materials
Q16	Communications with other people (e.g. friends) using mob. dev. help me to better understand information/content
Q17	Using a mob. Dev. slows down my communication with others
Q18	Using a mob. Dev. to comm. enables me to more openly share my opinions with others
Q19	I can easily communicate my attitudes/opinions effectively using a mobile/handheld device via e.g. Email,
Q20	I can easily communicate my personal emotion using a mob. Dev. via e.g. SMS
Q21	Using a mob. dev. to comm. via e.g. IM would encourage me to ask questions that I would not ask during a face to face discussion

Item	Phase II (Part A, B and C)– PMR Questions
Q1	**U**sing a mobile device enables me to access information quickly

Q2	**U**sing a mobile device enables me to access reliable information
Q3	**M**obile devices enable me to access diverse types of information
Q4	**I** like to receive messages on a mobile device which contain various types of media (e.g. text/image sound)
Q5	**C**ommunication of messages containing e.g. sound/images can distract from the main message
Q6	**U**sing a mobile device helps me exchange communications quickly
Q7	**T**he importance of a task would dictate whether I would use a mobile device to communicate my message to others
Q8	**U**sing a mob. dev. to communicate would encourage me to ask questions that I would not ask face to face
Q9	**T**here are issues that I can't communicate using a mobile device
Q10	**U**sing mobile devices slows down my communication with others
Q11	**U**sing mob. Dev. to comm. enables me to more openly share my opinions with others
Q12	**I** can easily comm. my opinions effectively using a mob. Dev. e.g. Email

5.3 Discussion of Findings

Technology brings a new set of challenges and pressures for educational institutions (Romeo, Lloyd, & Downes, 2013) The importance of empirical studies such as this study investigating user attitudes to mobile device use in learning, a technology prevalent in use across society, is highlighted by Andrew and Jones (2015) and Green and Hannon (2007) who argue that successful technology integration in learning must start with the learner and not the device if we want to successfully understand learning, learners and mobile technology use in education.

The research findings highlight the growing importance in student use of the smartphone. Şad and Göktas (2013) argue that smartphones sit in a category of their own and are the most suitable device for m-learning. The findings in this study highlight that over 68% of post-primary users and over 99% of university users have daily access to a mobile telephone and this is the device that was the most highly referred to by participants during focus group discussions. In fact, the researcher constantly had to remind participants of the broad variety of types of mobile devices available; however, participants instinctively referred to a mobile device as the mobile telephone. Users specifically value the convenience of the mobile telephone for ease-of-use, anywhere (connection dependent) and at any time. The findings indicate that a mobile device is, in the majority, accessed to communicate with friends, family, social purposes using social media platforms, email, SMS, IM and Chat and to access the world wide web which is similar to the findings in Kim et al.'s (2017) study investigating university students' resistance to mobile learning.

The widespread penetration of the smartphone across the world is particularly highlighted in Nayak's (2018) study of HE students in India and in my study the mobile telephone is the device of choice for learning both at school and at home, which is apparent from interrogation of the quantitative and the qualitative data. It must also be noted in this study that at the end of the academic year that a significant 46% of university students had access to a tablet computer. Kobus et al.'s (2013) study investigating student ownership versus on-campus use of mobile IT devices found a laptop awkward to use on campus in comparison to easily portable devices such as the mobile telephone and tablet computer. In my study, there is a sharp contrast in school and home laptop use, at 36% and 92% respectively and similarly 7% of users had previously used a tablet computer in school, where 50% of users had previosuly used a tablet computer at home.

. Conversely, Sad and Gorktas's (2014) study of preservice teachers' perceptions of mobile telephones and laptops in education as learning tools found that the participants had less positive perceptions about the use of the smartphone in comparison to laptops for learning.

The data highlight that at the time of data collection post-primary schools were slow to embrace the use of mobile technologies as a transformative tool for formal learning purposes (NI DoE, 2016). It is difficult to implement m-learning in an educational sector (post-primary) where 88% of respondents, from the 16 participant schools in this study, indicate that school policy does not permit use of mobile technologies on school premises. Device use is based on specific teacher permissions and use during study periods. A proportion of students (26%) had previously used a mobile device for learning at school which included use in free periods and during study-time such as browsing the world-wide web for information. In fact it is evident from Phase I findings that mobile devices were viewed as a potential add on to traditional learning and not in a stand-alone approach to learning. Participants also referred to the incompatibility of teacher-led instruction in school and the current learning styles adopted by the student with students adding that they prefer to write and learn. This is also evident from the survey data which indicates that specific learning resources and platforms such as the Virtual Learning Environment (VLE) and digital libraries are accessed by less than half of the post-primary users. Teachers utilise learning management systems such as 'Moddle' or 'NI2' to deliver coursework notes or worksheets for downloading; however, less than one third of users have previously used a mobile device to access the school VLE.

In Phase II (A), qualitative data findings suggest that the VLE is mainly accessed outside of school via a laptop device with respondents highlighting frustrations with use of the school VLE due to the interface and file navigational issues. Beckman et al. (2014) argue that the overall culture towards the use of technology in schools must radically evolve to empower student use of technology in an increasing digital society. This has implications for the student transition from the post-primary sector, where practice is developing at a slower pace than the HE sector. In Phase I of my study the majority of pre-university students' indicated during focus group sessions their intention to use a mobile device at university and discussed the future purchase of specific types of handheld devices. There is a continual emergence of increasingly advanced technologies that have seamlessly blended into everyday life, which Merchant (2012) describes as objects of desire and there is an expectation of the use of the mobile device at HE for learning;

however, users require digital literacy skills so that mobile technologies can be used effectively in learning, so it is vital that students entering HE are adequately upskilled for this. It must also be highlighted that in order to effectively integrate m-learning in education, studies such as this research are imperative to help understand student skills and intention to use mobile devices for learning purposes both inside and outside formal education.

This empirical study interrogated student use and intention to use mobile devices in the context of both school/university and home. Phase I data indicates that student use of mobile technologies outside of school is dominated by the use of communication applications such as WhatsApp, email, telephone calls and SMS messaging. A mobile device was predominately used to communicate with friends about everyday life activities and during examination revision periods mobile devices were used for school-related tasks and revision purposes. Post-primary students agreed that using a device had a positive effect on their learning at school and at home and the university student sample agreed that the use of digital devices enhanced learning effectiveness which concurs with the findings of Lam and Tong's (2012) study where participants felt that the use of a digital device was beneficial to learning. Student social adjustment to university is a significant issue and there are many reasons why university students suffer negative experiences or drop out during the transition from second level into 3rd level; social media technologies may provide some solutions to this as they are designed to maintain relationships. In my study, 91% of pre-university students have previously accessed a social media platform using a mobile device. In fact, Gray et al.'s (2013) empirical study found that social media technologies such as Facebook may indeed support student social outcomes regarding student transition into university.

The study findings also highlight that the majority of school and university students have digital confidence in their ability to effectively use mobile technologies for learning, which is at odds with JISC (2017) research that identified a gap in student digital skills entering the workplace after university. The user perceived belief of skills level and perceived ease of use of mobile devices does not necessarily translate into effective use in learning as the focus group participants listed dictionary access, translation services and researching examination question answers as examples of when they used a device for learning. These findings highlight that the use of digital technologies are still conservative and users are either unsure or believe that devices can be disruptive to learning. The study findings report that nearly a third of users in the survey have previously accessed

a blog and nearly half have previously accessed a Wiki using a mobile device. However, during focus group sessions, participants made few explicit references to the creation of content using Web 2 technologies such as blogs. In fact, only one participant described the use of a laptop to create and publish information in a log related to a coursework task. This is in direct contrast with literature that makes reference to all young people being extensive users of Web 2.0 technologies (Barnes and Tynan, 2007; Lorenzo et al., 2007). It does support Lai and Hong's (2015) study, which found that while students spent a large amount of time on digital technologies, the range of digital technologies accessed was limited.

5.4 Reconsider Research Questions

Pavia et al. (2013) argue that the Information Age has reached its prime where the use of technology is now an accepted constituent of learning. Technology can provide access to knowledge, resources and materials from anywhere at anytime and equip 21st century students with the essential skills required to succeed (OECD, 2015). My study utilised an extended TAM to incorporate PR and PMR constructs to investigate post-primary and university level student attitudes and intention to use mobile devices. The research addressed three principal questions;

- Is there a relationship between student perceptions of Resources and Usefulness and Ease of Use, Attitude and Use of a mobile device?

- Is there a relationship between student perceptions of Media Richness and Perceived Usefulness and Perceived Ease of use, Attitude and Use of a mobile device?

- Is there a relationship between student perceptions of Usefulness, Ease of Use, Attitude and Use of a mobile device?

5.4.1 Findings based on Research Questions

The emergent research model in Phase I and Phase II (A) did not match the hypothesised model and comprised of seven and six components respectively. However,

the model that emerged from Phase II (B and C) findings matched the hypothesised model.

In Phase I, PR emerged as two separate variables, ‘School-based’ and ‘Home-based’ and in Phase II (B and C) emerged as a construct; however, in Phase II (A), PR was removed from analysis due to unreliable statistical results. This suggests that evidence of a relationship between PR, the core TAM constructs and IU requires further empirical investigation with post-primary and HE users.

In Phases I and II (A), PMR emerged as two constructs; ‘Flexibility for Communication’ and ‘Access to Information’ and Task Importance respectively. In the final survey of first year undergraduate students, PMR (Flexibility for Communication) again emerged as a construct. This suggests that there is a relationship between PMR and TAM’s core constructs and intention to use a mobile device for learning.

Scherer and Teo (2019) highlighted that all the studies included in the special edition editorial on the TAM convey that student perceptions of PU, PEOU and ATT to technology are key explanatory variables. The core constructs of TAM, PU and PEOU produced a positive relationship and effect on IU in each phase of this research study. PU presents a positive effect on IU which is consistent with other empirical studies such as Althunibat (2015) and López-Bonilla and López-Bonilla (2017). PEOU also presents a positive effect in Phases I and II, which is consistent with other studies such as Chung et al. (2015) and Teo and van Schaik (2012). In Phase I, the ATT construct items were immersed into IU which is consistent with TAM2 (Davis et al., 1989), where the ATT construct was removed, whereas in Phase II (A) and Phase II (B and C) ATT produced enough statistically significant results to emerge as a construct, consistent with many other studies (Celik and Yesilyurt, 2013; Chen & Huang, 2012; Presley and Presley, 2009; Park et al., 2012) and was found to be predictive of IU.

The widespread use of mobile wireless devices and ever improving wireless technologies means that learning can now be supported by the use of mobile devices (Hoi, 2020), hence the emergence of research studies focusing on technology acceptance using robust frameworks such as TAM for the planning and administration of research in the field of education (Granić and Marangunić, 2019). The use of TAM2 with external constructs in this empirical study produced strong statistical results and highlights that it is a strong model for predicting user acceptance of mobile devices. The findings from the study have also additionally highlighted suggested areas for future

research and potential implications for stakeholders, which will be discussed later in this chapter.

5.5 Study Limitations and Future Research Opportunities

Despite all the methodological care given to this study, the results must be interpreted cautiously. There are several limitations of the present study which should be noted and addressed in any future research. The participating schools in Phase I included mixed sex and a single-sex female school. The researcher could not secure a single-sex male school to participate in the study which resulted in the representative sample containing a high proportion of females. However, this does not mean that it may be difficult to generalise the findings to other students with a greater proportion of male students.

Phase I applied a mixed method approach to data collection including qualitative based focus group sessions. School timetables and examination schedules only allowed for the organisation of six focus groups in five of the participating schools. The facilitation of a higher number of focus group sessions with upper-sixth level would benefit knowledge and provide more in-depth knowledge of student attitudes and perceptions to mobile device use. Focus group sessions in Phase II with undergraduate students would also be beneficial for future research data collection to gain further insights into students' use of mobile device for learning at university.

As the second phase of this study was performed at a single site with first year undergraduate students, further work is needed to increase study and finding generalisability and transferability. There should be further measurement studies with different levels of students across different sites. Although undergraduates compose the largest population of higher education students, it would be useful to conduct studies on other postgraduate students and graduate students using devices for teaching and learning. Crompton and Burke (2018) also highlight that studies across more than one HE institution as to how mobile learning is being used would help better understand best pedagogical practice (Crompton and Burke, 2018). Although, it must also be argued that it is not inconceivable that students in other universities or other countries have the same access to mobile devices at post-primary level education and face similar use of devices at university. Indeed, research in universities in other countries have demonstrated

relationships between the variables in the TAM model and have included other supported and unsupported variables. Lai and Chang (2011) study in a Taiwanese university and Sharma and Chandel's (2012) study in a university in Oman found considerable support for the extended TAM model.

Scherer and Teo's (2017) argue that although researchers have started to integrate variables of teachers' professional knowledge into TAM, there is still a need for further exploration of other perspectives in mobile learning research. Crompton and Burke's (2018) review of mobile learning studies in higher education call for future research studies focusing on the positive benefits of using mobile learning in informal settings to explore learning in different contexts and future research including target populations such as graduate students and academic staff. Given the study findings about home use which highlight an increase in the type of device use and because at post-primary level the majority of second level institutions did not have a formal policy for use, in fact there was restricted use of devices in the majority of the schools surveyed. The findings from the Phase I survey also highlight the lack of potential support for the use of mobile devices from teachers and parents in the home; this indicates that there is a need for future research into parent and teacher perspectives on the use of mobile devices in learning.

Meaningful learning can only occur when mobile technologies are used in association with effective pedagogical methods (Ng'ambi, 2013). Clarke et al.'s (2013) research concluded that use of the tablet PC for learning must support the pedagogical approach adopted by the school and that teacher training is essential to effectively integrate the technology into teaching. There is a need for more in depth studies investigating how schools can use mobile devices such as the smartphone or tablet in everyday formal learning (Merchant, 2012). Future research could rectify limitations and extend the study to other settings to include teacher perspectives in a school setting and university lecturing staff. Research studies have demonstrated that the use of digital technologies in classrooms is varied and often underwhelming (Perrotta, 2013), which is highlighted in the Phase I findings of this study. Also, the mobile accessibility of online collaboration applications have inevitably led to an increase in use in education; however, Maican et al. (2019) argue that more research is required into user (both student and teacher/tutor) attitudes and actual use of these applications for communication and in teaching and learning so that findings could be compared. The author recommends that future research should explore the relationship between teachers' perceptions of technologies

alongside user and institutional factors to complement current research and enhance the effective use of digital technologies in the classroom in the support of teaching and learning.

This study provides some interesting findings that warrant additional research, it must be noted that the emergent models in each phase present differently. The results reveal the evolution of PMR to Perceived Flexibility for Communication in each phase of the analysis. In Phase I, PR emerged as two separate factors 'School-based' and 'Home-based' where home-based presented a more significant impact on IU. This may be explained by the fact that schools at the time of writing had no formal policy for mobile device use in formal learning. Further investigation of the implications presented by PR on student acceptance of the mobile device for learning is required. Two separate PMR constructs also emerged in PMR, 'Flexibility for Communication' and 'Access to Content' both presenting a significant impact on IU. Ursavas (2013) argues that the role of ATT in the TAM requires further clarification and in this study the fact that the ATT construct did not emerge as a construct in the pre-university student phase; however, did emerge as a contributor to the overall variance in usage and played a significant indicator of mobile device use for university students highlights the need for further investigation. These results appear to be contributing factors to technology acceptance and warrant further investigation into student attitudes and perceptions of use of mobile devices for learning before generalisations can be made.

5.6 Study Implications

Educators and policymakers acknowledge the existence of a 'learning ecosystem' where learning can occur across settings and contexts (Sharples et al., 2016). A wireless campus utilising the vast array of Web 2.0 technologies on offer is key to improving interactions and collaborations between student and academic staff and the enhancement of the student learning experience at HE (Amemado, 2014). While the findings in this study highlight that students rely heavily on the use of mobile technologies for informal learning and communication purposes, the successful integration of mobile technologies in formal learning cannot be fully realised without institutional tutor support. This research study has potential implications for the implementation of mobile device use both at second and third level education. It has implications for both researchers

(education and IT) and practitioners (school principals/management, academic teaching staff, university IT managers/support, eLearning developers).

Kim et al. (2017) argue that devices such as the smartphone were designed as a tool for communication and not learning, so as a result, user's resistance to mobile learning may increase due to required levels of concentration and motivation. In my study, it is clear from the survey findings that the mobile telephone (with Internet connection/smartphone) is the mobile device most highly utilised by both pre-university and university students both inside and outside of formal learning. There is also evidence that while more of the post-primary users accessed learning materials and Web 2.0 technologies using mobile devices outside of school, the majority of all students surveyed indicated the use of devices for communication purposes via, for example, email and Chat and the access of online static information was of paramount importance. From the findings of this study, while conveying the importance of the mobile device as a tool for communication, it is this functionality (PMR-Flexibility For Communication) that emerged as a predictor of intention to use mobile devices in learning. We know that learning can and will occur without the use of technology through the use of sound methodological and pedagogical approaches; however, successful integration of technology with these can optimise and modulate the traditional learning experience by making it more student driven in terms of collaborative learning (Groff, 2015). The findings of my study where the key role of the mobile device as a platform for communication and collaboration has emerged also may have implications and potential solutions in the provision of social and academic support for students transitioning from post-primary into third level education.

Guidance, instruction on best practice and support on the use of learning using digital devices must be provided to students if they are to gain maximum benefits from use (Lam and Tong, 2012). It is telling that only one focus group participant noted previous use and engagement of digital skills through the use of Web 2.0 technologies for coursework purposes. Just under 70% of post-primary users had never previously used the school VLE and focus group sessions highlight user negative views due to navigational difficulties and unorganised learning materials. In order to engage post-primary students in the use of mobile devices for formal and strategic learning purposes, and to aid the development of digital skills now essential for continuing education and future employment, then school management need to address the use of mobile devices in school for task/subject specific learning purposes. This highlights that students require guidance and assistance with digital skills from teachers and lecturers/IT support staff to

enable them to effectively integrate mobile technologies and tailor use of devices for learning purposes.

The survey findings in this research indicate that secondary school users agreed that mobile devices can distract from learning and this perception also strongly emerged from focus group participants where participants agreed that a mobile device was not used in the days leading up to examinations and many of the participants agreed with parental confiscation of a mobile device during study periods. This not only would have implications for practitioners in second level education, but would feed into user attitudes about device use for learning at third level education. And indeed, in this study, the university participants at the end of the first academic year also agreed that mobile devices were a distraction to learning. It is imperative that in-class technology use policies are adopted by educational practitioners to adequately deal with mobile device use in formal learning and minimise disruptive opportunities by regulating off-task use such as web browsing and digital literacy programs alongside the adoption of technical solutions (Kim et al., 2019). The findings of my study may also have implications for the development of teacher training programmes, that more attention needs to be paid to the teaching model that is used in HE and adapt it for the integration of digital learning technologies. In Taiwan for example the Ministry of Education established the 'Mobile Learning Program for post-primary schools with the aim of supporting and collaborating with teachers in the integration of mobile learning activates through various learning strategies (Hsieh and Tsai, 2017).

The integration of technology is a challenging process of change in education and technology acceptance and usage is still a complex issue across all sectors of education (Scherer et al., 2019). Research and the findings of this study reveal that integrating technology is a complex process of educational change, and the extent of technological applications in schools is still extremely varied (Fraillon et al., 2014). The university in this empirical study has been advancing learning technology support with the employment of learning technologists across many schools alongside an institutional wide promotion of digital literacy for all staff and students. It is also important that practitioners are aware of studies such as Wakefield et al. (2018) that found tablets motivated students to complete homework in advance of a tutorial; however, the study also highlights the importance of the need for continuous evaluations and assessment of technology use in the classroom to ensure educationally sound and appropriate use and maximise a beneficial impact for student learning.

Greener and Wakefield (2015) address barriers to staff adopting technology in the classroom such as time to prepare materials, confidence issues and questions over pedagogical advantages to the use of technology which must be addressed by other stakeholders such as learning or educational technologists in HE settings in order to ensure the sound and appropriate use of tools and make it accessible for all staff (Wakefield et al., 2018). A substantial number of lecturers and teaching staff are still resistant to the immersion of technology in the classroom and one of the major reasons for this is digital literacy issues with regards to use and integration into teaching (Mac Callum et al., 2014). Derbel (2017) argues that research highlights the need for teachers to develop pedagogical knowledge and expertise to blend old and new approaches in order to effectively integrate technology for learning.

The digital transformation of an organisation is a challenging task and if technology use is to be beneficial and successful in learning it is imperative that it is accessible to all staff and engages all users so there is also a need to fully understand the attitudes of all users including academic staff. With this in mind Greener and Wakefield (2015) argue instead of staff workshops and technical support that pedagogical issues faced by staff need to be addressed and how the integration of mobile technologies could help solve learning issues and increase learning opportunities. In order that technology is effectively integrated into teaching and learning environments inside or outside of formal learning, it is critical that lecturers receive adequate support and participate in lifelong learning to develop 21st century teaching skills including, for example, digital literacy and knowledge of educational technologies (Kruger and Bester, 2014).

Hsieh and Tsai (2017) argue that in order for technology enhanced learning to be 'normalised' and fully integrated into the teaching and learning process, then it is imperative that digital literacy is a core competence of the teacher. This has implications for teaching, lecturing and services providing professionals across all educational sectors as it illuminates the importance of staff digital skills. Staff require training, opportunities to develop skills and access to information and communication technologies to remain knowledgeable on developments and effective use to enhance the student learning experience both inside and outside of formal learning. Positive and confident teacher-student-technology engagement will help equip them with digital skills, essential for the 21st century workplace (Duncan-Howell and Lee, 2007). Wakefield (2018) points to research that highlights lack of academic enthusiasm for the integration of technology such as the tablet computer in learning due to factors such as time

constrictions, so in order to amend this, professional development is required. Teachers require formal training to effectively engage, for example, in online discussions relevant to schoolwork and the curriculum outside of the formal classroom environment (Kio, 2016). THE University is currently introducing a new cloud-based VLE where teaching staff can, for example, embed audio and video, plug into LTI learning tools and broadcast to students with the click of a button. Personalised mobile and social notifications can also be automatically forwarded to students. The 3rd level institution's (that participated in this study) educational development team objective is that the new VLE will become the central hub for student resources, information and communications, making it essential throughout HE for successful academic studies.

An m-learning environment is where learners can use a mobile device such as smartphone or laptop, individually or collaboratively to access learning materials and support learning activities anytime, anywhere (Lan and Sie, 2010). This presents policy implications for education and highlights the required development of a standardised plan for the successful integration of mobile devices and technologies in post-primary education for teaching and learning. The findings from this study suggest that although users at post-primary level intend to use mobile devices in learning, the user does not fully understand the potential benefits for learning. The findings also highlight that cost can be a barrier to mobile device ownership for both pre-university and university students. This further highlights the importance of both financial and non-financial resources impact on student attitudes to the use of mobile devices in learning.

Derbel (2017) outlines that the effective use of technology in education requires cooperation and contributions from all stakeholders. While this study presents important insights into post-primary and university student attitudes to the use of mobile technologies for learning, the findings highlight the need for further understanding of how technologies can be integrated into existing practices (Merchant, 2012). For educators to make use of these findings, they must take into consideration and understand student attitudes and perceptions of mobile device use and usefulness in learning. The majority of students have access to at least one mobile device, but in order to effectively integrate use for learning and academic communication they must be integrated at core level. This may require additional time and effort to encourage student use in learning. The integrated use of mobile devices in HE learning may be viewed inevitable and easy to integrate successfully due to the increasing use of technology across education. However, it should be noted that pedagogical and practical considerations are essential

to the design process. Future research should include teachers, faculty staff, staff and administrators before generalisations can be made, alongside the development of tailored learning resources suitable for access via a mobile device.

5.7 Conclusions

Ng and Nicholas (2013) claim that a unified agreement on the maximisation of learning opportunities through mobile learning is yet to be agreed. Newman and Beetham's (2017) research demonstrates that technology is not fully embedded in teaching and assessment which is highlighted in an identified gap in graduate digital skills required for the workplace. IS literature is dominated by positive perceptions and use of mobile technologies; a subjective analysis of potential negative associations with mobile device use is required (Bernroider et al., 2014) which is provided by this research study. As universities strive to compete in a global market place, there is a growing need to understand student attitudes towards use of mobile technologies in learning contexts. Greener and Wakefield (2015) emphasise that key and strategic importance of students in the process of incorporating TEL into teaching and learning. Many challenges are faced my HE institutions throughout the process of technology insemination in the curriculum such as staff acceptance of technologies, effective use by learners, issues with the streamline of learning to occur in digital and mobile technologies, the integration with other learning activities and the challenge of integrating a seamless flow between formal and informal learning. Thus, it is crucial that we understand the potential and limitations of mobile devices for teaching and learning, as it is only then that the effective embedding into learning can be successful if any potential obstacles to successful integration are addressed.

Merchant (2012) argues that if we are to sufficiently learn from and with the ongoing rapid technological developments, then it is important to investigate, for example, student use of technology, such as the use of mobile devices inside and outside formal learning environments. My study illuminates the student voice, both positive and negative attitudes and perceptions of upper-sixth level students at the end of post-primary education and first year undergraduate students at the beginning, middle point and end of the academic year and their intention to use mobile devices for learning and communication purposes. The transition from second to third level and the successful integration of first year undergraduates into third level education is a process of adaption

for the learner. Mobile technologies can offer more than just browsing the Internet and can enhance opportunities for engagement and interaction with online activities and communications (Beckman et al., 2014). My study highlights positive user attitudes towards and the key function of the mobile device as a communication tool and its potential to provide information, social support and connect with other students during this transition process through social media such as personal blogs and SNS (Gray et al., 2013). My study highlights the difference in attitudes to the use of mobile devices for learning which are evident across each phase of the research study.

Hoi (2020) argues that a new era has emerged in education where due to the widespread use of handheld wireless devices such as the mobile telephone and the increasing accessibility of mobile networks, learning can be supported using these devices. However, studies such as Vogel et al.'s (2009) of nearly 1,000 first year undergraduate student use of devices and mobile applications within a specifically created mobile learning environment found that use does not guarantee learning, even when support is provided. Tossell et al. (2015) also imply that learner access to a smartphone without the use of specified learning activities could potentially adversely affect and distract from learning. Lam and Tong (2012) emphasise how critical it is to provide specific guidance, support students and promote recommended practice for effective use of digital devices in the classroom. While undoubtedly a complex area, this can be due to a wide range of issues such as the educational institution, the tutor, pedagogical issues and access issues, all of which require due methodological process through the engagement of theory and evaluation. This study set out to identify student attitudes and perceptions of mobile device use before starting university and during first year undergraduate studies to help inform future use of specific mobile technology devices, technologies or applications for learning both on and off campus.

The results of this study highlight that the TAM successfully predicts user behaviour, and thus is of interest to all potential users of a new technology (Scherer et al., 2012). My study aimed to determine the role that PR and PMR potentially play in affecting the adoption of the mobile device through an extension of TAM. TAM's primary factors are PU and PEOU (Elwood and Cutshall, 2006) and this study highlights that TAM2 does provide explanation for IT adoption in both school and university. However, the results also reveal that the TAM2 may miss other important factors in measuring students' acceptance of mobile devices for learning. This study has shown that variables included in the model, which extended TAM (PR and PMR), contribute significantly to the

explanation of several aspects of mobile device use. Although, the results of the study should be interpreted with caution; if these results prove to be reproducible in other studies, then these findings hold significant implications for both IT researchers who wish to study the adoption of mobile technologies and practitioners who want to implement the successful use of mobile devices for learning in education.

5.8 Personal Statement of Research Value

Technological changes have seen the introduction and embedding of new devices, tools and platforms not only in the learning and teaching arena but across society as a whole. HE is changing, due to factors such as globalisation, the digital revolution alongside funding issues and rising costs. This is compounded by increasing competition world-wide for a share of the student market, a now more consumer-orientated population where graduate career-readiness alongside the highest quality education is of growing importance (Krause, 2005). Learning approaches, theories, policies and technologies are dynamic and changing at a pace perhaps never witnessed before.

Students enrol at HE with specific demands on services and expectations for their educational experience. Mobile devices, particularly the mobile telephone has become part and parcel of daily life (Atas and Delialioglu, 2017) inside and outside of education which means that it is essential that educators in third level education understand how these technologies can be utilised for effective learning purposes (Schuck et al., 2010). Users require access to services and education across new technologies and more flexible delivery options so it is paramount that institutions invest in services, facilities and infrastructure to aid the enhancement and enrichment of the student learning experience (Duncan-Howell and Lee, 2007).

Undergraduate attitudes and perceptions of technology are the key barometer of mainstream use and also drive staff acceptance of technology in learning and teaching (ECAR, 2012). It is imperative that education recognises and implements mobile technologies effectively into the learning process so that learning can be extended beyond the classroom, anywhere and at any-time (Lindsay, 2016). Bradley and Holley (2013) argue it is essential that students can make use of their own devices so that effective mobile learning activities can be introduced into the blended learning arena. Where this has the potential to lessen operational costs for the institution to reduce opposition to initiatives; however, this also brings with it challenges for teachers and

tutors when learning activities take place outside the classroom (Şad and Göktas, 2014). Mobile devices can be used as a vehicle to access free and ready-to-use tools and applications to deliver ICT needs. Worley (2000) reminds us that the medium, in this case the mobile device, is not the message and an understanding of user attitudes and perceptions of mobile technologies is crucial to the effective integration of the device in learning across all educational sectors. This study represents a contribution to the IT literature because it is one of the first attempts to validate an extended TAM model in the UK focusing on student attitudes and perceptions of mobile devices use for learning at two distinct levels of the education spectrum; post-primary and third level.

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