# TOWARD MOBILE LEARNING DEPLOYMENT IN HIGHER EDUCATION

**A thesis submitted in fulfilment of the degree of Doctor of Philosophy**

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**In the name of Allah, Most Gracious, Most Merciful.**

"Praise be to Allah, the Cherisher and Sustainer of the worlds; Most Gracious, Most Merciful; Master of the Day of Judgment; Thee (alone) we worship; Thee (alone) we ask for help; Keep us on the right path; The path of those whom Thou hast favoured; Not the (path) of those who earn Thine anger nor of those who go astray".

**(Holy Quran 1:1-7)**

# Abstract

Mobile Learning (M-learning) refers to any kind of learning which takes place within and beyond the traditional learning environment via wireless mobile devices. These devices are able to move with the learner to allow learning anytime, anywhere. M-learning is considered as the next step beyond electronic learning (E-learning) and distance learning (D-learning) by using mobile wireless devices with internet connectivity to facilitate formal and informal learning. Over the past decade M-learning has become gradually popular in university settings by providing mobile access to learning resources, collaborative learning and to exchange formative evaluation and feedback between students and instructors. Therefore, M-learning involves learning activities that are not restricted to a specific time or place.

Despite the familiarity with M-learning as a new paradigm in modern education, there has been a shortage of research concerning how to deploy this technology in a successful way. The integration of M-learning in a university environment needs to involve some aspects in terms of the readiness of users and institutions, users' acceptance and engagement, and the sustainability of the system. There are some initial models that investigate the implementation of M-learning which provide some guidelines that work as starting point for the future of M-learning deployment. However, there is no theoretical model that provides guidelines for staged deployment of M-learning. In addition, there was no clear definition of sustainability factors that will assure continues evaluation and upgrade of M-learning systems after deployment.

The aims of this research work are to study students' readiness for M-learning, investigate the factors that affect students' acceptance and analyse M-learning literature in order to propose and evaluate a model which can be used to foster the sustainable deployment of M-learning within teaching and learning strategies in higher education institutions.

The research was conducted in Brunel University, West London. Data were collected from School of Information, Computing and Mathematical Science students using three surveys: the first studied students' readiness for M-learning, the second investigated factors that affect students' acceptance of M-learning and the last one developed and evaluated a sustainable M-learning deployment model.

The outcome of this research lead to a conceptual model that gives a wide overview of all elements that need to be addressed in the M-learning environment and bridges the gap between the pre- and post-implementation phases in order to ensure sustainability. Furthermore, the model provides university educators with a planned approach to incorporate M-learning in higher education curriculums with the aim of improving teaching and learning.

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I would like to thank all my Brunel University friends for their best wishes, help and support.

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# Dedication

This thesis is dedicated to the memory of my mother, Umm Mohammad, who always believed in her children.

May Allah rest her soul in Paradise.

# Publications

**1.** Abu-Al-Aish, A., Love, S. and Hunaiti, Z. (2012). Mathematics Students' Readiness for Mobile Learning. *International Journal of Mobile and Blending Learning*, 4(4), 1-20.

**2.** Abu-Al-Aish, A., Love, S.(2013). Factors Influencing Students Acceptance for M-learning: An Investigation in Higher Education. *The International Review of Research in Open and Distance Learning*, 14(5), 82-107.

**3.** Abu-Al-Aish, A., Love, S., Hunaiti, Z. and Al-masaeed, S. (2013). Toward A Sustainable Deployment of M-learning: A conceptual Model in Higher Education. *International Journal of Mobile Learning and Organization*. 7(3/4), 253-276.

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# CHAPTER 1: INTRODUCTION

## 1.1 Overview

This chapter provides an overview of the research background, statement of the problem, research questions and objectives of the research, followed by the significance of the research. Finally, a discussion of the research approach and the outline of the thesis are presented.

## 1.2 Background of the Study

Technology has a fundamental impact on the educational system. Nowadays technology plays a significant role in teaching and learning processes, whether supportive or administrative. Educational technologies have become increasingly important in the higher education environment due to the rapid proliferation of the internet and personal computers. Computers and the internet are educational tools which offer efficient use of time and ease of access to educational materials for students and staff alike. Most universities have adapted a range of management learning systems (MLS) such as Blackboard and Moodle. This revolution of information and communication technology (ICT) has facilitated communication, sharing data and collaboration between students and between students and their lecturers.

In recent years, computing wireless devices have become ubiquitous in today's college campuses (Motiwalla, 2007). The advent of mobile devices like smart phones, PDAs and tablet PCs give people the freedom to use what they need, where and when it is needed (Trifonova and Ronchetti, 2007). Mobile devices have become more affordable, effective and easy to use (Nassuora, 2012). These devices can extend the benefits of E-learning systems (Motiwalla,2007) by offering university students opportunities to access course materials and ICT, learn in a collaborative environment (Nassuora, 2012) and obtain formative evaluation and feedback from instructors (Crawford, 2007). Mobile devices can extend the learning process beyond university settings by providing flexible, portable and independent learning environments; they can allow students a method of communication both among themselves and between them and their lecturers (Khaddage et al., 2009). In addition, these devices also give students and lecturers an opportunity to exploit their spare

time while traveling to work on an assignment or in lesson preparation (Virvou and Alepis, 2005).

Mobile learning (M-learning) is regarded as a new stage in the development of computer support and distance learning (Georgieva, Trifonva and Georgiev, 2006). M-learning is a new learning paradigm created by mobile devices and wireless networks which support accessible and collaboration education at all levels including schools, colleges and universities. It is considered as the next step of E-learning system and distance learning, further enhancing learning anytime, anywhere (Milrad, 2003; Georgieva, Trifonva and Georgiev, 2006; Motiwalla, 2007). Salmon (2004) considered it as the fourth generation of the electronic learning environment. It can be defined as any sort of learning that occurs when the learner is not bound by location or time; it can happen anytime, anywhere, with the services offered by mobile technology devices that present learning content and allow wireless communication between lecturers and students (Dye, Solstad and K'Odingo, 2003).

M-learning provides an option for self-study (Eschenbrenner and Nah, 2007; Jacob and Issac, 2008a) by making course materials and educational resources readily available and easily accessible. In addition, M-learning facilitates the interaction between students and teachers in the classroom and allows the exchange of information outside the university (Lam et al., 2011). It is likely to become one of the most effective ways of delivering higher education materials in the future (El-Hussein and Cronje, 2010).

Despite the fast spread of mobile devices and wireless networks within university campuses, and the advantages of M-learning in higher education, M-learning will not replace the traditional classroom or the electronic learning system, but it can work as additional support to complement and add value to the existing learning models (Motiwalla, 2007).

The potential of M-learning is being realised in educational environments around the world, and many studies have investigated the use of M-learning to facilitate teaching and learning in higher education (Hayes, Joyce and Pathak, 2004; Keane and Crews, 2007; Lee and Chan, 2007; Rekkedal and Dye, 2007; Cavus, 2011). Both learners and lecturers have noted the advantages of M-learning, which include flexibility, mobility and availability (Triantafillou, Georgiadou and Economides, 2006; Rekkedal and Dye, 2007; Yordanova, 2007). However, M-learning is still in the early stage of development (Motiwalla, 2007;

Park, 2011). In some cases, implementation resistance and institute infrastructure shortcomings have inhibited the successful uptake of new educational technologies.

Liu and Han (2010) indicated that M-learning has not reached its maximum potential and there is a gap between what is offered and what is used. There are several issues facing the adoption of M-learning: the technical limitations regarding connectivity, small screen size, inadequate memory and slow network speeds (Wang and Higgins, 2006; Wang, Wu and Wang, 2009; Haag, 2011; Park, 2011); pedagogical issues regarding the use of mobile devices in classrooms, such as potential to disturb the learning process (Corbeil and Valdes-Corbeil, 2007; Park, 2011); and users' acceptance (both students and lecturers) to adopt this technology. User acceptance of new technology is an important key concern for institute management considering investment in technology. Users' unwillingness to adopt new technology can cause system failure and end-up being of no benefit for the institution (Taylor and Todd, 1995a; Davis and Vanketash, 1996). The success of M-learning system might may depend on users' willing to utilize new technology which different from what they have used before (Wang, Wu and Wang, 2009), therefore investigating factors influencing students' acceptance of M-learning is an essential step before the implementation stage in order to ensure that time and money invested in M-learning is used efficiently (i.e. to promote successful adoption and use). Furthermore, this will help universities to deliver high quality services to students and improve their pedagogical and learning strategic plans.

The deployment of M-learning in higher education needs a lot of effort to overcome all difficulties facing the deployment of this new technology. There are several issues facing M-learning deployment such as lack of awareness and motivation (Wang, Wu and Wang, 2009), technical aspects regarding suitable mobile devices and internet connectivity issues (Naismith and Corlett, 2006; Park, 2011), and issues related to the institutes' challenges and resistance to change (Vavoula et al., 2004; Cobcroft et al., 2006); some university lecturers do not want to apply this technology, or might face some difficulties in trying to use it effectively, as it may require a lot of effort on their part to ensure implementation (Abu-Al-Aish, Love and Hunaiti, 2012). In order to improve M-learning outside the classroom and lecturer theatres in both the real and virtual environments, a significant investment of time, resources and effort is required of institutions and stakeholders.

Due to the pioneering nature of M-learning deployment (Motiwalla, 2007; Liaw, Hatala and Huang, 2010), there is a shortage of academic studies investigating the phenomenon in

higher education. However, deployment has risen markedly since 2007 (Ng and Nicholas, 2012). Cobcroft et al. (2006) indicated that a successful conceptual framework for designed M-learning needs to consider learners' creativity, collaboration, communication and critical engagement. Naismith et al. (2004) observed that educational institutes have to adopt policies that support the integration of mobile devices into the formal learning environment. Naismith and Corlett (2006) indicated some critical success factors for implementing M-learning, derived from a number of M-learning projects from 2002-2005, comprising availability of technology, institutional support, integration, connectivity and ownership. Vavoula and Sharples (2009) determined six aspects that are presented as challenges in developing M-learning initiatives. These aspects are capturing and analysing learning in context and across context, assessing M-learning system and outcomes, utility and usability assessment of mobile technology, organizational and socio-cultural context and identifying the characteristics of M-learning learning environment in terms of formal and informal learning.

Thus, the deployment of M-learning in higher education necessitates guidelines on how to build an effective and sustainable M-learning system that attracts all users and provides them with services that meet their needs while overcoming all infrastructure challenges and institutes' resistance to change. Therefore, there is a need to investigate all critical success factors that ensure the success deployment of M-learning system.

## 1.3 Statement of the Problem

There is limited understanding of the factors that influence the deployment of M-learning in higher education. In addition, there is also a shortage of resources available for all M-learning stakeholders on how to deploy and support M-learning in university education (Litchfield et al., 2007; Cherian and Williams, 2008). The availability of wireless mobile devices and connectivity to the internet do not in themselves achieve sustainable M-learning deployment. Therefore, there is a need to investigate the factors that influence the adoption and deployment of M-learning in the higher education context. By identifying the critical factors that ensure the successful deployment of M-learning, universities can align their strategic planning with the demands of students and lecturers, make meaningful integration of technology in teaching and learning and enhance better policy decisions.

There is a lack of M-learning deployment models which guide the deployment of M-learning in the educational context. Furthermore, no available model provides a theoretical approach to guide the strategy of M-learning deployment. The following are some models

related to M-learning deployment that can serve as starting points for the development of a sustainable M-learning model. These models are explained in chapter two:

- M-learning Framework (Mostakhdemin-Hosseini and Tuimala , 2005).
- Model for Framing M-learning (FRAME) (Koole, 2006).
- Proposed Theoretical Model for M-learning in Developing Countries (Barker et al., 2005).
- A Framework for Sustainable Mobile Learning in Schools (Ng and Nicholas, 2012).
- A conceptual model for the educational deployment of QR codes (Saravani and Clayton, 2009).

These models are limited in their practical applicability. No one of the previous M-learning models/frameworks has defined guidelines that consider the stages for the deployment of M-learning. In addition, they did not provide any clear definition of sustainability factors to assure continuous evaluation and upgrading of M-learning systems after deployment. Therefore, there is a need to develop and evaluate a model that clarifies M-learning pre-deployment success factors and provides post-deployment sustainability factors.

## 1.4 Aims of the Study

This research aims to investigate the following questions:

- What is the level of students' readiness for M-learning system?
- What are students' expectations towards mobile learning services and the challenges that might affect the implementation of this new technology?
- What are the factors influencing students' acceptance towards M-learning in higher education?
- What are the key issues and critical success factors that are essential to ensure successful deployment of M-learning?
- How can the identified factors be worked (or considered) into development of a sustainable M-learning model for the higher education environment?

Related to the research questions, the main objective of this research is to study and analyse the factors that affect the adoption and deployment of M-learning in the higher education environment in order to develop a successful and sustainable M-learning model.

The model will consist of pre- and post-deployment stages including all key issues and critical success factors that are essential to ensure successful deployment.

## 1.5 Significance of the Research

The outcomes of this research include the development of a sustainable M-learning deployment model for higher education. This model represents a roadmap that identifies the challenges facing the deployment of M-learning in university education and also to involve all the elements that need to be in place for M-learning deployment.

The findings of this research will be of interest of educators and university managers concerned with the adoption and deployment of M-learning in higher education. By developing and evaluating a sustainable M-learning deployment model with pre- and post-deployment stages, including all key issues and critical success factors that are essential to ensure successful deployment, this research provides educational professional with insight how M-learning can be harnessed in order to adapted in higher educational institutes. The outcomes of this research might also be useful to educational designers who are in charge of designing university courses.

## 1.6 Research Approach

This research is divided into three phases: exploring students' readiness for M-learning; investigating the factors influencing students' acceptance of M-learning; and developing and evaluating a model for M-learning sustainable deployment.

For phase one, a questionnaire was designed to identify students' readiness for M-learning, their expectations of how M-learning would work and their thoughts about the obstacles that might hinder M-learning.

For phase two, based on the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), a theoretical model was constructed to investigate students' acceptance for M-learning.

For phase three, depending on the results obtained from first and second phases and the analysis of literature review of M-learning deployment, a model for sustainable M-learning with pre- and post-deployment stages was developed and evaluated by students and lecturers. A questionnaire was designed to identify the challenges facing the deployment of

this technology in higher education and also to involve all the successful elements that need to be in place for M-learning deployment.

The conceptual research framework is explained in Figure 1.1.

## 1.7 Outline of the Thesis

This thesis comprises seven chapters. This chapter (chapter one) introduces the research topic, and presents an overview of the research background, the aims and objectives of the study, its significance and the research approach.

Chapter two reviews existing literature relevant to M-learning. It describes the relationship between E-learning and M-learning, with definitions and comparison. It provides a discussion of the motivation and benefits of M-learning in higher education, and its limitations and challenges. In addition, the literature reviewed includes M-learning implementation studies and students' readiness towards M-learning. Furthermore, the chapter provides the theoretical background of M-learning acceptance and discusses some studies related to M-learning acceptance. Finally, the factors that affect the deployment of M-learning and a comparison of four theoretical models relevant to M-learning deployment are demonstrated.

The third chapter provides details of the general methodology applied in this research. It describes and explains the research strategies, design and methods used in this thesis. For each research method a description of research instruments, participants, procedures and ethical concerns and data analysis are illustrated.

The fourth chapter describes the first study undertaken in this research to explore students' readiness for M-learning, and their attitudes and expectations of the future of M-learning services. It details the research methods, participants, data collection instruments, procedure and data analysis. Finally, the results of the pilot and main study are reported and discussed followed by a summary of the chapter.

The fifth chapter explores the findings of the second study of this research, which aimed to investigate the factors the determine students' acceptance of M-learning in higher education. The chapter provides an overview of the research model, the research dimension and the hypotheses. In addition, the data collection, the profile of respondents and the statistical analysis to test the validity and reliability are presented. Finally discussion of the results hypotheses' testing and summary of the chapter are also included.

The sixth chapter describes the research methodology utilized for developing a sustainable M-learning deployment model as well as the users' evaluation. The participants, procedure and data collection are discussed. In addition, the chapter presents the results obtained from two questionnaires (for lecturers and students). The refined model is also provided followed by a discussion and chapter summary.

Finally, the seventh chapter presents a summary of the research findings obtained from chapters four, five and six. The chapter discusses the contribution to the knowledge in M-learning subject that this thesis makes, and provides the limitations of the research with recommendations for future work.

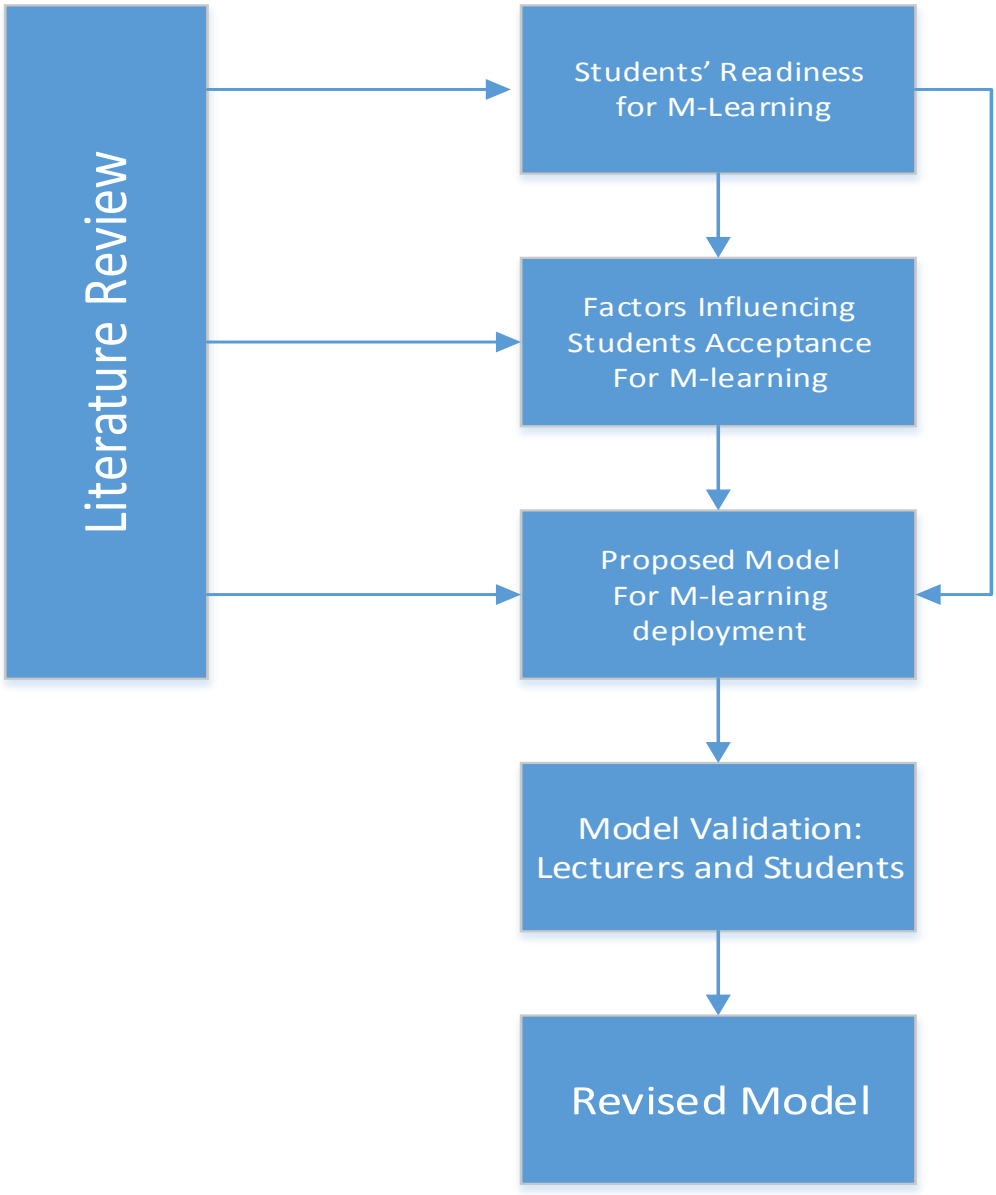


**Figure 1.1: Research Conceptual Framework**

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Overview

This chapter provides a background to the research conducted in this thesis. Firstly, the chapter introduces the concept of E-learning and its advantages, M-learning definitions, and a comparison of E-learning and M-learning. In addition, motivation and opportunity, and benefits and limitations of M-learning in higher education are discussed. Secondly, the chapter reviews the implementations of M-learning in higher education, studies and projects and students' readiness for M-learning. Furthermore, this chapter provides a theoretical background of M-learning acceptance models and discuss some studies related to M-learning acceptance. Finally, the last section outlines and compares four theoretical models relating to M-learning implementation. Justification of the research and a chapter summary are also provided.

## 2.2 Electronic Learning: E-learning

E-Learning has become increasingly important in higher education institutions. Many institutes and universities utilize E-learning in different fields of study to facilitate teaching and learning (Kim, Mims and Holmes, 2006). The online teaching and learning system (E-learning) became widespread due to the numerous advantages of this technology. E-learning can work either as a separate system or as part of a blended learning system (i.e. E-learning system with traditional learning) (Matheos, Daniel and McCalla, 2005). In addition, E-learning helps universities to provide distance learning programmes. It is a formal learning activity, which can take place when learners and instructors are isolated by geographical distance or by time (Haverila and Barkhi, 2009).

There are different definitions of E-learning in previous literature. Begicevic and Divjak (2006) defined E-learning as a type of learning supported by ICT that improves the quality of teaching and learning. Trifonova and Ronchetti (2003) defined E-learning as technology-enhanced learning. Rosenberg (2001) defined it as the use of internet technologies to deliver a broad group of solutions that enhance knowledge and performance. Another definition of E-learning, which is similar to Rosenberg's (2001) was

suggested by Clark and Mayer (2003), as training delivered on a computer using CDs, DVDs and internet communication to support institutional teaching and learning.

E-learning comprises more than internet communication tools; it depends on a learning management system (LMS) such as Blackboard and Moodle. This system allows university student learning on and off campus. Hadjiathanasiou (2009) indicated that E-learning can occur in the campuses of the universities, from home and at the workplace; it is not limited to a fixed location.

### 2.2.1 E-learning advantages

Nowadays E-learning is widely deployed to some extent at most universities around the world. It provides flexible access to the learning materials at a time and place that is suitable and convenient for learners. E-learning improves the flexibility and quality of learning (Nyvang, 2006). This flexibility establishes the foundation of distance learning (Willems, 2005). Distance learning is appreciated by working adults who like to continue their learning without the constraints of conventional residential educational institutions, in addition to offering easier access to education for conventional students.

E-learning systems provide students, lecturers and university managers with different services including grade management, student feedback and student tracking (Caladine, 2008). In addition, students can register for courses, drop, add and update their profiles, services which are usually now conducted via LMS (Caladine, 2008).

Bates (2005) indicated that E-learning involves different teaching methods, such as information management, creative thinking, critical thinking, collaborative learning and problem solving. Another study Harriman (2007) set out ten advantages of implementing E- learning in education: (1) the accommodation of multiple learning styles, (2) offering individualized instruction, (3) providing self-paced instruction, (4) on demand access, (5) allowing collaborative learning, (6) engaging users, (7) increasing retention, (8) increasing consistency, (9) tracking learners and (10) reducing learning time.

According to O'Neill and Singh (2004), E-learning is the only tool for delivering the resources required to facilitate lifelong learning. Furthermore, E-learning can facilitate more efficient communication in multiple languages, and help students with special needs.

The literature review of E-learning indicated that the system has been used in higher education as a key element for providing successful learning environments. However, E-

learning still has some limitations in terms of connectivity and mobility. E-learning systems depend on a personal computer connected to the internet, which does entail a relative limitation on mobility, which motivated researchers to investigate these challenges and provide solutions to maximize the accessibility of E-learning system services.

## 2.3 Mobile Learning Definition

The ubiquitous access to wireless technologies has motivated schools, universities and other education institutes to use mobile technology to improve learning and teaching methods. In the past decade, the use of mobile and wireless technologies in offering learning opportunities within and beyond the traditional class has grown alongside significant research in the education field (Leung and Chan, 2003; Sharples, Taylor and Vavoula, 2005; Buedding and Schroer, 2009). These devices facilitate the communication and interaction between students and lecturers (Khaddage, Lanham and Zhow, 2009). In addition, they allow users to learn on the go, and to exchange the information outside the university (Lam et al., 2011).

The definitions of M-learning used by previous studies have varied based on the mobility of the learners, mobile device applications and the relation between M-learning and E-learning.

As observed by Georgieva, Smrikarov and Georgiev (2005), M-learning depends on the use of wireless mobile devices to facilitate learning anytime, anywhere. Naismith et al. (2004) defined mobile learning as learning which employs wireless devices like smart phone, PDA, iPod, palmtop, laptop or even digital camera and USB keys in the learning and teaching process. Keegan (2005) focused on the mobility in the definition of mobile learning, defining it as the provision of education and training using PDAs, palmtops, handhelds and smart phones (devices easy to carry and use everywhere and anytime). Keegan eliminated the use of the laptop from M-learning, thus restricting M-learning to those devices which are portable, ubiquitous and flexible in order to provide a wide range of social contexts (Pachler, Bachmair and Cook, 2010).

In other research, M-learning was considered as an extension of e-learning, where the concentration is on the use of mobile devices. Trifonova and Ronchetti (2003) defined M-learning as E-learning through mobile computational devices that are small and autonomous for everyday use. Similarly, Pinkwart et al. (2003) and Doneva, Nikolaj and

Totkov (2006) considered M-learning to be the next step of E-learning through the use of wireless mobile devices and communication technologies for teaching and learning.

Mobile learning can be defined as the intersection between mobile technologies and web-based learning to provide an anytime, anywhere learning environment (Khaddage, Lanham and Zhow, 2009). Kambourakis, Kontoni and Sapounas (2004) suggested that M-learning is the point at which mobile technology and E-learning intersect to provide an anytime, anywhere learning experience. However, Liu and Han (2010) proposed that M-learning would be the new primary education channel, helping people to gain knowledge and skills with the support of mobile wireless technologies.

## 2.4 M-learning vs. E-learning

The literature review identified some differences between E-learning and M-learning regarding technology, learner access and mode of communication. Moreover, some comparisons involve distance learning (D-learning) (Brown, 2003; Georgiev et al., 2004; Peters, 2007).

Gerogiev et al. (2004) assumed M-learning to be a subset of E-learning, as shown in Figure 2.2, where E-learning is a subset of D-learning. Therefore any M-learning activity is an E-learning activity, and any E-learning activity is in turn a D-learning activity.

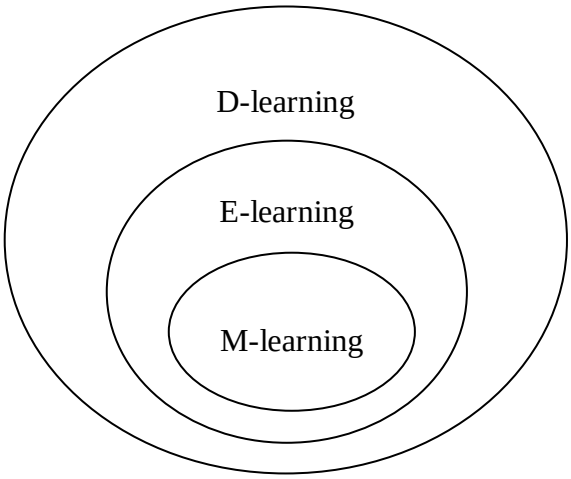


**Figure 2.1: The place of M-learning as part of E-learning and D-learning (Georgiev et al., 2004)**

Brown (2003) proposed a diagram for flexible learning showing the relationship between M-learning, online learning and E-learning within the wide context of distance learning and flexible learning, as shown in Figure 2.2.

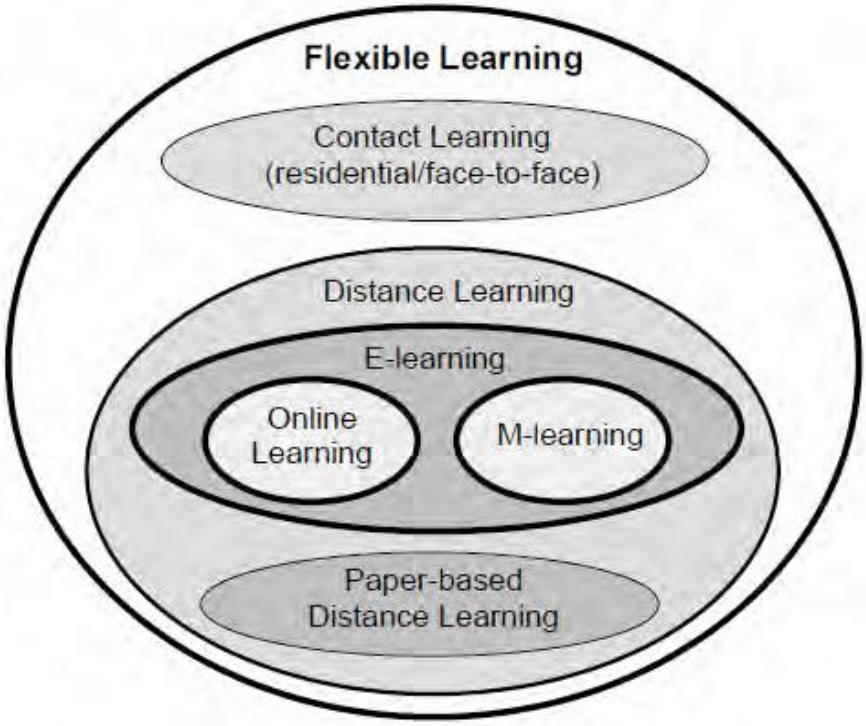


**Figure 2.2: The subset of flexible learning (Brown, 2003)**

Figure 2.2 shows that E-learning is a subset of D-learning, and M-learning and online learning are subsets of E-learning. However, there is no intersection between M-learning and online learning. This means that these are unrelated parts of E-learning. Moreover, the figure states that E-learning is a subset of distance learning, but not a subset of face-to-face learning. Khaddage, Lanham and Zhow (2009) observed that although this assumption was generally true for many learning environments in the past, M-learning can now provide location awareness and allow access to learning contents anytime, anywhere. In addition, Martin (2011) explained that this diagram excludes opportunities of blended learning; students can use mobile devices while they are in face-to-face class (i.e. use face-to-face learning blended with M-learning simultaneously).

Peter (2007) contradicted the view of M-learning being a subset of E-learning. He suggested the 'just enough, just in time, just for me' model of flexible learning. Figure 2.3 explains the model which shows that E-learning and M-learning are both subsets of flexible learning. Although there is an intersect area between E-learning and M-learning, the latter is not fully a subset of the former as there is an M-learning area located beyond the boundary of E-learning. This means that E-learning does not always include M-learning aspects.

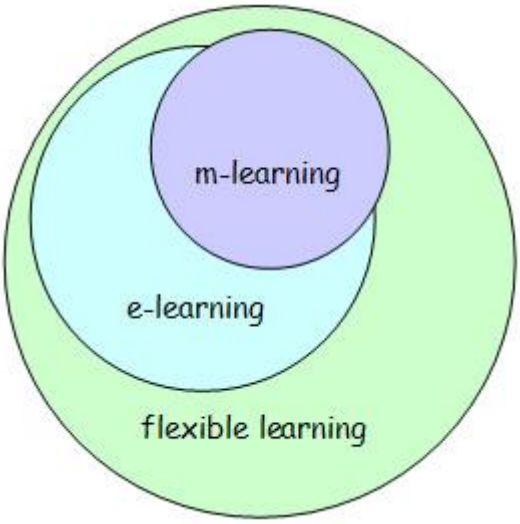


**Figure 2.3: The 'just enough, just in time, just for me' model of flexible learning (Peter, 2007)**

It is worth explaining the similarities and the differences between E-learning and M-learning in this research regarding the strong relationship between them. Table 2.1 compares aspects of E-learning and M-learning derived from a literature review of M-learning (Attewell, 2005; Laouris and Eteokleous, 2005; Traxler, 2007).

**Table 2.1: Comparison between E-learning and M-learning**

| Feature | E-learning | M-learning |
|---|---|---|
| Network | Wired | Wireless |
| Devices | Computer, Laptop | Mobile phone, smart phone, PDA and Tablet PC |
| Accessibility | Anytime | Anywhere |
| Connectivity | Internet and intranet Networks | Mobile Networks |
| Learning | Collaborative | Networked-personal and private |
| | Distance Learning | Situated Learning |
| | Formal | Informal |
| | Multimedia | Objects |
| Instructor-Student Communication | Time delayed-Asynchronous | Instant delivery-Synchronous |
| | Late Communication | Immediate communication |
| | Scheduled | Unprompted |
| Student-Student Communication | Face-to-face | Flexible |
| | Limit by location and time | Anytime, anywhere |
| | Late Communication | Immediate communication |
| | Poor due to group consciousness | Rich due to one-to-one communication |

## 2.5 Motivation and Opportunity of M-learning

Mobile devices have some characteristics which allow them to be suitable tools for modern education in terms of providing exploring and sharing learning contents, which

characteristics can be summarised as portability, functionality, ubiquity, utility and connectivity (Pachler, Bachmair and Cook, 2010). Mobile devices are small and easy to fit in the pocket, which allows students to use and carry them with minimum effort. Mobile devices provide anytime, anywhere communication between users and supply them with many properties of desktop computers such as processing and storing data. In addition, mobile devices are easier to use and cost less than computers (Fetaji, Ebibi and Fetaji, 2011). Kloper, Squire, and Jenkins (2002) discussed five unique educational attributes of mobile devices:

1. Portability: devices allow movability
2. Social interactivity: devices facilitate and enhance the communication between users
3. Context sensitivity: devices provide real data in learners' location, environment and time.
4. Connectivity: devices can be connected to each other or a shared network.
5. Individually: devices allow individual learning.

Mobile devices are designed to provide a lot of functionalities that can be used for supporting and enhancing teaching and learning methods, like messaging, games, internet access and multimedia convergence (Khaddage, Lanham and Zhow, 2009). Fetaji and Fetaji (2009) indicated that mobile devices can carry educational media that support teaching which focus on the teachers and on the contents. More and more services are becoming available in these small devices, and their capabilities increasingly rival standard computers (Khaddage, Lanham and Zhow, 2009).

Mobile learning that utilizes the ubiquitous mobile communication devices will be a successful approach now and in the future because these devices (e.g. PDA, tablet PC, smart phone) are more attractive among students for several reasons, including that they are cheaper than PCs, while providing satisfactory and efficient tools (Mahamad, Ibrahim and Taib, 2010). Laurillard (2007) indicated that M-learning is activity that motivate students by providing:

- Interaction in social life by encouraging collaboration, fun communication.
- Control over learning goals.
- Learning in contexts and continuity between contexts.

Mobile learning has the ability to implant learning into daily real life by transferring learning materials in small format and deliver it through wireless network.

## 2.6 Benefit of Mobile learning in Learning Environment

A lot of empirical studies have represented the benefit of using wireless and mobile devices in learning and teaching environment (Naismith et al., 2004; Attewell, 2005; Barker et al., 2005; Caudill, 2007). This ubiquitous technology became a part of daily learning and teaching processes and enables students to use computing power anytime, anywhere.

Samuels (2007) stated that traditional teaching methods for undergraduate mathematics are failing for the following reasons:

- Many students are weak in basic mathematical knowledge.
- Variation in capability between students registered in the same class.
- The implementation of technology in teaching mathematics for school students is faster than its implementation in mathematics teaching at universities. Universities that maintain traditional methods appear outdated.
- Failure to engage students to use new technologies in their learning will increase the culture of alienation.

Samuels (2007) pointed out that the main reasons for merging the new technology in teaching mathematics for higher education are that the new technologies provide new kinds of interactive learning, and the 'new generation' (those born after 1990) are more interested in using mobile technologies, enabling a flexible learning environment for those people who are busier in their lives or registered for part time courses (reflecting the reality of modern university education in contrast with the traditional model). In addition, the use of new technology may provide a more economical means of teaching, in addition to augmenting existing traditional learning formats.

Despite the undoubted barriers and limitations of mobile learning, its advantages are clear, and many researchers have discussed its benefits in the learning environment; there is consensus that mobile learning is effective, mobile and collaborative (Denk, Weber and Belfin, 2007).

In terms of affectivity, Ooms et al. (2008) stated that using mobile technology in learning will improve interaction, encouraging feedback for both teachers and students. Students

can concentrate their learning around weakness areas; mobile learning can enhance their learning and reduce misunderstanding. On other side, teachers can acclimatize their teaching practices, identify students' weaknesses and encourage assessment and feedback.

The most important characteristic in the mobile learning environment is mobility, which gives the students freedom to practice learning anytime, anywhere and maintains contact between students and lecturers outside the class (Wang and Ryu, 2009). Using their mobile devices they can extend learning environment beyond the university setting. Mobile devices provide learning materials with movable, flexible and independently controlled environments (Juniu, 2002). Mobility adds new options to the activities that can be enhanced regarding to the portability and the features of mobile devices (Naismith et al., 2004).

The features of mobile learning allow an environment favouring communication and collaboration, enhancing dynamic interaction in learning activities (Barker et al., 2005). Peer-to-peer or learner-to-lecturer communication facilitates discussion and explanation of information resources; they can give feedback during the learning process (e.g. questions or assessment). Lecturers can monitor the learning process and give their comments. This social collaboration and data interchange using communications channels (e-mail, messages, forums, blogs) improves the community of practice between learners and teachers and among learners themselves (Barker et al., 2005; Denk, Weber and Belfin, 2007).

Moreover, M-learning provides informal and lifelong learning. M-learning activities help in the coordination of learners and resources for learning activities. This type of learning usually happens in daily life outside the classroom. Mobile devices can support this kind of learning (Naismith et al., 2004). In addition, M-learning has benefits in learning and teaching management. Mobile devices can provide course materials such as timetables, workshop booking, and assignment dates (Corlett et al., 2005).

As a subset of E-learning, the benefits of M-learning have common features with the benefits of the former (Jacob and Issac, 2008a; Hashemi et al., 2011), as summarized below:

1. Ease of access (e.g. access documents libraries, access to video or audio).
2. Provides options of self-study.
3. Facilitates evaluation method, self-assessment and feedback.

4. Offers communities of practice and allows participation in virtual learning communities.
5. Exhibits student work.
6. Enables reading asynchronous postings.

There are many evidences in the literature reviewed (projects in M-learning) supporting the position that M-learning improving learning. Many studies have investigated the use of mobile technologies to support learning and teaching in school settings (Hung et al., 2013). Previous studies indicated that mobile devices can assist children in learning English as a foreign language (Chang and Hsu, 2011; Hsu et al., 2013). Other studies (Hung et al., 2013; Hwang et al., 2013) adapted inquiry-based mobile learning approach to help elementary school students to learn and collect data about ecology and temples observations. The results showed that mobile learning can integrate real world and digital world resources to improve the learning achievement and reduce cognitive load.

In addition, mobile devices have been used recently in higher education. Yin et al. (2013) developed a conceptual framework called Scaffolding Participatory Simulation for Mobile Learning (SPSML) using mobile devices with the aim of helping students learn conceptual knowledge inside the classroom or in a social context. The innovative framework was applied to improve learning performance on the subject of computer algorithms. The results indicated that students were willing to use the system. The learning system using SPSML framework led to experiential learning, facilitated collaboration, motivated students and improved their learning achievement. Wu et al. (2012) designed a context-aware mobile learning system for nursing training courses. The mastery learning strategy combined the cognitive apprenticeship approach and a context –aware ubiquitous learning environment to guide nursing students to practice a physical assessment, including gathering patient symptoms, identify disease and providing nursing treatment. The learning system applies personal guidance and provides students with appropriate feedback. The results indicated that experimental students were better than those in control group in terms of learning attitudes and achievements.

There has been an increase in the number of universities using mobile learning to support learning and teaching (Cavus and Ibrahim, 2009; El-Hussein and Cronje, 2010; Cavus, 2011; Ogata et al., 2011; Wu et al., 2012). M-learning is likely to become one of the most

effective ways of delivering higher education materials in the future (El-Hussein and Cronje, 2010).

## 2.7 Limitations and Challenges of M-Learning

Despite the many advantages of M-learning as a new technology to enhance learning and teaching in all education institutes, it does have some limitations that need to be considered as issues facing its implementation. According to previous studies, the limitations of implementing M-learning are as follows:

- *Technical limitation or restriction of mobile devices.* Many studies (Seppala, Sariola and Kynaslahti, 2002; Corlettt et al., 2005; Wang, Wu and Wang, 2009; Hashemi et al., 2011; Park, 2011) indicated that mobile devices have some limitations due to small screen, memory size, slow network speed, battery life and small and limited keyboard. Furthermore, the devices being used in M-learning may not give the same resolution or design of contents as a computer (Barker et al., 2005). In addition, mobile devices are limited in processing power and resources and they have a variety of different input possibilities and operating systems.

- *Users' psychological limitations*. Some studies (Wang, Wu and Wang, 2009; Park, 2011) indicated that students are more likely to use mobile devices for entertainment uses such as listening to music, texting other friends and checking social networks rather than for educational purposes.

- *Safety and security issues*. Mobile devices are easy to lose, subject to damage, and are more likely to be stolen and misused. These issues might be barriers to learners from low-income backgrounds owning these devices to collaborate in the learning environment (Barker et al. 2005).

- *Pedagogical aspects*. Some pedagogical aspects should be taken in consideration while mobile devices integrated in learning (Wang, Wu and Wang, 2009; Park, 2011). For example, using mobile devices in class might disturb students' concentration and impede the learning process.

- *Implementation cost*. The cost of the mobile devices and infrastructure of implementing M-learning is still expensive, in addition to the need for wireless services, budgeting for maintenance and repairing the tools, and training and support costs for teachers, learners and parents, all of whom have to understand the

functionality of the devices to fully engage in the M-learning process (Nasimith et al., 2004; Barker et al. 2005).

Naismith et al. (2004) identified some thematic challenges that need to be considered when implementing an M-learning system:

- *Context*. M-learning provides the ability to access information about the user's environment, which can cause privacy concerns.

- *Mobility*. M-learning offers a link to activities anytime, anywhere, inside and outside the classroom. Although intended to improve relations between those involved, this could allow learners to break away from engagement with their lecturers or with the curriculum.

- *Learning over time*. Effective mobile devices are needed to organize and reflect the M-learning experience for lifelong learners.

- *Informality*. M-learning enhances informal learning. In this kind of learning, learners might misuse the technology to pursue leisure activities (e.g. social networks) rather than focusing on M-learning tasks.

- *Ownership*. Learners like to own and control their technology devices. This allows them to engage and evaluate the learning practices. However, this might create a challenge for the institute to control this ownership of technology.

Yardanova (2007) highlighted numerous social and technical issues in the implementation of M-learning in education. He indicated that the most three key problems related to use of M-learning in education are students' acceptance, specific features of mobile technology and the limited range of mobile devices. Young people are familiar with functionality and capability of mobile devices, and easily accept the idea of wireless technologies integration. In addition, Yordanova (2007) suggested that learning materials have to be delivered to mobile devices in the format of learning objects that can be displayed in a flexible and user-friendly manner. Furthermore, she indicated that the privacy of user data and the confidentiality of learning materials are critical success factors for the implementation and development of an effective mobile learning system.

## 2.8 Mobile Learning for Higher Education

The fast spread of mobile devices and wireless networks within university campuses makes higher education a particularly a suitable place to integrate student-centred M-learning (Cheon et al., 2012). Mobile learning that utilizes ubiquitous devices will be successful now and in the future because these devices (PDA, tablet PC, smart phone) are more attractive among higher education students for several reasons, including that they are cheaper and more flexible than conventional PCs, and they are satisfactory and economical tools (Mahamad, Ibrahim and Taib, 2010). M-learning can extend the benefits of E-learning system (Motiwalla, 2007) by offering university students opportunities to access course materials and ICT, learn in a collaborative environment (Nassuora, 2012) and obtain formative evaluation and feedback from instructors (Crawford, 2007).

### 2.8.1 M-leaning Studies and Projects in Higher Education

Mobile devices nowadays play a significant part in educational processes according to their flexibility, information sharing, mobility and motivation. Many studies of M-learning in higher education investigated the implementation of wireless mobile devices in universities learning and teaching methods.

Houser, Thoronton, and Kluge (2002) investigated the implementation of both cell phone and PDA for studying English as a foreign language at a Japanese university. This implementation contained developing, estimation and analysis of language activities. They tried to design language curricula focusing on evaluation, teaching, and materials including mobile hardware and software. Houser, Thoronton, and Kluge (2002) pioneered the first step in the roadmap for creating and evaluating materials to teach foreign languages using mobile devices.

Liu et al. (2003) paved the way for constructing a wireless technology enhanced classroom (WiTEC) by incorporating wireless LAN, wireless mobile devices, an electronic whiteboard and classroom servers. The study explained how teachers and students use the tools in (WiTEC) to implement effective project-based learning.

The researchers represented the design of (WiTEC) and explained its components. WiTEC consists of two servers and two clients. The servers contain interactive classroom server (ICS) and a resource and class management server (RCMS). The two clients were interactive instruction centre (IIC) and interactive learning centre (ILC) for both for teacher

and students. From an educational perspective, the WiTEC can provide the following features:

- Teachers can utilize this technology to save time usually spent on traditional classroom tasks.
- Students are more interested and engaged in the learning activities and group working is simplified in a collaboration environment.
- Enables teachers to monitor students' learning activities.
- Records teaching and learning processes as learning portfolios or group archives in RCMS.
- User-friendly interface which provides smooth teaching and learning.

Project-based learning is applied within the (WiTEC) to illustrate how the previous features can help students and teachers participate effectively in learning and teaching processes difficult to effect in a traditional classroom. The results indicated that WiTEC enables teachers and students to apply technologies to traditional teaching and learning activities seamlessly.

Liu et al. (2003) identified a set of issues to be explored by other researchers. First, introducing mobile learning devices into teaching and learning activities in classrooms may change current classroom phenomena. Second, it is necessary to consider if other innovative learning approaches are appropriate for WiTEC. Finally is important to guide class members using various functions of the devices and to involve these technologies with everyday teaching and learning activities.

Jacob and Issac (2008a) investigated the concepts of mobile learning for higher education and discussed the potential of some different wireless technologies. They conducted a survey to find and analyse the essential factors that can overcome the difficulties of the implementation mobile learning in higher education. In addition, they gave attention to some variables that might influence student perceptions of mobile learning: gender, course of study and attitudes to new technology. They concentrated on mobile learning using wireless laptop with some discuss to other technology.

The survey contained three specific objectives: 1) discovering students' general attitudes toward mobile learning on campus; 2) examining the relationship between the attitudes in (1) and essential background factors like gender, course of study and attitudes toward the

new technology; and (3) revealing the advantages and disadvantages that students expected in the context of mobile learning.

A sample of 250 students from business and engineering schools in a Malaysian university who are familiar with wireless networks participated in the survey. The results showed that the majority of students expressed vocally that they need laptops, PDAs and hand phones to be working together for communication and learning anytime, anywhere. Students expressed some predilection to laptop-based network communication over mobile phones due to the former's greater effectiveness in displaying learning contents.

Khaddage, Lanham and Zhow (2009) discussed the use of mobile learning in higher education, suggesting a model based upon a combination of blending learning and mobile learning into the higher education environment. The blended learning model incorporates all aspects and methods from both face-to-face and online learning (Lanham, 2007), as shown in Figure 2.4. Khaddage, Lanham and Zhow (2009) upgraded the blending learning model by adding the mobile learning as additional method which combines online learning and traditional classroom learning. Stead et al. (2006) indicated that mobile learning is more efficient when used as a part of an existing blend. Figure 2.5 presents the mobile learning model.

The blending learning model forms an effective, amenable, collaborative and efficient learning environment, with the ability to provide learners with anytime, anywhere and real-time learning. Online learners as well as distance learners can benefit from this process; they can download resources directly from the university server and learn these materials through their phones. In addition, they can send messages, capture images and contact teachers. Therefore learners can easily access their course contents.

El-Sofany and El–Seoued (2009) gave a description of the analysis, design, construction and experimental development of wireless course management system (WCMS) whereby a prototype supplied students and instructors with a wireless access to course information contents. Using WCMS, students can access course syllabus, lectures, assignments and tutorials anytime, anywhere. In addition, WCMS allowed the instructors to upgrade the course contents as required, controlling students' progress, administering students' tests, and creating and cancelling students' accounts. The wireless course management was tested by a group of students and instructors. The results showed high performance and the positive promise of this course.

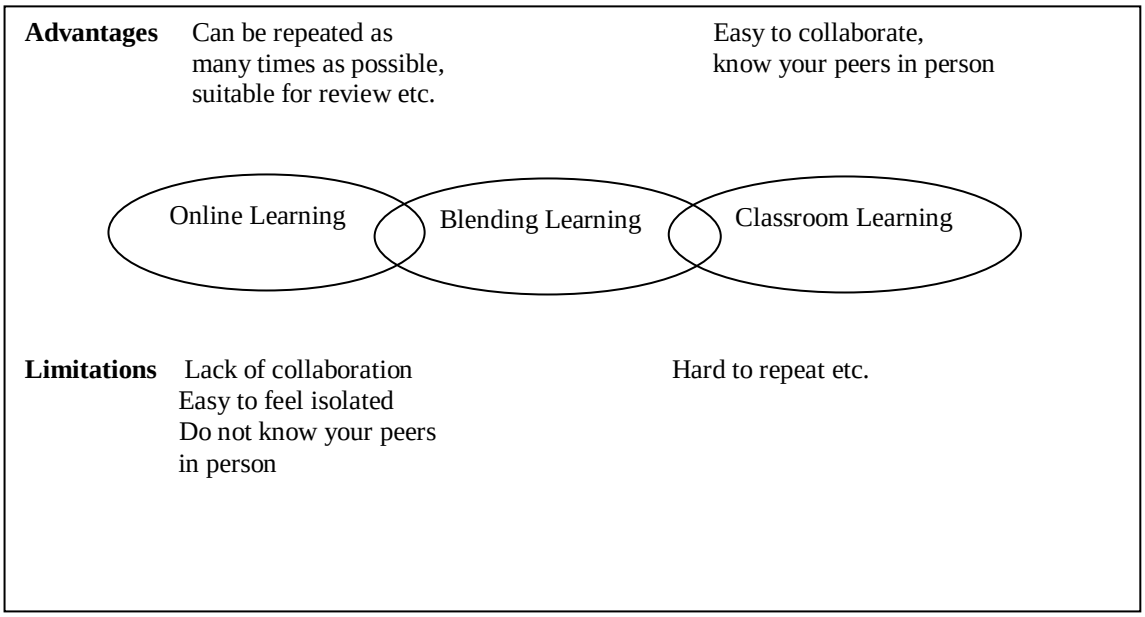


**Figure 2.4: Blended Learning Model (Lanham, 2007)**

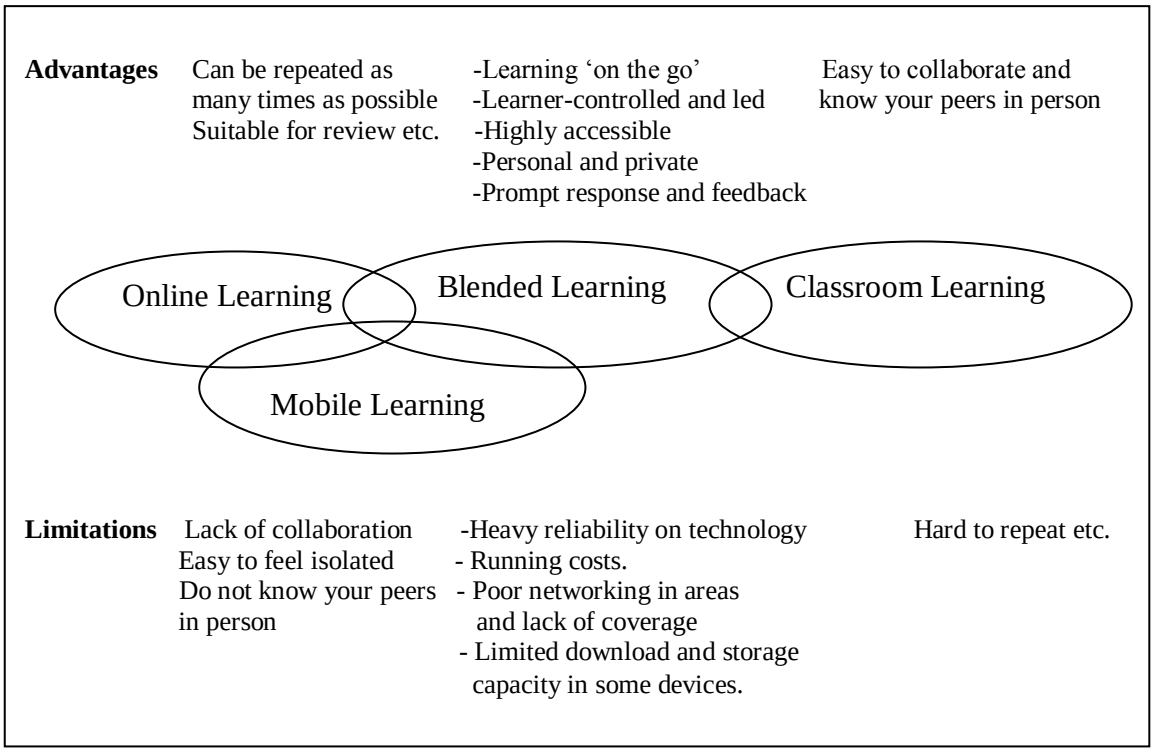


**Figure 2.5: Blending Mobile Learning Model (Khaddage, Lanham and Zhow, 2009)**

Cavus and Ibrahim (2009) investigated the use of wireless technologies (mobile phones) in teaching first-year undergraduate students new English language words with the aim to support their English lectures. The project was carried out based on a Windows program called Mobile Learning Tool (MOLT), designed by the researcher on a PC. The programme sends the text message to a mobile phone connected with the PC via Bluetooth. A pre-test and post-test were conducted in order to evaluate the learning ability of the

students. The results indicated that students believed that the system brought greater value to their learning, and their interest in using mobile phones helped them to learn new words. In addition, the students wanted the system to be used in other courses.

Botzer and Yerushalmy (2007) investigated how socio-cultural and situated learning aspects are affected in a learning paradigm within the new mobile technology learning environment. Their project presented a study for use of a cellular application, 'math4mobile', which is a project that examines the opportunities of using ubiquitous and personal technologies for educational purposes, especially of using the mobile phone for mathematics learning. The researchers proposed a construction of learning materials and applications that use a singular characteristic of the cellular phone, which aims to incorporate mobile application in teaching and learning. The participants were four female mathematics students studying a mathematics methods course. The project contained some collaboration activities like using cellular video camera to videotape simple phenomena, using multimedia massages system (MMS) to share the video clips between participants, using mathematical applets to design the graphs that represent the phenomena and using short massages system (SMS) to exchange mathematical objects and verbal massages. The practices of the learner were registered during the time of the project and interviews were held with two of them.

Botzer and Yerushalmy (2007) stated that the positive engagement of the students in the project was due to the mobility of learning environment, communication capability of cellular devices and ease of use of the application. They found that the advantage of mobile environment is not just in creating a dynamic mathematical application, but also in supporting the implementation of mathematical tasks that are closer to student experience, which enhances the learning process.

### 2.8.2 Students' Readiness for M-learning

One of the key factors that determine the success of implementing new innovation in the context of education is the degree of users' readiness towards the adoption of the technology (Lam et al., 2011). University students may be ready to adopt M-learning faster than K-12 students due to their higher ownership of mobile devices and greater familiarity with E-learning system. However, M-learning is still in the early stages of development and many challenges face the adoption of this technology (Motiwalla, 2007; Park, 2011). In order for M-learning to succeed in higher education and achieve its aims, there is a need to assess students' readiness for it (Corbeil and Valdes-Corbeil, 2007).

A number of studies have been carried out to examine students' readiness for mobile learning. Trifonova, Georieva and Ronchetti (2006) investigated the use of M-learning in two European universities: the University of Trento, Italy, and the University of Ruse, Bulgaria. Students were asked about the availability of mobile devices, their opinions on learning systems and the services that mobile learning should supply. The findings indicate that students' attitude toward M-learning is dependent on the way they have used E-learning. For example, students who use E-learning tools and are comfortable with these types of services, have a positive attitude about M-learning. Students expect M-learning to provide several services that integrate E-learning solutions. Also, the prices of the suitable device as well as the price of the services being supplied are important factors for the adoption of a successful M-learning application. In terms of gender, the study found that male students were more interested in using an M-learning system than female students, who stated a preference for the traditional class-based approach to learning.

In a similar study, Corbeil and Valdes-Corbeil (2007) investigated whether distance-learning students and faculty members were ready to make the jump from E-learning to M-leaning. An informal survey was conducted to determine students' and faculty members' use of mobile devices in their learning and teaching activities. The results indicated that both students and faculty members had not fully integrated mobile technologies into their teaching and learning activities. They used their mobile devices at work but only for entertainment purposes, however, a high portion of students expressed readiness for M-learning.

Jacob and Issac (2008b) investigated attitudes towards the usage of mobile devices for mobile learning purposes among undergraduate students in a Malaysian university. The results indicated that students were fully ready for M-learning and they expected that true M-learning would be a popular trend within three to five years. They also stated that they thought M-learning would be a useful additional tool for making the learning process more enjoyable.

In a similar study, Abas, Peng and Mansor (2009) conducted a study at the Open University Malaysia (OUM). The results indicated that students perceive themselves as mobile learners. They also thought that M-learning would help them to arrange their time more effectively and increase their interest in learning.

As the above examples indicate, several studies have been undertaken in different countries to investigate the usage of mobile devices for learning purpose. The results of

these studies show that there is widespread use of mobile devices among students. However, these studies also generally indicate that students are not yet ready to adapt M-learning technology in their studies; they believe that M-learning will develop as a new technology of learning in the near future (Lam et al., 2011).

However, one study took a different approach from the studies outlined above (Economides and Grousopoulou, 2009). They explored the attitudes of undergraduate students (male and female) toward mobile devices characteristics. They tried to provide an illustration from the students' perspective about the important services offered by M-learning and the ability of students to pay extra money to get these services. The results indicated that both male and female students were willing to spend extra money on their mobile devices. However, the females thought that the price for these services should be lower than the male participants in this study.

In relation to this, some researchers have recommended that institutions of higher education should offer a high level of infrastructure and technical support to help the adoption of M-learning within campuses. Lam et al. (2011) suggested that universities might offer an additional informal learning environment to allow students to start their learning. Abas, Peng and Mansor (2009) encouraged universities to form a good partnership with mobile industrial companies, like mobile telecommunication operators and programmers, who can design and develop M-learning applications. Additionally, technical decisions need to be made in a way that allows the development of learning materials and makes them available on mobile devices (Ally, 2009). In this way, universities can overcome the technical problems and supply their learners with useful and comfortable learning opportunities.

Other studies in M-learning literature that investigated students' perceptions of M-learning were agreed that such perceptions influence the adoption of this technology and provide insights into the reasons of success or failure in such a technology like M-learning system (Cutshall, Changchit and Elwood, 2006). In a study based on graduate and undergraduate students at a Jordanian university, Muhanna and Abu-Al-Sha'r (2009) investigated the university students' attitudes towards the usability of cell phones in a learning environment wherein cell phones are used as learning tools in the classroom. In addition, the study aimed to explore any differences in students' attitude based on their gender and level of study.

The researchers conducted a survey consisting of two questionnaires among two groups of two different levels of university students. The first questionnaire distributed to 30 undergraduate students at the Faculty of Educational Science and the second was distributed to 20 graduate students who were master's degree students and worked as teachers. Two independent variables – university levels (graduate, undergraduate) and gender (male, female) – were compared. The findings indicated that students appreciate using cell phones in the learning environment. Undergraduate students are more interested in using cell phones than graduate students, and female students are less ambitious in this regard than males. These results were in agreement with previous research done in the same area.

Al-Fahad (2009) investigated students' attitudes and perceptions towards the effectiveness of M-learning. The author conducted a survey with 186 undergraduate students from different colleges in order to understand how they used mobile technologies in their learning environments. The results illustrated that M-learning is widely accepted by the student community. Students agree that wireless networks increase the flexibility of access to learning resources. Also, students are interested in using M-learning tools via laptops, mobile phones and PDAs to be able to access the information anytime, anywhere. The results of the study indicated that M-learning activities can engage students in the learning process and transfer them from passive learners to behaviorally and intellectually active learners.

## 2.9 Student Acceptance of M-learning

Students' perceptions of M-learning need to be investigated as the initial step to implementing M-learning in higher education (Cheon et al., 2012). Therefore, it is necessary to conduct research that identifies the factors university students' consider important in the acceptance of M-learning.

### 2.9.1 Unified Theory of Acceptance and Use of Technology: Theoretical Background

A number of models have been developed to examine the individuals' acceptance and intention to adopt new technologies in the world of information systems. Davis (1989) tried to determine what causes people to accept or reject information technology.

The most widely used model in the field of technology adoption is the Technology Acceptance Model (TAM) (Davis, 1989). The idea of TAM is to give a theoretical basis to explain the impact of external variables (i.e. objective system design characteristics,

training, computer self-efficacy) on internal beliefs, attitude toward use, behavioural intentions and actual system use (Ibrahim and Jaafar, 2011). Figure 2.6 explains TAM and the relationship between the different variables.

TAM has become a popular and widely used model in IS acceptance because of itT simplicity and its applicability in different areas of information technology (King and He, 2006). It has been applied to many different end–user technologies, such as e-mail (Adams, Nelson and Todd, 1992), the World Wide Web (Lederer et al., 2000; Yi and Hwang, 2003), internet banking (Wang et al., 2003), e-commerce (Henderson and Divett, 2003) and wireless Internet (Yu, Liu and Yao, 2003).

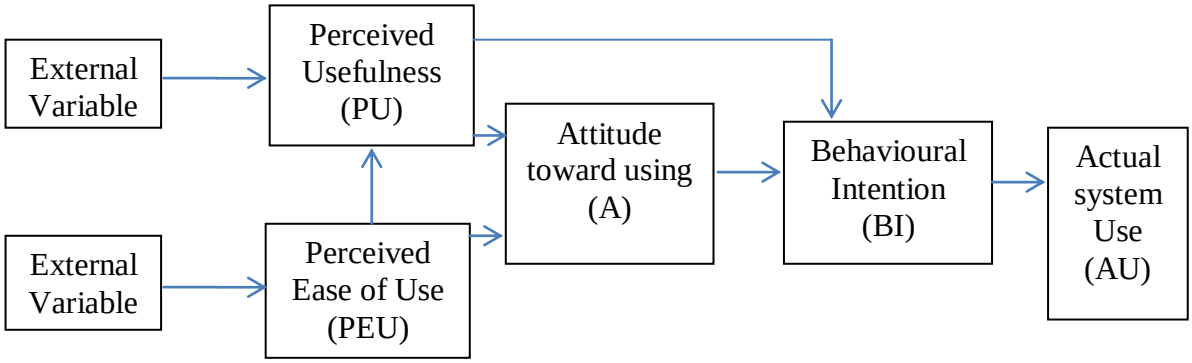


**Figure 2.6: Technology Acceptance Model (TAM) based on Davis (1989)**

Another popular and recent model in information technology acceptance is the Unified Theory of Acceptance and Use of Technology (UTAUT). This theory was proposed by Venkatesh et al. (2003), and attempts to integrate and empirically compare elements from eight different models. The eight models consist of the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), TAM (Davis, 1989), the Motivational Model (MM) (Davis, Bagozzi and Warshaw, 1992), the Theory of Planned Behaviour (TPB) (Ajzen, 1991), the Model of PC Utilization (MPCU) (Triandis, 1977; Thompson, Higgins and Howell, 1991), the Innovation Diffusion Theory (ITD) (Moore and Benbasat, 1991; Rogers, 2003), Social Cognitive Theory (SCT) (Bandura, 1986; Compeau and Higgins, 1995) and a model that combined TAM and TPB (C-TAM-TPB) (Taylor and Todd, 1995a). Table 2.2 describes all these models in a more detail.

**Table 2.2: Models and Theories of Individual Acceptance (Venkatesh et al., 2003)**

| Model/Theory | Core Constructs |
|---|---|
| *Theory of Reasoned Action (TRA)* | |
| TRA is drawn from social psychology and has been considered as one of the most fundamental and influence theories of human behaviour. TRA has been used to predict the individual acceptance of technology and provides largely variance explained. | Attitude Toward Behaviour,<br>Subjective Norm |
| *Technology Acceptance Model (TAM)* | |
| TAM was originally designed to predict the IT acceptance and usage on the jobs. It has been applied to various kinds of technologies and users. Venkatesh and Davis (2000) proposed TAM2 by adding subjective norm to the TAM in case of mandatory setting. | Perceived Usefulness,<br>Perceived Ease of Use,<br>Subjective Norm (in TAM2) |
| *Motivational Model (MM)* | |
| Many studies in psychology have applied MM theory for specific context. Davis, Bagozzi and Warshaw (1992) adapted MM theory to understand new technology acceptance and usage. | Extrinsic Motivation,<br>Intrinsic Motivation |
| *Theory of Planned Behaviour (TPB)* | |
| TPB extended TRA by involving the construct of perceived behavioural control. TPB has been used to understand the individual acceptance and usage of various technologies. | Attitude Toward Behaviour,<br>Subjective Norm,<br>Perceived Behavioural Control |
| *Combined TAM and TPB (C-TAM-TPB)* | |
| C-TAM-TPB is hybrid model combines the predictors of TPB and perceived usefulness from TAM | Attitude Toward Behaviour, Subjective Norm, Perceived Behavioural Control, Perceived Usefulness |
| *Model of PC Utilization (MPCU)* | |
| MPCU is derived from theory of human behaviour, Triandis (1977). Thompson, Higgins and Howell (1991) proposed this model and use it to predict the PC utilization | Job-fit, Complexity, long-term, Consequences, affect Towards Use, Social Factors, facilitating Conditions |
| *Innovation Diffusion Theory (IDT)* | |
| Moore and Benbasat (1991) adapted the properties of innovations obtained in Rogers (1995) and refined a set of construct that could be used to investigate the user technology acceptance. | Relative Advantage, Ease of Use, Image, Visibility, Compatibility, Results Demonstrability, Voluntariness of Use. |
| *Social Cognitive Theory (SCT)* | |
| Compeau and Higgins (1995) used and extend SCT to the context of computer utilization. SCT is considered one of the most powerful theories of human behavior | Outcome Expectations-Performance, Outcome Expectations- Personal, Self-efficacy, Affect, Anxiety. |

Venkatesh et al. (2003) compared the eight models in an empirical study and then formulated a unified model, UTAUT, which incorporates system characteristics (how the system will help the users in doing their jobs and how easy the system is easy to use) and

users' characteristics (attitude, social influence and facilitating conditions) in order to predict user acceptance.

The UTAUT contains four determents of IT user behaviour and four moderators found to mediate the effect of the four determinants on the behaviour intention and user behaviour. UTAUT theorizes that performance expectancy, effort expectancy, social influence and facilitating conditions are direct determinants of behaviour intention or user behaviour. This gives appreciable improvement to the explanatory power of the model. Also the mediating variables (gender, age, experience and voluntariness of use) are very important in understanding the characteristic of different user groups (see Figure 2.7).

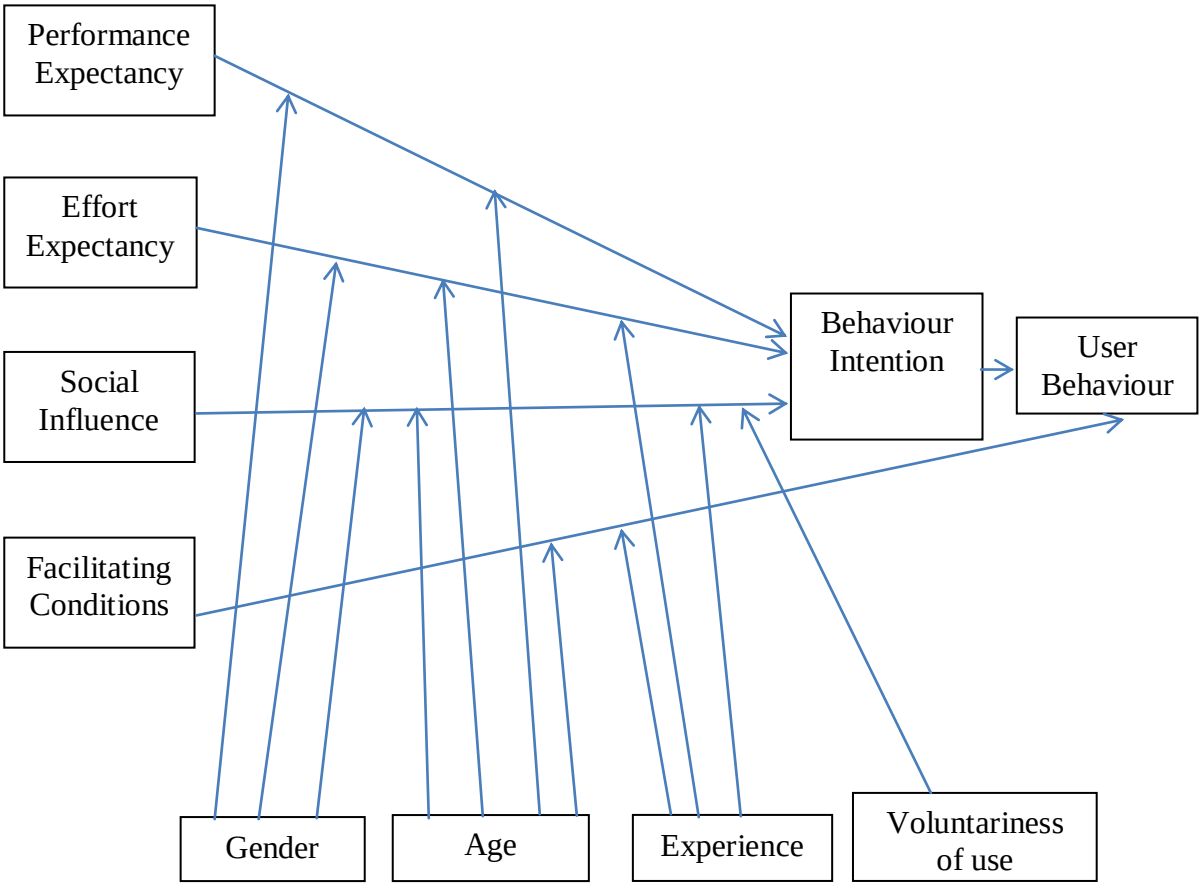


**Figure 2.7: The UTAUT Model Venkatesh et al. (2003)**

Venkatesh et al. (2003) indicated that UTAUT can offer organization managers a useful tool to assess the introduction of new technology and give them an overall understanding of the factors that affect the user's behaviour in accepting information technology. This can help to design early interposition (including training, marketing etc.) concentrated on the user who is less inclined to adopt new technology in their tasks. UTAUT has the ability to explain about 70% of variance in the intention (Venkatesh et al., 2003), and it can provide

a useful tool for managers to assess the success of the new technology (Ibrahim and Jaafar, 2011).

### 2.9.2 Studies in M-learning Acceptance

M-learning became useful in education in terms of administration, organization and teaching assistance for practitioners. Therefore, there is a need to understand the students' perception of M-learning before implementing it in university campuses. Thus, several studies addressed the factors that affect students' acceptance of M-learning. Some of these studies used TAM as the basis of a research design to explain the behavioural intention to use M-learning (Phuangthong and Malisawan, 2005; Ju, Sriprapaipong and Minh, 2007; Zarmpou et al., 2012).

Lu and Viehland (2008) found that perceived usefulness of mobile learning, perceived ease of use of mobile learning, attitude toward using mobile learning, subjective norm, self-efficacy and perceived financial resources are key factors that influence the behavioural intention of users to adopt M-learning. Prior use of E-learning is not considered to be a reliable factor that affects the adoption of M-learning. Liu, Li and Carlsson (2010) proposed a hypothesized model based on TAM to investigate the factors of M-learning adoption in a Chinese university. They found that personal innovativeness influenced behavioral intention to adopt M-learning. In addition, perceived (long-term) usefulness was found to be the strongest determinant of intention to use M-learning followed by perceived (near-term) usefulness. However, perceived ease of use was not a significant influence on perceived (near-term) usefulness as well as on behavioural intention.

Chong et al. (2011) examined the factors affecting the adoption of M-learning in Malaysian universities. They proposed a study using extended TAM (perceived ease of use and perceived usefulness that can be used to predict the intention to use a technology) by adding suitable constructs derived from TPB. The new extended TAM includes a new variable related to attitude towards using the construct derived from TPB and four other variables: technical feasibility, cost-effectiveness, quality of service and cultural aspects. The results indicated that perceived ease of use, perceived usefulness, quality of service and cultural aspects are all factors that influence attitudes towards using M-learning, whereas technical feasibility and cost-effectiveness were found to be non-significant in terms of influence. Similar to the work reported above, Park, Nam and Cha (2011) constructed a model to explain students' acceptance of M-learning in a Korean university. The model extends TAM by adding external latent factors, such as mobile learning self-

efficacy, major relevance, system accessibility and subjective norm. The results confirmed the acceptability of the model. Mobile learning attitude was found to be the most important construct, followed by students' major relevance and subjective norm.

Using the UTAUT, Wang, Wu and Wang (2009) conducted a study to investigate the determinants of M-learning acceptance and to explore whether age or gender differences play a significant role in the acceptance of M-learning. The researchers added two additional constructs to the UTAUT in order to apply this theory for M-learning acceptance: perceived playfulness and self-management of learning. They found that performance expectancy, effort expectancy, social influence, perceived playfulness and self-management of learning were all significant determinants of behavioural intention of M-learning acceptance. In terms of age and gender differences, the results indicate that age differences moderate the effects of effort expectancy and social influence on M-learning use intention, and that gender differences moderate the effects of social influence and self-management of learning on M-learning use intention.

Iqbal and Qureshi (2012) utilized the UTAUT to investigate students' perceptions of M-learning adoption. In addition to the UTAUT factors, they included perceived playfulness. The results indicated that perceived usefulness, ease of use and facilitating conditions significantly affect students' intention to adopt M-learning, while perceived playfulness is found to have less influence. Also, social influence is found to have negative affect on adoption of M-learning.

In addition, Lownthal (2010) used UTAUT to examine the factors that affect the behaviour intention of students to use M-learning technology. The factors include performance expectancy, effort expectancy, and self-management of learning, and the moderators were age and gender. The results indicated that performance expectancy and effort expectancy significantly influence BI. Self-management of learning was not significant. Age and gender were determined to have no mediating impact.

Jairak, Praneetpolgrang and Mekhabunchij (2009) gave a better understanding of acceptance of M-learning in the context of Thai students. The study was conducted using UTAUT based upon TAM. The results indicated that performance expectancy, effort expectancy and social influence have a significant positive relationship with attitude towards behaviour. Furthermore, effort expectancy, social influence and facilitating conditions have a significant positive relationship with BI. Jairak, Praneetpolgrang and Mekhabunchij (2009) point out that good perception toward M-learning and university support are two main

factors that lead to a successful M-learning system. Therefore, university administrations need pay attention to designing a good M-learning system that is appropriate to the students' perceptions.

The results indicate that student's acceptance of M-learning is key in designing a successful M-learning system. Therefore, there is a need to investigate the factors that affect their acceptance of M-learning and to overtake all challenges that face the success of the factors.

## 2.10 M-learning Theoretical Models

While M-learning implementation research is still in its infancy (Motiwalla, 2007 Liaw, Hatala and Huang, 2010), it has received increasing attention since 2007 (Ng and Nicholas, 2012). Cobcroft et al. (2006) indicated that a successful conceptual framework for M-learning needs to consider the learners' creativity, collaboration, communication and critical engagement. Naismith and Corlett (2006) indicated some critical success factors for implement M-learning, derived from a number of M-learning projects from 2002-2005: availability of technology, institutional support, integration, connectivity and ownership. Vavoula and Sharples (2009) determined six aspects presented as challenges in developing M-learning initiatives: capturing and analysing learning in context and across context, assessing M-learning system and outcomes, utility and usability assessment of mobile technology, organizational and socio-cultural context and identifying the characteristics of M-learning learning environment in terms of formal and informal learning.

The following four models are relevant to the deployment of M-learning in schools and higher education; they are described in details in the following sections.

### 2.10.1 M-learning Framework (Mostakhdemin-Hosseini and Tuimala, 2005)

Mostakhdemin-Hosseini and Tuimala (2005) defined a framework for mobile learning system, and constructed a mobile learning system based on three domains: mobile usability, wireless technology and E-learning system. Figure 2.8 shows the three domains in the M-learning system.

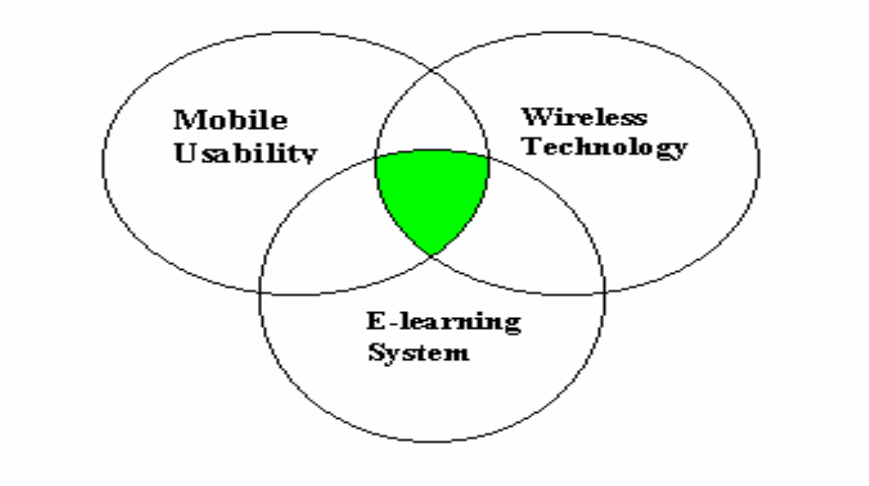


**Figure 2.8: The Domain of Mobile Learning System**

Mostakhdemin-Hosseini and Tuimala (2005) indicated that usability is an important factor to identify the requirements of each mobile device's capability in order to provide useful services. They considered that the content of mobile devices, service types, requirements of each service and the service limitations are the main issues which should be demonstrated carefully when designing educational services for mobile devices.

The second construct of mobile learning system is the wireless network technology, especially network infrastructure and operators rules. The type of network infrastructure and the cost of the services affect the successful of overall M-learning system; users are willing to pay to get *useful* services, therefore they like the network to be fast, secure and with a reliable network connection.

The final construct of M-learning system is the existing E-learning system. The requirement of the E-learning system and the way the E-learning platform is utilized influences the M-learning system, as the new adaptive system is more complicated than the existing E-learning system. Mostakhdemin-Hosseini and Tuimala (2005) recommended that M-learning system developers need to consider some issues while developing the M-learning system, as shown in Figure 2.9.

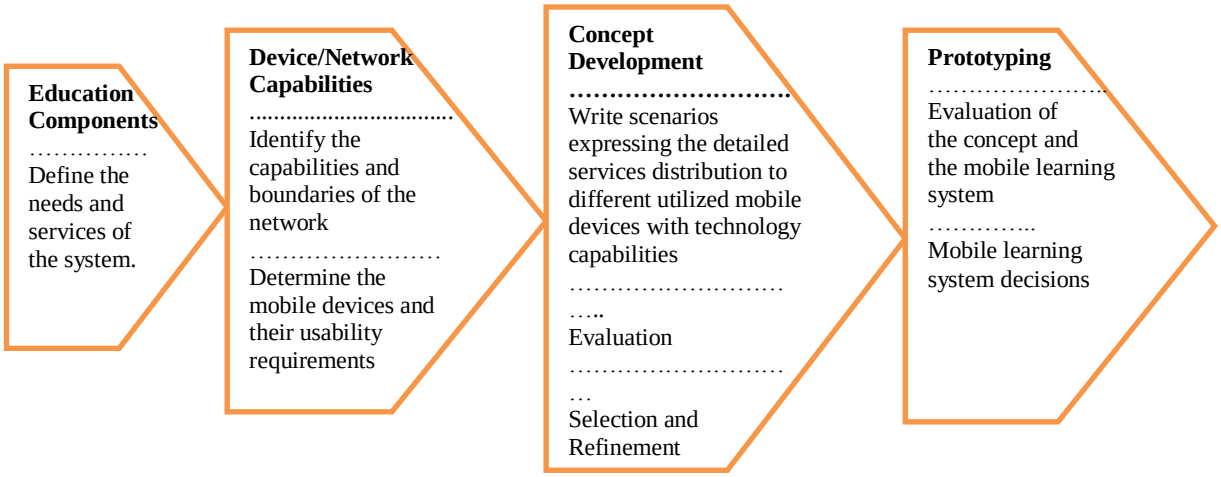


**Figure 2.9: Framework of the Mobile Learning System Development and Evaluation**

### 2.10.2 A Model for Framing Mobile Learning (Koole, 2006, 2009)

Another theoretical model for M-learning, the Framework for the Rational Analysis of Mobile Education (FRAME), was originally developed by Koole (2006) in order to understand the process of M-learning. The aims of the model were:

1. To help educators and leaders in assessing of the effectiveness of various mobile devices used in distance learning.
2. To guide the development of future mobile devices.
3. To help the development of learning materials designed for M-learning.
4. To specify teaching and learning strategies for mobile learning.

FRAME was the first theoretical model to describe mobile learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction (Koole, 2006). The FRAME model is represented by the Venn diagram shown below in Figure 2.10. The context for the model is 'information', which may be internal or external to the learner.

The three circles in the Venn diagram represent:

1. Device Usability Aspect: refers to characteristics (i.e. physical, technical and functional) description of mobile devices.
2. Learner Aspect: refers to learners' characteristics (i.e. cognitive abilities, memory and prior knowledge).

3. Social Aspect: refers to the process of interaction and cooperation between individual learners.

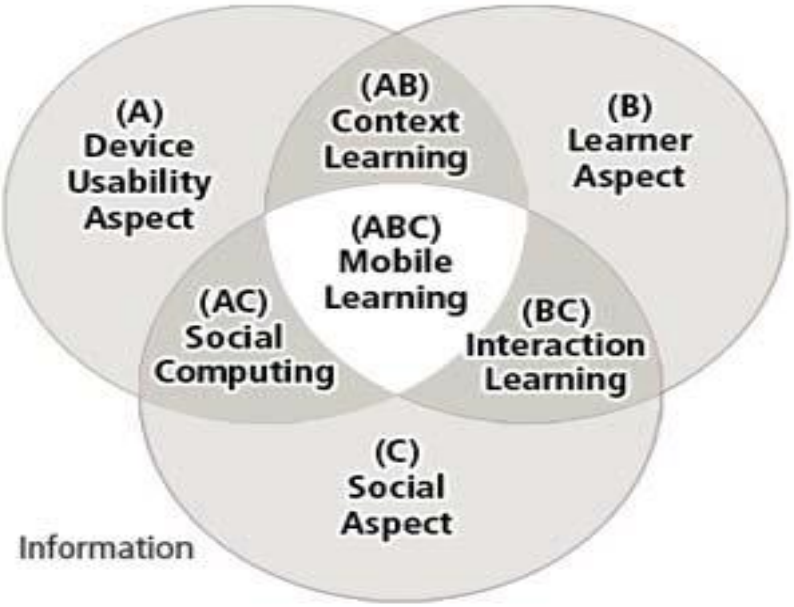


**Figure 2.10: FRAME: Model for Framing Mobile Learning (Koole, 2006)**

From Figure 2.10, it can be seen that the intersection between device Usability Aspect (A) and Learner Aspect (B) produces a flexible learning environment which can be found in Context Learning intersection (AB). Between Device Usability Aspect (A) and Social Aspect (C) we find Social Computing intersection (AC), which refers to the communication environment between users. Combining Learner Aspect (B) with Social Aspect (C) provides the Interaction Learning intersection (BC), which represents the instructional and learning theories. The intersection region which combines the characteristics of the three aspects produces and defines the mobile learning process (ABC).

Koole (2009) updated the FRAME model by replacing the original Device Usability Aspect (A) with a Device Aspect (D) and the Context Learning (AB) intersection with the Device usability (DL) intersection. As shown in Figure 2.11, the intersection region between the three circles (ABC) is changed now to DLS, which is a convergence of all three aspects and represents and defines an ideal M-learning process. Regarding the degree to which all of the aspects in the FRAME are involved in the M-learning process, designers might use the model to design a successful mobile learning experience (Koole, 2009).

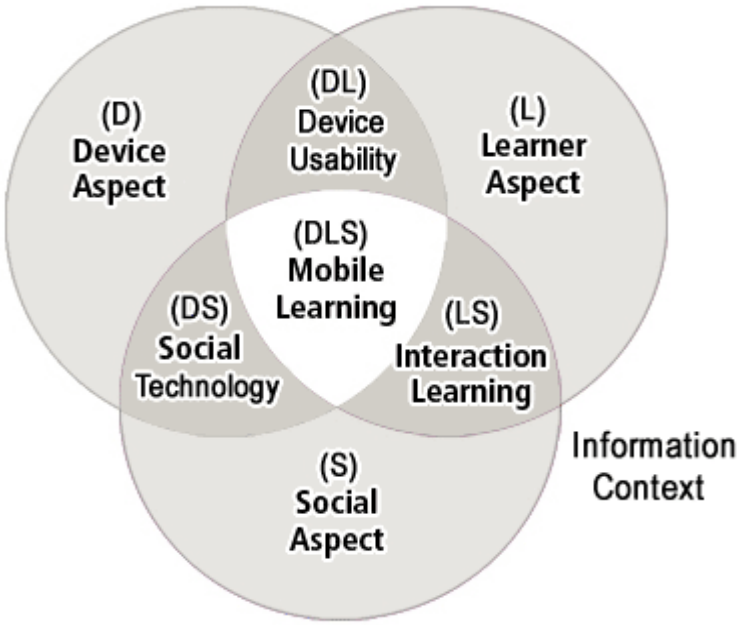


**Figure 2.11: Revised FRAME: Model for Framing Mobile Learning (Koole, 2009)**

As Koole (2009) observed, the proliferation of the internet over recent decades makes the access and publishing of information immeasurably easier; however, learners need to utilize skills and tools to search through the immense volume of information available. M-learning can allow learners to access relevant information and materials anytime, anywhere, and as needed. In addition, a successful implementation of M-learning will help in reducing the cognitive load for learners; this will open different ways of presenting information which helps learners to preserve, restore and transfer data when needed.

Koole (2009) also designed a checklist which can be used in planning and analysing of M-learning environment. This checklist is based on the FRAME model and can provide M-learning practitioners and researchers with questions that address each aspect and intersection of the model, guiding the development of M-learning and assessing the degree to which learners are engaged in effective M-learning process.

### 2.10.3 A proposed Theoretical Model for M-learning Adoption in Developing Countries (Barker et al., 2005)

Barker et al. (2005) proposed a Theoretical Model for the Adoption of M-learning in Developing Countries. They indicated that the use of wireless technologies in educational institutions can benefit all students and lecturers. Therefore, considerations need to be taken when adopting this technology in education, especially in the context of limitations to wireless technology, security issues and support elements.

The researchers identified in their model the key issues that critical to successful adoption of M-learning: stakeholders (students, teachers and parents), critical success factors (collaborative learning components, motivation and collaboration), communication infrastructure and mobile devices. Barker et al. (2005) suggested that future work investigate the guidelines and polices that need to be addressed in order to ensure successful adoption of M-learning. In addition, other research might examine the technical capabilities of the mobile devices to determine their suitability for M-learning environment.

### 2.10.4 A framework for Sustainable Mobile Learning in Schools (Ng and Nicholas, 2012)

Another framework related to this research was created by Ng and Nicholas (2012) to explain the findings and actions of a three-year project investigating M-learning in a secondary school in Australia. The framework is based on a person-centred model and involves all stakeholders (i.e. leadership and management, teachers, students, technicians and community). The aim of the framework was to explore the varied influences on the sustainability of M-learning programme in schools using PDAs. A pre-M-learning conference was held five months before the implementation of the project to train the teachers with mobile devices, share experiences and build confidence between users.

Data gathering was conducted at the beginning of the M-learning programme and 12 months into the programme to investigate the factors that sustain M-learning. The data was collected from students, teachers, leadership and management using a mixed-method (quantitative and qualitative) approach.

There are five components for sustainability of ICT in education: (1) *economic sustainability*, which refers to the universities' availability of funding to provide a continuous ICT program over a long period of time; (2) *social sustainability*, which involves the wider community in M-learning projects, such as parents, political leaders and mobile companies; (3) *political sustainability*, associated with the leadership roles and universities' policies to deploy and sustain mobile learning programmes; (4) *technological sustainability*, which contains the decision making on the suitable technology tools that will be used in the programme (in addition, the provision of technical support to maintain the infrastructure for the technology and ensure users' access to high quality services was another component added; Ng and Nicholas, 2012); and (5) *pedagogical sustainability*,

which addresses the teaching and learning practice that arranges the roles and relations between teachers and learners in order to facilitate the learning with mobile devices.

The results indicated that the school provided the whole support and finance for the programme. However, the model provided minimal funding to get the M-learning programme running. The social sustainability was successfully executed as the interaction with the wider community was satisfactory. In terms of political sustainability, the results showed that there was tension between the principal and programme coordinator as well as between the principal and some teachers, in addition to the weak relationship between the leadership team, which made political sustainability the least successful dimension. Technical sustainability was affected by some issues related to software limitations, internet accessibility and the availability of the technical team. Pedagogical sustainability addressed the teachers' practices in facilitating learning via mobile devices and considered that the informal learning was not domain-specific; the reason given for this was that the teachers' knowledge and trust in students was unimportant in maintaining interest and successful learning. However, there was no evidence that the teachers were ready to address informal learning via M-learning, such as setting homework.

Ng and Nicholas (2012) clarified three human-related issues in order to sustain M-learning in schools: (1) constructing positive attitudes in students and teachers towards the programme by providing suitable devices with other technolog services and supplying the M-learning programme with regular maintenance and technical support; (2) opening effective communication channels and interchanging feedback in order to avoid any misunderstanding or stress between all members of the M-learning team; and (3) increasing the degree of trust and confidence between management team and between teachers and students and ensuring that everybody has some responsibility for the programme, which concept hinges on the communication and information-sharing between all stakeholders.

### 2.10.5. A conceptual model for the educational deployment of QR codes

Saravani and Clayton (2009) proposed a conceptual model for the educational deployment of QR codes. Quick Response (QR) codes and Mobile Tags (MT) provide learners who have handheld computing devices (i.e. smart phone with embedded camera) and communication technology with speedy and ready access to learning contents and services based location anytime and anywhere, in order to increase the successful deployment of M-learning, enhance the flexibility and to improve the personalization in learning.

Institutions need to monitor the outcomes and services provided, assess usability, identify users' learning needs, provide suitable mobile learning contents and work together to engage users (students and lecturers) with mobile learning in consistent and meaningful ways. The project was developed by the Waikato Institute of Technology team in order to review the use, effectiveness and the effect of QR codes and mobile Tags in higher education, and was designed with regard to the following three aspects:

- Creation: to test the potential of software applications to store, organize QR Codes and Mobile Tags, their reliability and their usability by users.

- Deployment: to identify the factors that need to be addressed on how QR codes and Mobile Tags can be used to generate location-based content and provides learning services. This will include institutional guidelines and policies, technical and pedagogical support for all stakeholders who are involved in the use of this technology, and identify ways in which lecturers and students can be informed of the outcomes on their learning and teaching methods.

- Impact: to provide strategies how QR Codes and Mobile Tags usage can be assessed, how the achievements and the outcomes can be evaluated and what are the requirements to blend the new technologies with existing learning system.

The A.C.E. conceptual framework is shown in figure 2.12, and consists of three parts:

- The 3As: Awareness (users reflect the existing learning system capacity and capability), Action (providing guidelines for M-learning implementation) and accomplishment (measured and assess the impact of implementations).

- The 3Cs: Context (factors formulate and affect users perceptions), content (factors affect directions and concentrate) and capability (factors formulate users' confidence and their understanding).

- The 3Es: Enabled (initiatives can be measured in a way depend on how they have qualify users to participate in learning process), Engaged (initiatives can be measured in away deepened on how they establish and sustain engagement) and Empowered (initiatives can be measured to determine the extent to which they have ensured the ability of users).

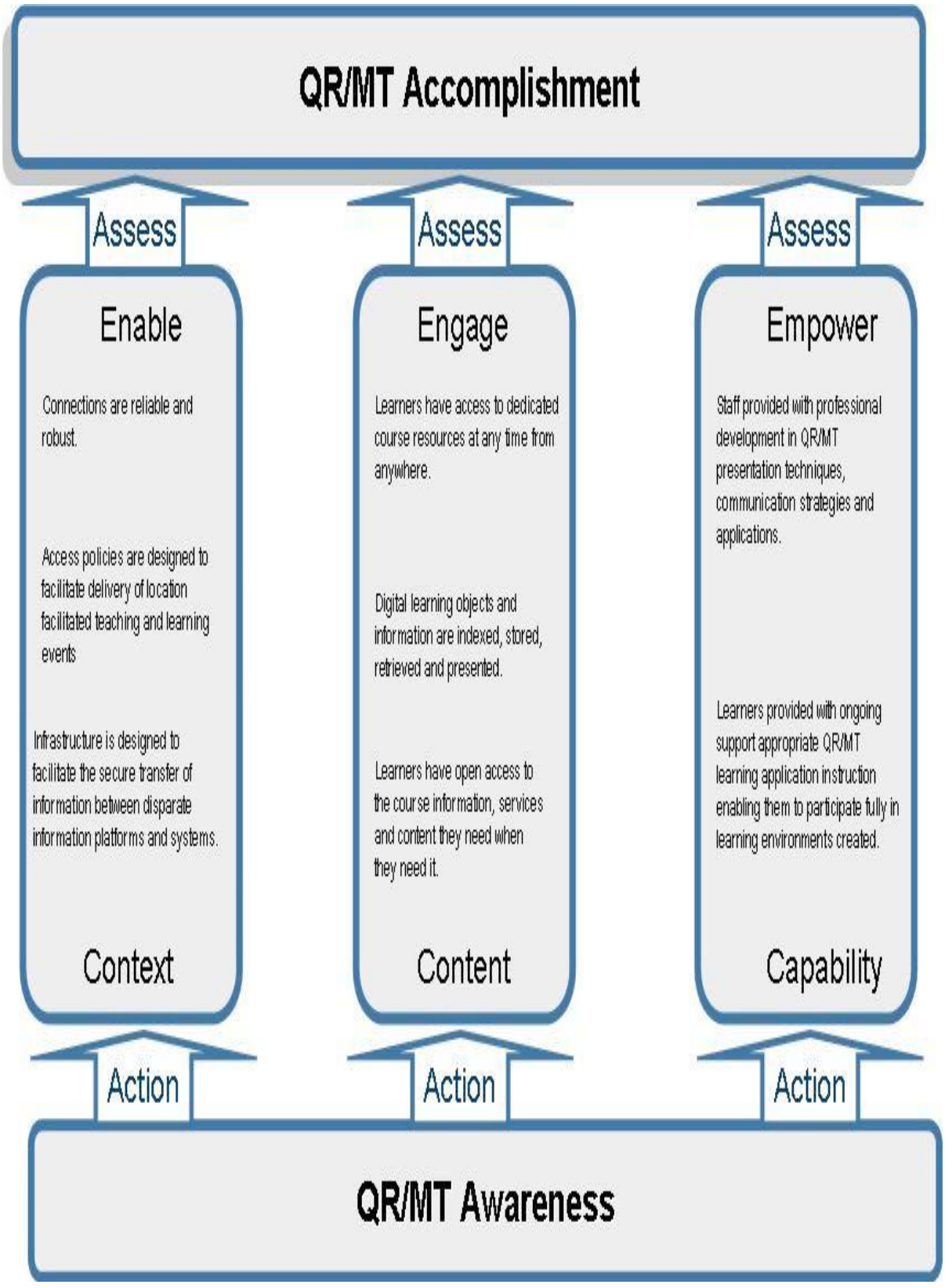


**Figure 2.12: The QR/MT A.C.E. Conceptual Model**

Saravani and Clayton (2009) indicated that any model intended for implementation in a new learning system in an organization needs start from the existing learning system.

Therefore, the strengths of the model can allow measuring the mobile learning system in a way similar to that currently used for E-learning system assessment.

### 2.10.5 Analysis and comparison of the previous M-learning models and frameworks

This section analyses and compares all previous M-learning models and frameworks mentioned in the previous academic literature. Table 2.3 summarises the differences between previous frameworks in terms of the following aspects: approach used to create the model, main elements used in the model, evaluation and validation, sustainability reflection, the existence of deployment stages and the relationship with E-learning.

## 2.11 Research Justification

Anytime anywhere connectivity to internet via mobile devices means that learning objects can be achieved using those devises (Muyinda, Lubega and Lynch, 2010). However, the availability of mobile devices connected to the internet does not necessarily lead to successful implementation of M-learning. Therefore, educators need to highlight the factors that need to be considered in M-learning adoption, taking into account the technical capability of institutes, all stakeholders in M-learning and learning design (Barker et al., 2005).

Analysis of the literature shows that deployment stages of M-learning have not been clearly defined by any previous M-learning models/frameworks. Furthermore, there was no definition of sustainability factors to ensure continuous evaluation and upgrading of M-learning systems after deployment. The models are thus limited in their practical applicability, but they can guide initial research in M-learning deployment. Therefore, there is a need to create a model which represents a roadmap to identify the challenges facing the deployment of this technology in university education and also to clarify M-learning pre-deployment success factors and post-deployment sustainability factors.

By investigating the students' readiness level toward this new technology and identifying the factors that influence their acceptance of M-learning, an opportunity exists to get a better understanding of how to create an M-learning model that contains all key issues and critical success factors that ensure successful deployment of M-learning in a higher education environment, and consequently to enhance students' learning.

**Table 2.3: M-learning Models/Frameworks Comparison**

| | **M-learning Framework (Mostakhdemin-Hosseini and Tuimala, 2005)** | **Model for Framing M-learning (FRAME) (Koole, 2006, 2009)** | **Proposed Theoretical Model for M-learning in Developing Countries (Barker et al., 2005)** | **A Framework for Sustainable Mobile Learning in Schools (Ng and Nicholas, 2012)** | **A conceptual model for the educational deployment of QR codes (Sarvani and Clayton, 2009)** |
|---|---|---|---|---|---|
| Approach used to create the model | Based on user studies conducted at Helsinki University and analysing gathered data from Mostakhdemin-Hosseini et al. (2004) | M-learning as result of convergence of mobile technologies, human learning capacities, and social interaction | Literature review (results of M-learning projects) | -Person-centred model<br>-Project spanned 3 years at a secondary school adopting M-learning programme using PDA.<br>-Data collected using mixed-methods (questionnaires, focus groups and observations) | Systematic review for open, flexible and networking learning capability depending on results obtained from an external review using e-learning Maturity Model (Left, Neal and Marshall, 2008). |
| Main elements used to create the model | -Education components<br>-Device/network capabilities<br>- Concept development<br>- Prototyping | Aspects:<br>-Device Aspect,<br>- Learner Aspect,<br>- Social Aspect<br>Mobile learning is the intersection between all the three aspects. | -Traditional learning and E-learning system<br>-M-learning guidelines<br>-Communication infrastructure<br>-Critical success factors (mobility, coordination, materials , motivation, communication, interactivity collaboration, negotiation) | -Interrelationships between the stakeholders and their interaction with devices.<br>-Support and trust between stakeholders.<br>-Wider community in M-learning<br>-Financial issues<br>-Roles of leadership and institutional policy.<br>-Technical support, pedagogical elements. | - 3 As: Awareness, action and accomplishment.<br><br>- 3 Cs: Context, content and capability.<br><br>3Es: Enabled, engaged and empowered. |

| | **M-learning Framework (Mostakhdemin-Hosseini and Tuimala, 2005)** | **Model for Framing M-learning (FRAME) (Koole, 2006, 2009)** | **Proposed Theoretical Model for M-learning in Developing Countries (Barker et al., 2005)** | **A Framework for Sustainable Mobile Learning in Schools (Ng and Nicholas, 2012)** | **A conceptual model for the educational deployment of QR codes (Sarvani and Clayton, 2009)** |
|---|---|---|---|---|---|
| Model evaluation and validation | The prototype was tested with actual users (students and staff) at Hame Polytechnic | No evaluation , the FRAME used as a basis for assessing the effectiveness of mobile devices for distance learning | No evaluation | Model was tested through the following:<br>-Pre- and post-test questionnaire for both students and staff.<br>-Focus group interview (students and teachers, interview with coordinator, principal at the end of first year) | No evaluation |
| Is the model sustainable? | No sustainability. | No sustainability | No sustainability | Reflects sustainability | Reflects sustainability |
| Does the model define deployment stages for M-learning? | No, it defines development stages and not deployment stages | No, this framework is useful for guiding development of the following: mobile devices, learning materials and design of M-learning teaching strategies | No, It provides strategy for the adoption of wireless technologies | No, it clarifies the process of achieving effective integration of ICT into teaching and learning in M-learning | Yes , the design of the model contains deployment stage which involve some factors like institutional policies, learners and tutor support, how technologies are distributed |
| Does the model relate to E-learning system? | E-learning will influence M-learning system | No relation | Related to E-learning | No relation | Measuring the mobile learning system can be done in a manner similar to that for e-learning assessment. |

## 2.12 Summary

This chapter reviewed the literature on M-learning, including the definitions of M-learning, the relation between M-learning and E-learning, benefits of M-learning and the limitations and challenges of this technology. The chapter also presented research studies discussing the factors that affect students' readiness and acceptance of M-learning in higher education. In addition, the findings of a review of five theoretical models related to M-learning deployment were presented and compared. The review of M-learning literature shows that such technology has the potential to impact positively on the higher education environment.

However, the implementation of M-learning in higher education still faces challenges due to technical limitations, institute infrastructure and users' readiness and acceptance to adopt M-learning. Furthermore, there are limited guidelines available to assist in developing strategic plans and decision-making towards a sustainable deployment of M-learning in higher education. There are a few theoretical M-learning models that are limited in their practical applicability, but they can direct future M-learning deployment research. The researcher fully realised that there is indeed a need to identify the success factors that should be considered when deploying M-learning in higher education environment. Therefore, there is a need to assess students' readiness toward M-learning and their expectations of the future of M-learning services, as well as factors that affect their acceptance of M-learning in the hope of developing an M-learning deployment model that contains all success factors that need to be addressed in deployment and to provide guidelines that ensure the sustainability of such technology in the higher education environment.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Overview

The purpose of this chapter is to describe the design and methodology used in conducting this research. The chapter provides details of the general methodology utilized in this research. It described the research strategies, research design and a description of the research methods used in each study of this thesis. For each research method a discussion is given of research instrument, participants, procedures, ethical concerns and data analysis.

## 3.2 Research Strategy

In this thesis, a quantitative research was constructed as the research strategy which emphasizes quantification in both collection and analysis of data (Bryman, 2008). According to Creswell (2012), the major characteristics of quantitative research are:

1. Describing the research problem by explaining the research trends and the relationship between the variables.
2. Determining the main role for the literature by providing research questions to be asked and clarifying the research problem.
3. Designing purpose statements, research question and hypotheses.
4. Gathering numerical data from a big sample of people using data collection instruments.
5. Analysing the data, comparing groups, test hypotheses using statistical analysis.
6. Writing the final research report using standard criteria.

Asking questions is one of the basic research techniques for collecting both quantitative and qualitative structured information from people (Walliman, 2011). Questionnaires are usually designing for specific research and to collect numerous kinds of data, like people's opinions or patterns of attitude. The questionnaire is a flexible tool, both financially and time efficient, and allows the researcher to organise the questions and get large numbers of participants without the need to talk to everyone. However, there are some principles that the researcher has to keep in mind while constructing the questionnaire. Walliman (2011) cited the rules for devising a questionnaire as follows:

1. Establishing which variables data will be collected about and how these variables can be measured.
2. The language of the questionnaire must be clear and unmistakable.
3. The questions should be written in simple way and short as possible. This will increase the response rate and decrease the effort required by the participants.
4. Considering how the data from the final questionnaire will be processed. This might help while designing the questionnaire by counting spaces for coding and scoring.

Furthermore, Coolican (2004) suggested some concerns while designing the questionnaire. Firstly, the researcher needs to ask for the minimum information required for the research purpose. Secondly, the questions should be designed in a simple way that can be answered. Thirdly, the researchers need to make sure that the questions will be answered truthfully. Finally, the researcher should make sure that the questionnaire will be answered and will not be refused.

To collect data for the work conducted in this research, a questionnaire was designed for the first and second studies of this research. However, two questionnaires were designed for the third study. In each questionnaire there were two types of the questions: closed questions (including five-point Likert scale questions), and open-ended questions.

Closed questions can be in many forms, such as yes or no questions (e.g. 'Do you access the internet using the campus wireless network?'), questions with one specific answer (e.g. 'what kind of mobile device do you have?') and multiple choice questions (e.g. 'what is your opinion on the price of accessing the internet via your mobile device?' answerable by '(a) high price'; '(b) normal price'; and '(c) low price'. A Likert scale was utilized to assess students' readiness, attitude, acceptance towards adoption and implementing of M-learning in higher education. The Likert scale is one of the most common techniques for conducting research (Bryman, 2008). Its multiple items measure of a set of attitudes relating to specific area where the aim is to measure general feelings about that area. The Likert scale consists of a series of statements (items) that concentrate on a specific issue or theme. There are some formats of Likert scale ranging from 1 to 3 points up to maximum of 1 to 9 points with a middle point of neither agree nor disagree (neutral) (Dix et al. 2003). The most effective method uses scales of 1 to 5 or 1 to 7 points, ranging from strongly agree to strongly disagree. Each participant reply is called the score (Bryman, 2008).

In this research, the five-point Likert scale took the following format. For example, for the statement 'I find M-learning useful for my studies', the scale of answers is as shown in Table 3.1.

**Table 3.1: Likert scale**

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

The advantages of Likert scale were discussed by Coolican (2004) as a high degree of validity and reliability, being effective at measuring changes in attitude over time, and being more natural to complete (thus maintaining the direct involvement of respondents).

Open-ended questions are answerable in prose at the discretion of the respondent (e.g. 'in your opinion, what are the challenges that might face implementing M-learning in your department?'). Coolican (2004) explained that open-ended questions have many advantages, including that they enable participants to answer in their own way without sticking to a fixed choice answer. Open-ended questions generate richer data and more realistic responses as participants usually provide explanation and reasons for why they agree or disagree

## 3.3 Research Design

The aim of the research presented in this thesis is to identify the factors that affect the deployment of M-learning in higher education. The research design of this study was intended to be exploratory and it belongs to IS category. A survey method was used in order to obtain personal attitude, thoughts, facts and perception. Such quantitative investigation helped the researchers to systematically investigate and explore the students' readiness and their acceptance towards M-learning. In addition, this helped to develop and validate a conceptual model for M-learning deployment in higher education.

Therefore, this research has three different studies using surveys for different research objectives, as illustrated below in Figure 3.1.

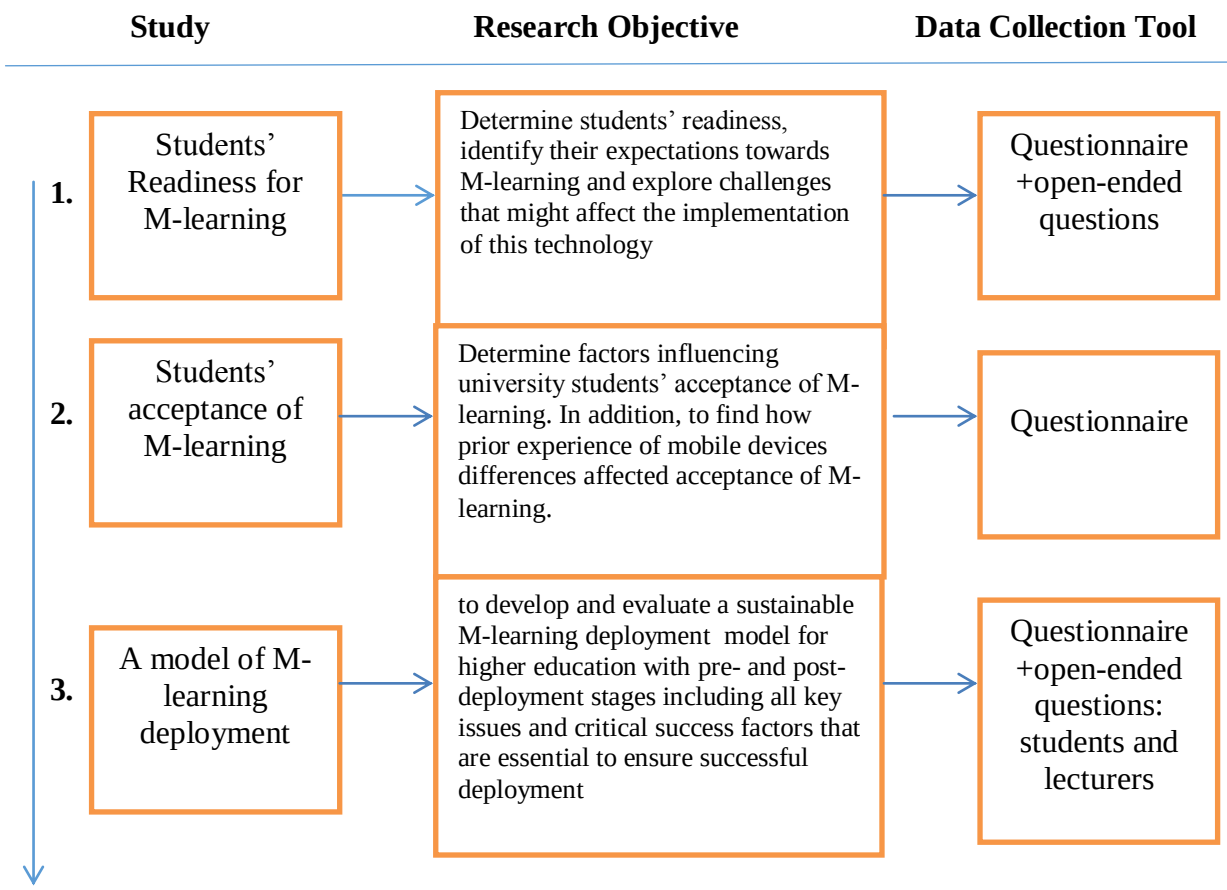


**Figure 3.1: Research Design**

## 3.4 Research Methods

This section comprises three research methods for the three studies used in the research: research methodology for students' readiness for M-learning, research methodology for factors influencing students' acceptance for M-learning and research methodology for the conceptual M-learning model.

### 3.4.1 Research Methodology for Students' Readiness for M-learning (Study 1)

This subsection presents the data collection tool, participants, procedure and data analysis techniques utilized in study 1.

*3.4.1.1 Research Instruments*

A questionnaire was designed to evaluate the readiness of the students towards using mobile learning. Hsieh and Huang (2008) indicated that questionnaire is an easy, inexpensive, effective, and efficient way to collect data in scientific investigations. The aim of this study is to determine the readiness of the School of Information Systems,

Computing and Mathematics at Brunel University for using mobile learning in their studies, and to establish what factors might influence their readiness. In addition, the study aims to identify students' expectations of mobile learning services and the challenges that might affect the implementation of this new technology. The instrument was adapted from Trifonova, Georieva and Ronchetti (2006). Students were asked to complete a questionnaire which contains five sections.

The first section (general information) collects data about users' demographics and did not contain any identifiable questions; it merely asked about gender, age, education level and course title.

The second section was closed format questions (13 questions), which include multiple choice answers to find out about the availability of mobile devices**,** usability of the internet, price of accessing the internet and user's experience and knowledge of mobile technology media (e.g. 'What kind of mobile device do you have?'). Previous studies have used this type of question format (Switzer and Csapo, 2005; Trifonova, Georieva and Ronchetti, 2006; Lam et al., 2011). Students were also asked to write an explanation for their answers.

The third section contains 11 statements of a five-point Likert scale developed to assess students' attitudes towards M-learning (e.g. 'I need training to understand how to use a new mobile application'). The Likert scale is regularly used in similar studies to access respondents' attitude and their perception towards M-learning (Jacob and Issac, 2008b). The scale ranged from 1-Strongly Disagree to 5-Strongly Agree.

In the fourth section, students were given a list of services of M-learning and they were asked to classify each one in term of the usefulness for learning (e.g. 'to access educational content online'). The scale ranged between 1-Useful, 2-Neutral and 3-Not Useful. This approach was used in other research in this area (Trifonova, Georgieva and Ronchetti, 2006; Corbeil and Valdes-Corbeil, 2007).

Finally, in the fifth section there were two open-ended questions eliciting students' opinions about challenges they anticipated to the implementation of this new technology in the context of their own academic programmes and any comments they had about the educational efficacy of M-learning applications (e.g. 'in your opinion, what are the challenges that might face implementing M-learning in your department?') .

*3.4.1.2 Participants*

The study was conducted at the School of Information Systems, Computing and Mathematics, Brunel University, in May 2011. Mathematical science students from different undergraduate levels were asked to complete an online questionnaire. Students were drawn from different subjects: Mathematics, Financial Mathematics, Mathematics and Management, Mathematics and Computers, Mathematics and Statistics and Management, Financial Computing and Information Systems.

*3.4.1.3 Procedures and Ethical Concerns*

An online questionnaire was designed in the second semester of the academic year 2010/2011 to collect the data for this study. A pilot study was administered to students enrolled in a mathematics course called 'Calculus'. The total number of students in the class was eleven; all of them were in the first year. The purpose of the pilot study was to test the reliability and validity of the questionnaire. Based on the results obtained some items were reworded and adjusted.

The questionnaire was sent as an email to all students in the school. The email contained the link to the questionnaire and the expected time for completing the survey was approximately 10 minutes.

The questionnaire's cover letter (appendix 1) contains a brief explanation of the research project and the aims of the study were also provided. Students were also given definitions of the concepts being used in the questionnaire i.e. E-learning and M-learning. In addition, students were informed that all the data and participants' details would be kept anonymous, and that they can withdraw at any time from the study. Participants were also provided with the contact information of the researchers.

The School of Information Systems, Computing and Mathematics research ethics committee reviewed the ethics of study 1 and issued a statement of ethical approval (see appendix 5).

*3.4.1.4 Data Analysis*

Descriptive statistics were used in first study to give a simple description of what is shown by the data presented. Descriptive statistics help researchers to simply large amounts of data in a sensible way (Research Methods Knowledge Base, 2013). Mean value and the

standard deviations for all responses were calculated. Some of the results were represented in diagrams to make them easier to comprehend and interpret. Furthermore, the results from the open-ended questions were analysed using thematic analysis. The researchers used the following steps to conduct thematic analysis: familiarization with datasets, generating initial codes, searching for themes, reviewing themes and refining themes (Silverman, 2011).

### 3.4.2 Research Method for Factors Influencing Students' Acceptance of M-learning (Study 2)

This subsection presents the data collection tool, participants, procedure and data analysis techniques utilized in study 2.

#### *3.4.2.1 Research Instrument*

A questionnaire was designed to investigate factors influencing students' acceptance of mobile learning and to explore whether prior experience of mobile devices affect students acceptance of M-learning.

The questionnaire consisted of three sections (appendix 2). Section one (cover letter) contained a brief description of the research, and the objectives and importance of the study. In addition, students were informed that all the data and participants' details would be kept anonymous, and that they can withdraw at any time from the study. In order to avoid any confusion in understanding the aims of the study, the definitions of the concepts being used in the questionnaire (i.e. E-learning and M-learning) were also attached. The time taken to finish the questionnaire (approximately 10 minutes) was also provided.

Section two contains questions about the participants' demographic background (i.e. gender, age), E-learning experience, mobile devices experience, frequency of using mobile devices, usability of M-learning in study and M-learning knowledge. Questions in this section were adapted from previous studies (Jairak, Praneetpolgrang and Mekhabunchij, 2009; Liu, Li and Carlsson, 2010; Park, Nam and Cha, 2011).

Section three contains six subsections that include the following: performance expectancy, effort expectancy, lecturer's influence, quality of service, personal innovativeness and behavioral intention. A five-point Likert scale ranging from 1-Strongly Disagree to 5-Strongly Agree was used and students were asked to measure each sentence from their point of view regarding its importance in the context of M-learning.

The questionnaire consisted of 26 items derived from different research areas with regard to the M-learning context. Table 3.2 shows the items used in the study and the literature whence the items were derived.

**Table 3.2: Operationalization of Variables and References**

| Scales | Number of Items | Study |
|---|---|---|
| Performance Expectancy (PE) | 5 | Davis (1989)<br>Vankatesh et al. (2003) |
| Effort Expectancy (EE) | 4 | Davis (1989)<br>Vankatesh et al. (2003) |
| Lecturers' Influence (LI) | 3 | Igbaria, Schiffman and Wieckowski (1994)<br>Karahanna and Straub (1999) |
| Quality of Services (QoS) | 6 | Kuan, Vathanophas and Bock (2003)<br>Wang, lin and Luarn (2006) |
| Personal Innovativeness (PInn) | 3 | Lu, Yao and Yu (2005)<br>Kuo and Yen (2009) |
| Behavioural Intention (BI) | 5 | Moon and Kim(2001)<br>Yoon and Kim (2007) |

Performance expectancy and effort expectancy are defined as the extent to which a person believes that using an information system would help him or her to benefit in terms of job performance and the degree of ease that an individual thinks he or she will have when using it (respectively). The questions of these constructs were derived from previous studies (Davis, 1989; Vankatesh et al., 2003), with modification to make them suitable for M-learning in a higher education environment. Both of the previous studies established the user acceptance of technology and information systems using TAM and UNTAUT.

Lecturers' influence refers to the extent to which immediate faculty members or instructors directly encourage or motivate their students to use M-learning services were adapted from (Igbaria, Schiffman and Wieckowski, 1994; Karahanna and Straub 1999). The questions build upon the finding that lecturers' attitudes toward M-learning influence students' acceptance and use of M-learning.

The construct quality of M-learning services is composed of items related to reliability and response, content quality and security. The questions were derived from Kuan, Vathanophas and Bock (2003), and Wang, Lin and Luarn (2006), with modifications to make them suitable for M-learning service context.

Personal innovativeness construct investigated students' willingness to try out any new technology. The question were adapted from Lu, Yao and Yu (2005) and Yoon and Kim (2007), with modification to make them related to M-learning context.

The last construct contains questions targeting behavioural intention to use M-learning. Questions were adapted from Moon and Kim (2001) and Yoon and Kim (2007), with orientation to be suitable for M-learning context in higher education.

*3.4.2.2 Participants*

The study was conducted at the School of Information Systems, Computing and Mathematics, Brunel University, in the first semester of the academic year 2011/2012. Undergraduate students from both Information Systems Department and Mathematics Science Department were invited to participate in the study. Students were from the academic specialities of Computer Science, Information System, Mathematics Science and Financial Computing.

*3.4.2.3 Procedures and Ethical Concerns*

The second study used a convenience sample technique to collect the data (Creswell, 2012). The questionnaire was distributed to second-year students in the School of Information, Computing and Mathematical Science. Students from different classes were invited to participate in the study. The questionnaire was distributed to the students by hand while they were in the classroom, with cooperation of lecturers. A brief description about the research objectives and a definition of M-learning were given by the researcher before students completed the questionnaire. In addition, students were informed that all the data and participants' details would be kept anonymous, and that they could withdraw at any time from the study. Additionally, the questionnaire's covering letter contains a brief explanation of the research project and the aims of the study were also provided. Participants were also provided with the contact information of the researchers. The School of Information Systems, Computing and Mathematics Research Ethics Committee reviewed the ethics of study 2 and issued statements of ethical approval, which are presented in appendix 6.

*3.4.2.4 Data Analysis*

This study utilized two statistical tools to analyse the data obtained. First, the descriptive statistic was used by applying SPSS Version 16 to obtain frequency, percent and

accumulative percent of the participants, as well as the initial examination of the data (such as reliability test). Second, inferential statistics were used in order to test the hypothesis. Inferential statistics allow inferences from the sample data to make generalizations about the population. In addition, inferential statistics enable assessment of the probability that observed differences between groups are dependable or random (Research Methods Knowledge Base, 2013). The Structural Equation Modelling (SEM) method using AMOS (Analysis of Moment Structure) Version 16, which involves confirmatory factor analysis and structural model, was used to analyse the data and test the following hypotheses:

H1: Performance expectancy has a positive effect on behavioural intention to use M-learning.

H2: Effort expectancy has a positive effect on behavioural intention to use M-learning.

H3: Lecturers' influence has a positive effect on behavioural intention to use M-learning.

H4: Quality of service has a positive effect on behavioural intention to use M-learning.

H5: Personal innovativeness has a positive effect on behavioural intention to use M-learning.

- Structural Equation Modelling (SEM)

Structural Equation Modelling (SEM) is a collection of statistical models that aims to clarify and explain relationships between multiple latent variables (constructs). In SEM, researchers can examine interrelated relationships between multiple dependent and independent constructs simultaneously (Hair et al., 2006). SEM is similar to multiple regression, but enables more powerful analysis, taking into account the modelling of interactions, correlated independents, measurements errors, correlated error terms, multiple latent independents and one or more latent dependents. SEM offers a systematic technique to validate relationships among constructs and indicators and to test relationships between constructs in single model (Hair et al., 2006). It can evaluate causal relationships between multiple constructs simultaneously (Tabachnick and Fidell, 2001). Furthermore, SEM can be used to get insights into the direction of influence between research constructs, and to test how variables affect each other and to what degree (Judge and Ferris, 1993). In addition, it can provide an overall assessment of the fit of the proposed model, and test the individual hypotheses rather than coefficients, which is the case within multiple regressions.

The data analysis method using SEM consisted of two steps. Step one contained the assessment of the measurement model to examine if the model is a good fit with the data collected; based on the satisfactory results (i.e. after the construct reached the required measurement standard), before proceeding to step two, finding the causal relationships among the variables and hypotheses testing using structural model.

Many researchers indicated the benefit of the two step approach rather than one step (Kline 2005; Hair et al., 2006; Schumacker and Lomax, 2010; Zarmpou et al. 2012). A measurement model specifies how measurement variables (observed) come together to underline the latent variables (constructs), while the structure model specifies the relationship between theoretical latent variables (Hair et al., 2006).

- Measurement model (hypothesized model)

An exploratory factor analysis (EFA) was conducted at the beginning of the analysis using principle components extraction with Varimax rotation to extract six factors using SPSS 16. Confirmative factor analysis was then conducted using AMOS (Analysis of Moment Structure) 16 to assess the measurement model in terms of factors loading, reliability of measures, convergent validity and discriminant validity. A confirmatory approach of data analysis is highly required to be performed after the exploratory factor analysis that multivariate procedures use in order to explain the items derived from EFA. By using multivariate procedures alone it is difficult, if not impossible, to conduct hypothesis testing (Byrne, 2001; Hair et al., 2006).

There are two broad techniques used in CFA to evaluate the measurement model: (1) determine the goodness of fit (GOF) criteria indices (Hair et al., 2006); and (2) evaluating the reliability and validity of measurement model.

- Goodness of fit indices

Hair et al. (2006) defined GOF as the degree to which the actual input matrix is predicted by the estimated model. SEM has three main types of GOF indices: (1) absolute fit indices; (2) incremental fit indices; and (3) parsimonious fit indices (Hair et al., 2006).

First, the absolute fit indices are used to assess the ability of the overall model fit. The chi-square ($x^2$) statistic, chi-square per degree of freedom ratio ($x^2$/df), and the Root Mean Square Residual (RMSR) are absolute indices. Second, incremental fit indices are used to compare the proposed model to some baseline model. Incremental fit indices are

Goodness-of- Fit Index (GFI), Adjusted Goodness-of- Fit Index (AGFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI). Third, parsimonious fit measures could be used to investigate the fit in relation to the number of estimated coefficients necessary to reach the level of fitness. Root Mean Square Error of Approximation (RMSEA) considers the goodness-of-fit of the model into account. Details of these fit measures and their recommended level are presented in Table 3.3.

**Table 3.3: Goodness of Fit Statistics in SEM (Hair et al., 2010)**

| Fit indices | Recommended value |
|---|---|
| **Absolute Indices** | |
| $\chi 2$/d.f | Less than 2 |
| RMSR | Less than 0.01 |
| **Incremental Indices** | |
| GFI | 0.90 and above |
| AGFI | 0.90 and above |
| NFI | 0.90 and above |
| CFI | 0.90 and above |
| TLI | 0.90 and above |
| **Parsimonious Indices** | |
| RMSEA | Less than 0.08 |

Reliability analysis is related to the assessment of the degree of consistency between multiple measurements of a variable (Hair et al., 2010). Cronbach's alpha reliability coefficients were used to measure the internal consistency of each variable. Reliability coefficients less than 0.6 were considered poor, 0.7 were acceptable while those more than 0.8 were considered good (Sekaran, 2000; Hair et al., 2006). The second type of reliability conducted in this research is composite reliability. This test was developed by Fronell and Larcker (1981) and is the most commonly used index for estimating reliability in SEM. Employing Fornell and Larcker's (1981) formula, the composite reliability is calculated using following equation:

$$\textbf{Composite Reliability} = \frac{(\Sigma Li)^2}{(\Sigma Li)^2 + \sum \varepsilon j} \qquad \textbf{(1)}$$

Where ($L_i$) is the standardised factor loading for each indicator, and ($E_j$) is the error associated with the individual indicator variables. The composite reliability should exceed 0.60 according to Bagozzi and Yi (1988), or greater than 0.70 according to Holmes-Smith (2001).

A validity test is a step where by a research instrument is used to measure the constructs under study. The researcher used construct validity, which has two types: convergent validity and discriminant validity. The former is the extent to which observed variables of a particular construct share a high portion of the variance in common, while the latter refers to the extent to which a latent construct is truly distinct from other latent constructs (Hair et al., 2006).

Convergent validity can be evaluated using three criteria recommended by Fornell and Larcker (1981): (1) factor loading greater than 0.50 was considered highly significant; (2) composite reliability should be greater than 0.8; and (3) average variance extracted should exceed 0.5. Discriminant validity can be evaluated by the Average Variance Extracted (AVE) for every construct, which should exceed the squared correlation between that construct and any other constructs (Fornell and Larcker, 1981). The Average Variance Extracted is calculated using the following formula:

$$AVE = \frac{\sum(factor\ loading)^2}{\sum(factor\ loading)^2 + \sum measurement\ error}$$

The AVE values should be at least 0.50 for each construct (Bagozzi and Yi, 1988; Holmes-Smith, 2001).

- Structural model and hypotheses testing (revised model)

After reliability tests as well as the convergent and discriminant validities support the overall measurement quality, the measurement model is considered adequate for hypotheses testing. The recommendation values of Critical Ratio (CR) and p-value need to be ascertained; CR supports the path if it is greater than 1.96, otherwise, it would not support the path and then the path would reject the hypothesis. The probability level (p-value) provides a cut-off beyond which the researcher declares that the finding is statistically significant (by convention, this is $p<0.05$) (Hair et al., 2010).

### 3.4.3 Research Method for A sustainable Model for M-learning Deployment (study 3)

This subsection presents the method used for creating the conceptual model, data collection tool, participants, procedure and data analysis techniques utilized in study 3.

#### *3.4.3.1 Methodology for Creating the Conceptual Model*

The model was designed depending on the findings from the literature review of M-learning implementation and the results obtained from two previous studies undertaken by the researcher in collaboration with others. The first study was conducted to determine student readiness for mobile learning (Abu-Al-Aish, Love and Hunaiti, 2012), while the second study aimed to investigate the factors that affect students' acceptance of M-learning. The approach for creating the model is summarised in Figure 3.2, and Figure 3.3 explains the model design and lists the factors and their sources.

The conceptual model for M-learning deployment is a road map that will guide higher education institutions towards a seamless deployment of M-learning environment. The model consists of two stages: pre deployment stage and post deployment stage and will not contain a fully implemented M-learning service. However, the model will utilize M-learning as a part of an E-learning system. The initial model is shown in Figure 3.4.

#### *3.4.3.2 Participants*

The study was conducted end of the academic year 2012 at the School of Information Systems, Computing and Mathematical Science, Brunel University, which School is implementing the E-learning system in both of its departments. The study aimed to gather data from both students and lecturers. Therefore, Information System and Mathematics students from different undergraduate levels were asked to fill in the questionnaire. In addition, lecturers and research stuff from Brunel University who are interested and have already published concerning electronic and mobile learning topics were invited to take part in this study.

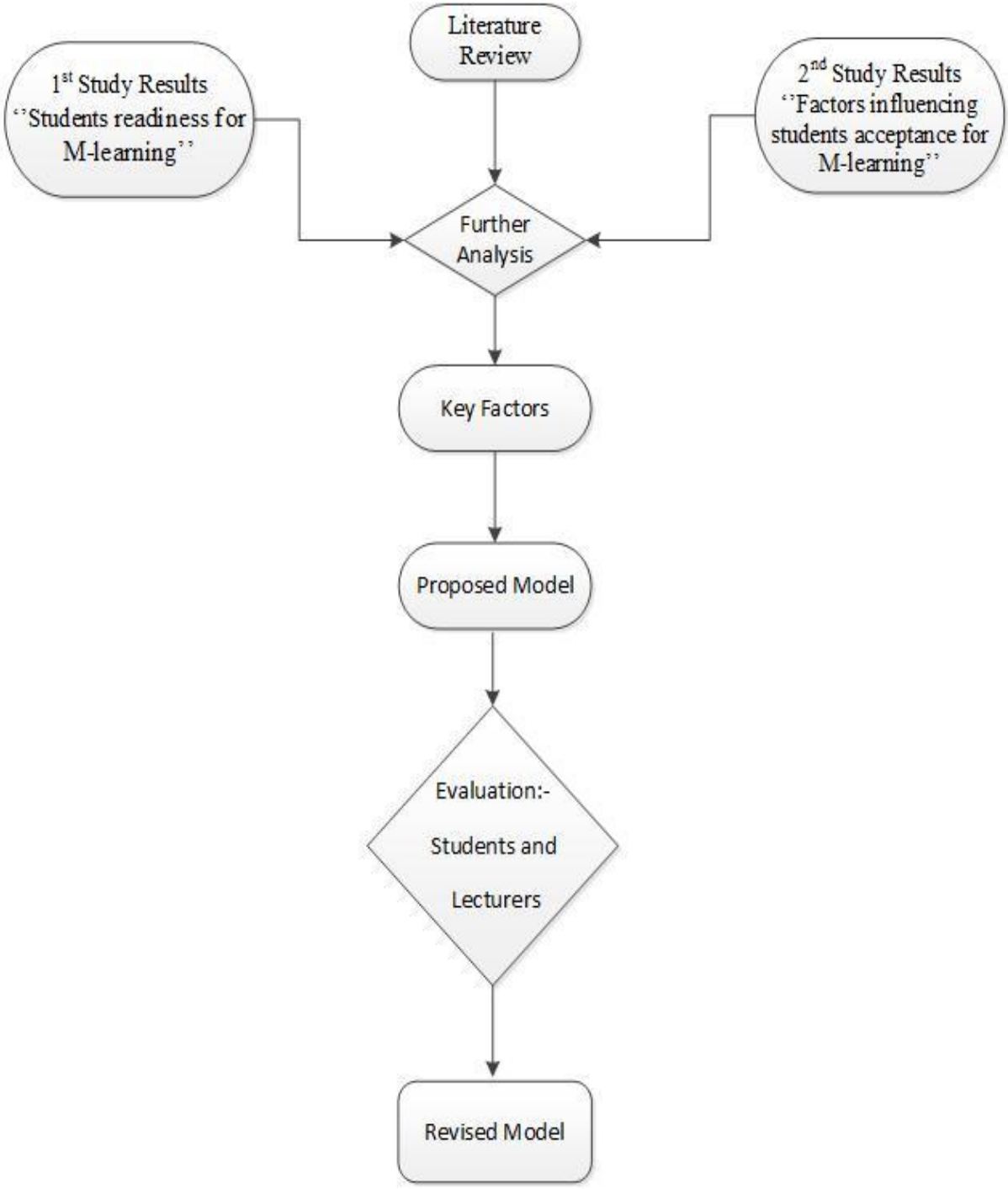


**Figure 3.2: The Approach for Creating the Model**

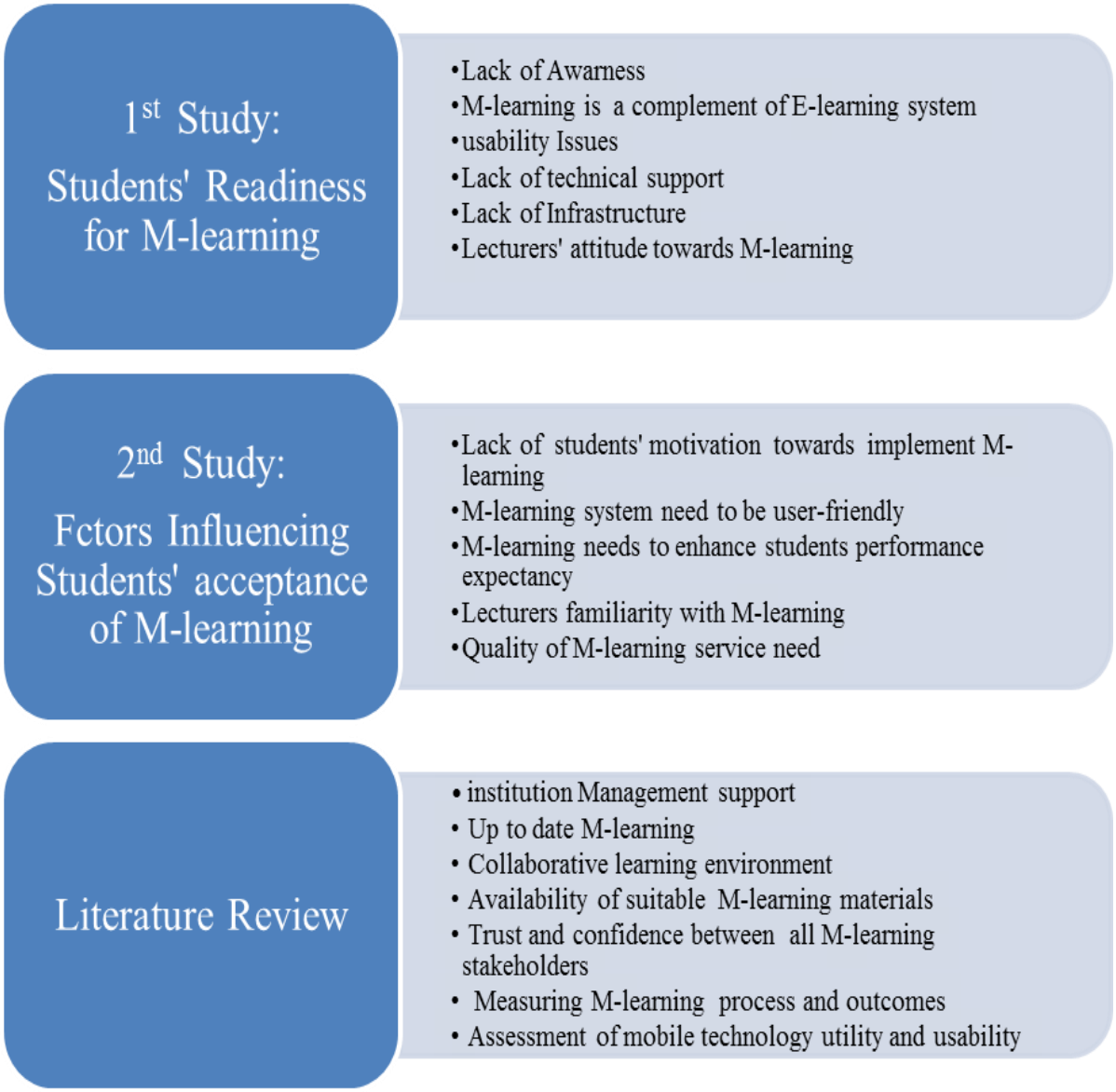


**Figure 3.3: Factors for Model Design**

*3.4.3.3 Research Instrument*

Two questionnaires were designed in summer of 2012 for both students and lecturers to evaluate and refine the proposed conceptual model. The items of the questionnaire were derived from the related research area, which investigates the implementation of M-learning and E-learning in higher education (Traxler and Kukulska-Hulme, 2005; Holsapple and Lee-Post, 2006; Demirkan, Goul and Gros, 2010; Kalyani, Pandeya and Singh, 2012; Ng and Nicholas, 2012).

The students' questionnaire consisted of three sections (appendix 3). Section one (cover letter) contains a brief description about the research, how the model has been constructed and the definition of M-learning. Students were informed that all the data and participants' details would be kept anonymous, and that they could withdraw at any time from the study.

Section two contains questions about the participants' demographic information (i.e. gender, age), usage of M-learning and how they rate their M-learning knowledge.

Section three contains eleven subsections that include the following: cross management initiative, awareness and motivation: students and lecturers, on-going technical support, on-going M-learning innovation, usability, quality of service control, collaborative learning, trust and confidence, achievement and evaluation, availability of suitable learning materials and M-learning as a complementary of E-learning. 34 questions of a five-point Likert scale ranging from 1-Strongly Disagree to 5-Strongly Agree were developed from the literature review of M-learning researches in order to investigate students thoughts about the factors that affect the deployment of M-learning. Table 3.4 shows the items used in the study and the literature from which the items were derived.

The lecturers' questionnaire consisted of four sections (appendix 4). Section one (cover letter) explains the aims and the objective of the research. Section two involves general questions about the lecturers (positions, experience and familiarity with M-learning). Section three contains two subsections: pre-deployment stage, with five Likert scale questions; and post-deployment stages, with six Likert scale questions, used to evaluate the pre- and post-deployment stages of M-learning. Part four enclosed 11 five-point Likert scale questions as a general evaluation of the model.

Both the students' and lecturers' questionnaires measured the same factors. In addition, two open-ended format questions were added to both questionnaires in order to encourage the participants to write their opinions about the obstacles they anticipated might face the university when deploying this technology in its teaching and learning setting, and also to add any other factors in accordance to their departments or end-user needs which might affect the deployment of M-learning. The two open-ended questions were 'In your opinion, what are the obstacles that might face university in the deployment of M-learning in its teaching and learning setting?' and 'What other factors would you like to add in accordance to your department or end-user needs?'

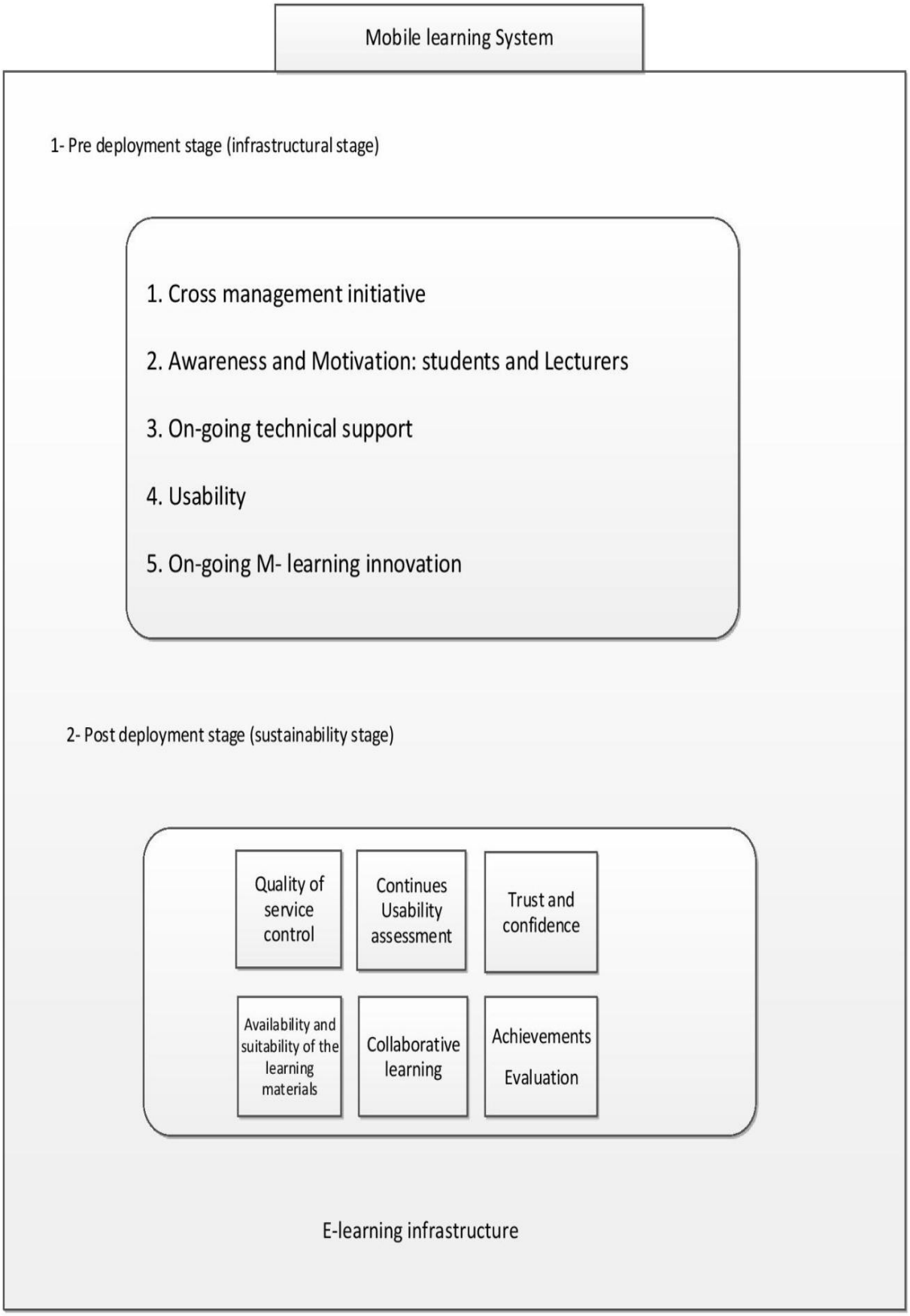


**Figure 3.4: Initial Proposed Model for Evaluation**

**Table 3.4: Items of third questionnaire and references**

| Factor | Number of items | Study |
|---|---|---|
| Cross-management initiative | 3 | Naismith and Corlett(2006) |
| Awareness and motivation: students and lecturers | 3 | Traxler and Kukulska-Hulme (2005)<br>Barker et al.(2005) |
| On-going technical support | 3 | West and Schofield (2012) |
| On-going M-learning innovation | 3 | Seppala, Sariola and Kynaslahti (2002) |
| Usability and continuous assessment | 4 | Vavoula and Sharples (2009)<br>Howarth, Smith-Jackson, and Hartson (2009) |
| Quality of service control | 3 | Pocatilu and Boja (2009) |
| Collaborative learning | 3 | Zurita and Nussbaum (2004) |
| Trust and confidence | 3 | NG and Nicholas (2012) |
| Achievement and evaluation | 3 | Traxler and Kukulska-Hulme (2005) |
| Availability of suitable learning materials | 3 | Traxler and Kukulska-Hulme (2005) |
| M-learning as a complementary of E-learning | 3 | Traxler and Kukulska-Hulme (2005) |

Cross management initiative contains questions that targeted to university management initiative to support and enhance the M-learning system. The questions were derived from *previous studies* (Naismith and Corlett, 2006; West and Schofield, 2012) *that* investigate*d* the success factors and the opportunities of M-learning in higher education.

Awareness and motivation refers to providing lecturers and students with appropriate skills on how to use the M-learning system and designing learning activities to engage them in the learning environment. The question were derived from Traxler and Kukulska-Hulme (2005) and Barker et al. (2005).

On-going technical support contains questions assigned to provide technical support for all users and maintain M-learning system tools and services delivery. The questions were derived from West and Schofield (2012), who discussed the opportunities of M-learning for executive education.

On-going M-learning innovation refers to up-to-date M-learning technology and providing suitable solutions for the new changes in teaching and learning methods. The question for this subsection was developed from Seppala, Sariola and Kynaslahti (2002).

Usability and continuous assessment contains questions concerning M-learning usability issues in terms of easiness, effectiveness and users satisfaction, in addition to asking about usability assessment in order to evaluate the success of the system. The questions of this subsection were derived from (Howarth, Smith-Jackson and Hartson, 2009; Vavoula and Sharples, 2009).

Quality of service subsection adapted some questions related to the control and the assessment of the quality of M-learning services in terms of technical and pedagogical sides. The questions were derived from Pocatilu and Boja (2009), who discussed the quality characteristics of M-learning process.

Collaborative learning subsection contains questions targeted about the importance of collaboration and communication in the learning context. The questions were adapted from Zurita and Nussbaum (2004).

Trust and confidence construct contains questions about the trust and confidence between all the stakeholders involved in in designing and using M-learning system. The questions were derived from Ng and Nicholas (2012), who investigated the sustainability of M-learning system in schools.

Achievement and evaluation contains questions targeted the evaluation of M-learning system in order test the effectiveness of the system and to ensure that the achievements benefit the users. The questions were derived from Traxler and Kukulska-Hulme (2005), who examined the evaluation practice, based on evidence drawn from literature.

Availability of suitable learning materials contains questions investigating the characteristics of M-learning materials (i.e. engagement materials, enhancing the learning experience and compatibility with all mobile device platforms). The questions were derived from Traxler and Kukulska-Hulme (2005) and West and Schofield (2012).

The last subsection considered M-learning as being complementary with e-learning. It contains questions about the benefits of utilizing M-learning within the e-learning system (i.e. minimizing university resistance, creating cost savings and utilizing personnel's past experiences with e-learning).

*3.4.3.4 Procedures and Ethical Concerns*

- Students' questionnaire

This study used a convenience sample technique to collect the data (Creswell, 2012). The students' questionnaire was distributed to second year students in School of Information, Computing and Mathematical Science, Brunel University. Students from different classes were invited to participate and complete the questionnaire in their class. The researcher gave a brief description about the research objectives, the definition of M-learning and its benefits before students filled in the questionnaire. Also, students were informed that all the data and participants' details would be kept anonymous. In addition, to get more participants for the study, the same questionnaire was also sent online as email to all undergraduate students of School of Information, Computing and Mathematical Science.

- Lecturers' questionnaire

Authors are considering M-learning as complementary and extension to the existing e-learning system, hence those people with e-learning experience would be better able to indicate and reflect on the proposed idea of M-learning.

A presentation for the proposed model was designed in PowerPoint which explained the objectives of the research, findings from previous studies, methodology for creating the model and the initial model itself. The presentation and the link for the questionnaire were sent by email to the lecturers and the researcher had contact with them in case there was any question or enquiry.

The questionnaires' covering letter contained a brief explanation of the research project and the aims of the study were also provided. In addition, students were informed that all the data and participants' details would be kept anonymous, and that they could withdraw at any time from the study. Participants were also provided with the contact information of the researcher.

The School of Information Systems, Computing and Mathematics Research Ethics Committee reviewed the ethics of study 3 and issued statements of ethical approval, which are presented in appendix 7.

*3.4.3.5 Data Analysis*

The questions and their responses were coded and analysed using SPSS software. Descriptive statistics were used to obtain the mean and the standard deviation of results and to describe the emergent data. In addition, inferential statistics using one-sample *t*-test were analysed to compare the mean with single standard value (Foster, 2001). The purpose of the one-sample *t*-test is to determine whether there is sufficient evidence to conclude that the mean of the population from which the sample is taken is different from the specified value (Elliott and Woodward, 2007).

The open-ended questions for both students and lecturers were analysed using thematic analysis. The researchers used the following steps to conduct thematic analysis (Silverman, 2011):

1. Familiarisation with datasets through noting initial comments and ideas.
2. Generating initial codes through coding the whole dataset.
3. Searching for themes through collecting similar codes into potential thematic groups.
4. Reviewing themes and check if generated themes work in relation to the dataset.
5. Refining themes through refining themes specifications and linkages.

## 3.5 Summary

This chapter provides specific details regarding to the research methodology, designs of the research instruments and statistical analysis employed in this research. The chapter started with discussion of the research strategy, including an explanation of the quantitative approach adopted to address the research aims. Consequently, the research design of the thesis was presented, which involves the three studies concerning students' readiness for M-learning, students' acceptance of M-learning and the evaluation of the proposed conceptual model for M-learning deployment. In each of the three studies a discussion of the research instrument, participants, procedures and data analysis was provided. Data analysis subsections illustrated the SEM, one sample t-test technique and the analysis of open-ended questions.

# CHAPTER 4: STUDENT READINESS FOR MOBILE LEARNING

## 4.1. Overview

This chapter presents the findings from the first study of this research. The aim of this study was to determine Brunel University students' readiness for using mobile learning in their studies, and to establish what factors might influence their readiness. In addition, the study aims to identify students' expectation toward mobile learning services and the challenges that might affect the implementing of this new technology. The chapter provides the results from the pilot study, results from the main study, discussion of the results and conclusion.

## 4.2 Pilot Study Finding

A pilot study was administered to students enrolled in a mathematics course called 'Calculus'. The total number of students in the class was eleven; all of them were in the first year. The purpose of the pilot study was to test the reliability and validity of the questionnaire. Reliability is the degree to which measures are free from the error and reflect consistently results (Ismail et al., 2010). Initial reliability was assessed on the pilot data using Cronbach's alpha (Cronbach, 1984). A Cronbach's alpha below 0.60 is considered poor or unacceptable; between 0.60 and 0.65 is undesirable; between 0.65 and 0.70 is minimally acceptable; between 0.70 and 0.80 is respectable; and between 0.80 and 0.90 is very good (DeVellis, 2003; Sekaran, 2000). Reliability analysis on the pilot data revealed that Cronbach's alpha for the 11 items was 0.68. After further inspection of the data and the reliability, it was discovered that some items need to be reverse coded or reworded. After this correction of the coding, the value of Cronbach's alpha improved to 0.75. In addition, one of the closed format questions, 'Does your device allow connection to Bluetooth, Wi-Fi and mobile network?', was deleted, as all mobile devices nowadays allow wireless connection.

## 4.3 Research Methodology

This section discusses the methodology used to conduct the study, and explains the participants, instrument and procedure.

### 4.3.1 Participants

The study was conducted at the School of Information Systems, Computing and Mathematics, Brunel University, UK, in May 2011. Students from different undergraduate levels were asked to complete an online questionnaire.

From a total population of 200 undergraduate students a total number of 82 students (41 percent) volunteered to participate in the online questionnaire; they were from different subjects. For example, Mathematics students made up the largest group of responses were (33%) followed by Financial Mathematics students (29%), Mathematics and Management students (8.5%), and Mathematics and Computer students (8.5%). The remaining groups were from Mathematics and Statistics and Management (4%), (12%) Financial Computing and (5%) Information Technology students. Gender, age and educational level distribution are shown in Table 4.1.

**Table 4.1: Demographic information of students**

| Item | N=82 | |
|---|---|---|
| | **Frequency** | **Percent (%)** |
| **1.Gender** | | |
| Male | 30 | 36.6 |
| Female | 52 | 63.4 |
| **Age** | | |
| 18-20 | 55 | 67.0 |
| 21-23 | 24 | 29.3 |
| 24 | 3 | 3.7 |
| **Education Level** | | |
| Foundation | 4 | 4.9 |
| Year 1 | 45 | 54.9 |
| Year2 | 19 | 23.2 |
| Year3 | 14 | 17.1 |

### 4.3.2 Research Instrument

A questionnaire was designed to evaluate the students' readiness towards using mobile learning. Students were asked to complete questionnaire, which contains different types of questions.

Firstly, a five-point Likert scale consisting of 11 statements was developed to assess students' attitude towards M-learning (e.g. 'I need training to understand how to use a new

mobile application'). The Likert scale is regularly used in similar studies to access respondents' attitudes and perceptions of M-learning (Jacob and Issac, 2008b). Secondly, closed format questions (13 questions) were used, which include multiple choice answers (e.g. 'What kind of mobile device do you have?'). Previous studies have used this type of question format to find out about the availability of mobile devices, usability of the internet and price of accessing the internet (Switzer and Csapo, 2005; Trifonova, Georieva and Ronchetti, 2006; Lam et al., 2011). Students were also asked to write an explanation for their answers. Thirdly, students were given a list of services of M-learning and were asked to classify each one in terms of the usefulness for learning mathematics, an approach used in other research in this area (Trifonova, Georgieva and Ronchetti, 2006; Corbeil and Valdes-Corbeil, 2007). Finally, at the end of the questionnaire there were two open format questions, which tried to encourage students to write their opinions about the challenges that might have to be faced when implementing this new technology and to add any comments about using M-learning applications to help teach mathematics for undergraduate students.

### 4.3.3 Procedure

An online questionnaire was designed in the second semester of the academic year 2010/2011 to collect the data for this study. The questionnaire was sent as an email to all students in the department. The email contained the link to the questionnaire and the expected time for completing the survey was 10 minutes. In the first page of the questionnaire, a brief explanation of the research project and the aims of the study were provided. Students were also given definitions of the concepts being used in the questionnaire (i.e. E-learning and M-learning). In addition, students were informed that all the data and participants' details would be kept anonymous, and that they could withdraw from the study at any time. Participants were also provided with the contact information of the researcher.

## 4.4 Results

The data were coded and analysed by using the Statistical Package for Social Science (SPSS) Version 16.0.

### 4.4.1 Results from Likert scale questions

Table 4.2 shows the mean responses of each subject and the mean total for 11 statements. Students responded to a five-point Likert scale from 1 (strongly disagree) to 5 (strongly

agree) for positive statements and from 5 (strongly disagree) to 1 (strongly agree) for negative statements.

**Table 4.2: Mean and Standard Deviation for each Item**

| Statements | Total Mean | Mean of each Subject | | | | | | | SD |
|---|---|---|---|---|---|---|---|---|---|
| | | Math | MSM | MM | MC | FM | FC | IT | |
| Q1. I feel I am not capable of using mobile technology applications | 4.17 | 4.26 | 3.33 | 4.14 | 3.86 | 3.96 | 4.70 | 4.75 | 1.142 |
| Q2. I need training to understand how to use a new mobile application | 4.21 | 4.30 | 4.00 | 3.86 | 4.43 | 4.00 | 4.60 | 4.25 | 0.978 |
| Q3. I believe that using a mobile device to learn math will increase the flexibility to learn inside and outside the classroom | 4.00 | 3.85 | 4.00 | 3.86 | 4.00 | 4.12 | 4.00 | 4.50 | 0.770 |
| Q4. I believe implementing and using M-Learning as part of teaching and learning math will make the educational process easier and more enjoyable | 3.59 | 3.37 | 3.33 | 3.43 | 3.43 | 3.58 | 4.10 | 4.50 | 0.916 |
| Q5. I think that using M-learning will help me to get good grades | 3.30 | 3.15 | 3.33 | 3.29 | 3.14 | 3.46 | 3.20 | 4.00 | 0.856 |
| Q6. I believe that implementing M-Learning in the educational process will increase communication between teachers and students | 3.84 | 3.85 | 4.00 | 3.86 | 3.57 | 3.75 | 4.20 | 3.75 | 0.793 |
| Q7. Implementing M-Learning will enable me to have independent learning | 3.68 | 3.70 | 3.33 | 4.00 | 3.29 | 3.63 | 3.80 | 4.00 | 0.784 |
| Q8. I think that M-Learning will improve The quality of the curriculum | 3.34 | 3.11 | 3.33 | 3.57 | 3.29 | 3.33 | 3.70 | 3.75 | 0.835 |
| Q9. It is not easy to find a hot spot to connect to the internet on your mobile phone or laptop | 3.51 | 3.33 | 3.00 | 3.14 | 3.00 | 3.88 | 4.00 | 3.25 | 0.972 |
| Q10. I do not think there is enough technical Support to implement M-learning | 3.02 | 3.11 | 2.33 | 2.71 | 3.00 | 2.92 | 3.20 | 3.75 | 0.846 |
| Q11.I believe that implementing M-learning is a complicated process | 3.50 | 3.41 | 3.00 | 3.57 | 3.29 | 3.46 | 3.80 | 4.00 | 0.878 |

*MSM: Mathematics and Statistics and Management, MM: Mathematics and Management, MC: Mathematics and Computer, FM: Financial Mathematics, FC: Financial Computing, IT: Information Technology*

The first two questions investigate the students' capabilities for using M-learning. The first question asked students if they are not capable of using mobile technology application. The mean of the responses was 4.17, which is located within the area 'Disagree' and 'Strongly Disagree'. The second question asked the students if they need training to understand how

to use the new mobile application. The mean score of the responses was 4.21, which is located within the area 'Disagree' and 'Strongly Disagree'. The results from these two questions indicate that students have the ability to use mobile applications in their studying.

The next set of questions (3-8) were designed to measure students' attitude towards the benefits of using M-learning for learning mathematics. Question 3 asked if M-learning will increase flexibility in the learning process. The mean was 4.00, which equals to 'Agree'. Then the participants were asked if M-learning would make the educational process easier and enjoyable. The mean of the result was 3.59, which is located between ''Neutral' and 'Agree'. The fifth question asked if M-learning would help students to get good grade. The mean score was 3.30, which located in the same area.

Question six examined if M-learning would increase the communication between teachers and students. The mean score was 3.84, which is a positive response indicating that students can see the benefits of M-learning in this respect. The seventh question asked if M-learning would enhance independent learning. The mean score response for this question was 3.68, which is close to 'Agree'. The next question was designed to find out if students thought to if M-learning would improve the quality of the curriculum. The mean score of the responses for this question was 3.34, between ''Neutral' and 'Agree'.

The last part of the questionnaire was designed to gather information on students' perception of the difficulties of implementing M-learning. Question nine asked how easy it was to find hot spots to connect to the internet. The mean responses were 3.51, between 'Neutral' and 'Disagree'. This suggests that students found it easy to connect a mobile device to the internet. The mean score for the next question ('I do not think there is enough technical support to implement M-learning') was 3.02, which is 'Neutral'. The last question was designed to find out students' opinion of implementing M-learning. The mean score for this question was 3.50, which suggests that students disagree with the idea that M-learning is a complicated process.

Finally, Table 4.2 shows the standard deviation of the data obtained. The standard deviation is important as it gives an indication of how the data spread around the mean. A large standard deviation would mean that there is a lot of variation in the answers. A small standard deviation would mean that the data are similar and less spread out. A standard deviation of 0 is obtained when all responses to questions are the same (Fielding and

Gilbert, 2006). The standard deviations of the questions in Table 4.2 range between 0.77 and 1.14, indicating that students' answers are similar.

### 4.4.2 Results Obtained from Closed Format Questions

Figure 4.1 shows that 65% of the respondents' own smart phones had advanced computing ability and connectivity; 28% owned mobile phone for calls and texts; 5% owned a Tablet PC; 1% had a PDA; and 1% had MP3 players.

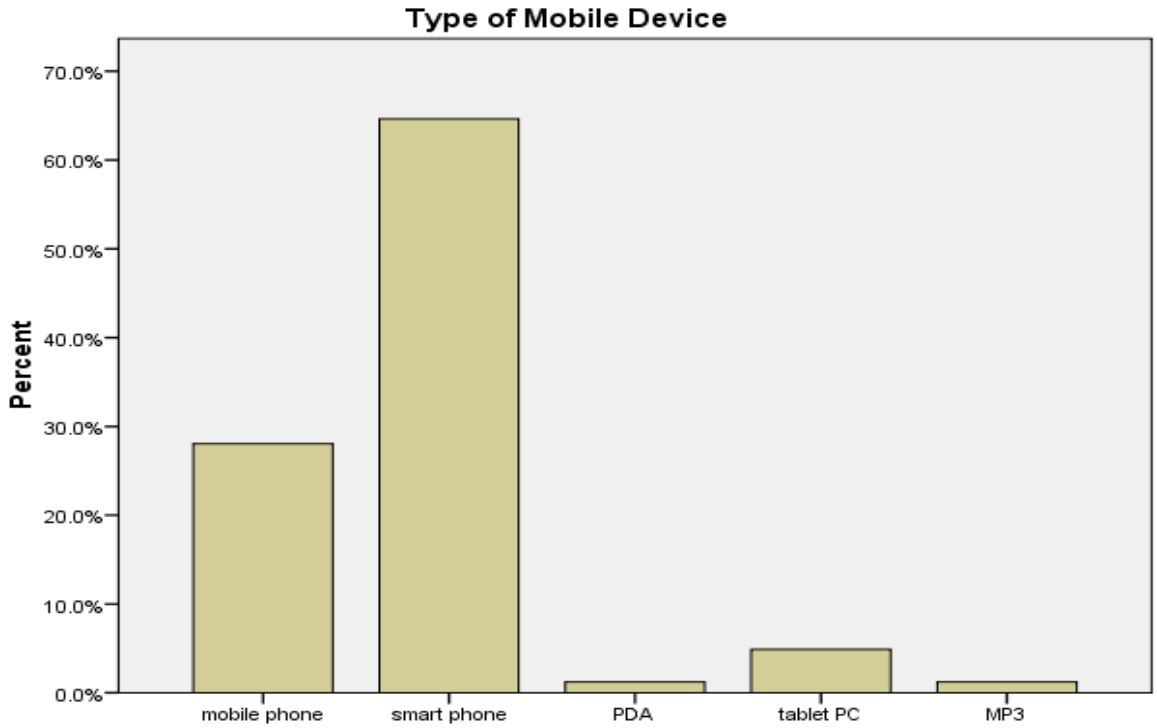


**Figure 4.1: Students' Availability of Mobile Devices**

The study also investigated how participants access the internet and where, in order to find how this could affect the implementation of M-learning. Approximately 83% of participants had constant accessibility to the internet on their mobile devices, 63% of the students accessed the internet from their mobile devices every day, 15% accessed the internet every week, 5% accessed it monthly and 17% accessed it rarely (Figure 4.2). It was also found that 96% of the students accessed the internet outside the University in various locations such as at home, in the public library and at internet cafés. Around 54% of the students accessed the internet using the campus wireless network.

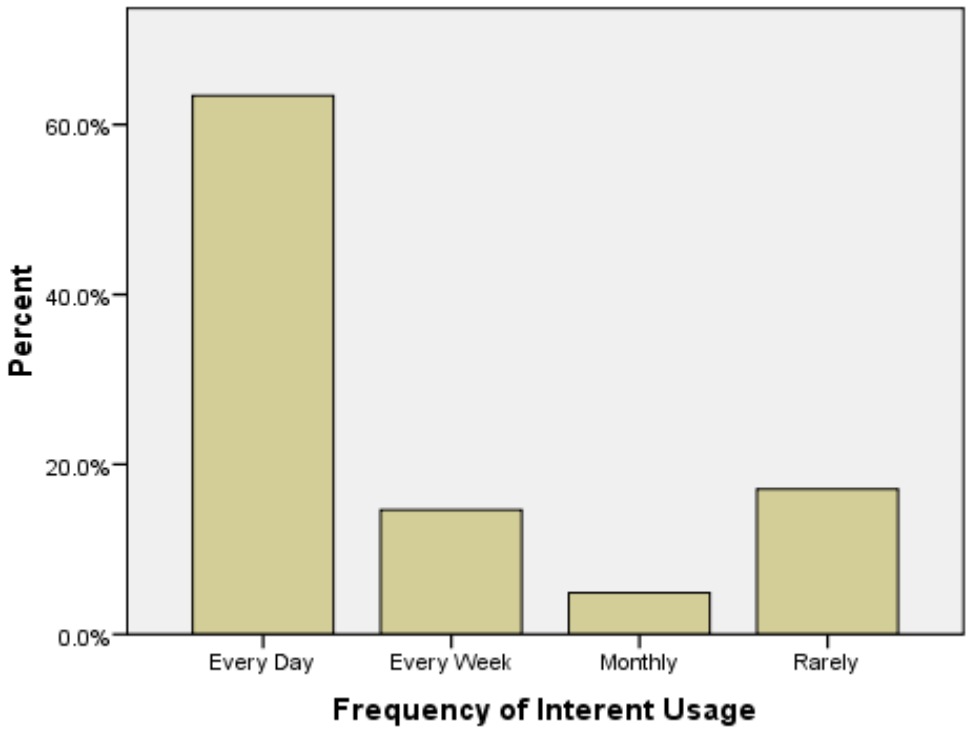


**Figure 4.2: Students' Usage of the Internet**

The results showed that 62% of the students pay money to access the internet. Considering the students' opinions about price, 7% think it is a low price, a high percentage of them (82%) considered it a normal price, while 11% thought it is a high price to pay for internet access.

The data also indicate that a high percentage (70%) of the participants use an E-learning platform (computer support/mediated learning) to learn mathematics. Some students mentioned that they used MATLAB and SPSS packages in their study. Other students use *YouTube* and recommended websites like interactive mathematics (www.intmath.com) to learn mathematical techniques. In terms of using mobile devices in learning, almost half of the participants access education applications on their mobile devices. For example, some students used their mobile devices to access University links such as checking lecture notes and reading e-books. Other students said that they used other applications such as Wolfram Alpha mobile application, calculators, iPhone education applications store and language learning applications.

In terms of using mobile devices in learning, 43% of students utilized their mobile devices to learn mathematics. This included applications that provided students with guidance and support for learning graphing routines and formulas. Students also mentioned that they can google mathematical concepts on their mobile devices and also access math broadcasts and

podcasts. A majority of the students (67%) indicated that it was useful to access mathematical lectures online using mobile devices, as the lectures are available anytime, anywhere, so they can quickly go over lectures while they are travelling or before exams. Table 4.3 shows the percentage of students who use computers and mobile devices for learning.

**Table 4.3: Students' Usage of Computers and Mobile Devices for Learning**

| | Yes | No |
|---|---|---|
| Using computer support in learning | 70% | 30% |
| Using mobile device to access educational applications | 45.1% | 54.9% |
| Using mobile devices in learning | 43% | 57% |

It is also worth mentioning that a low percentage of students (17%) participating in this study had actually heard about mobile learning, or knew what it was. However, in spite of this, the majority of the answers to the question 'what is your opinion of M-learning?' were positive; 70% of the students said that M-learning is a good idea and they would like to use it, whereas 15% think it is a good idea but they would not like to use it. 6% of the students do not think it is a good idea, and the rest of the students (9%) have no real opinion on this. Figure 4.3 shows students' opinion about M-learning.

In addition, the study found that the way of using E-learning platforms affected students' perception about M-learning. A high number of students who utilize E-learning gave a positive attitude towards M-learning, and they agree that it is a good idea and they want to use it. Figure 4.4 shows the students' usage of E-learning and their opinion towards M-learning.

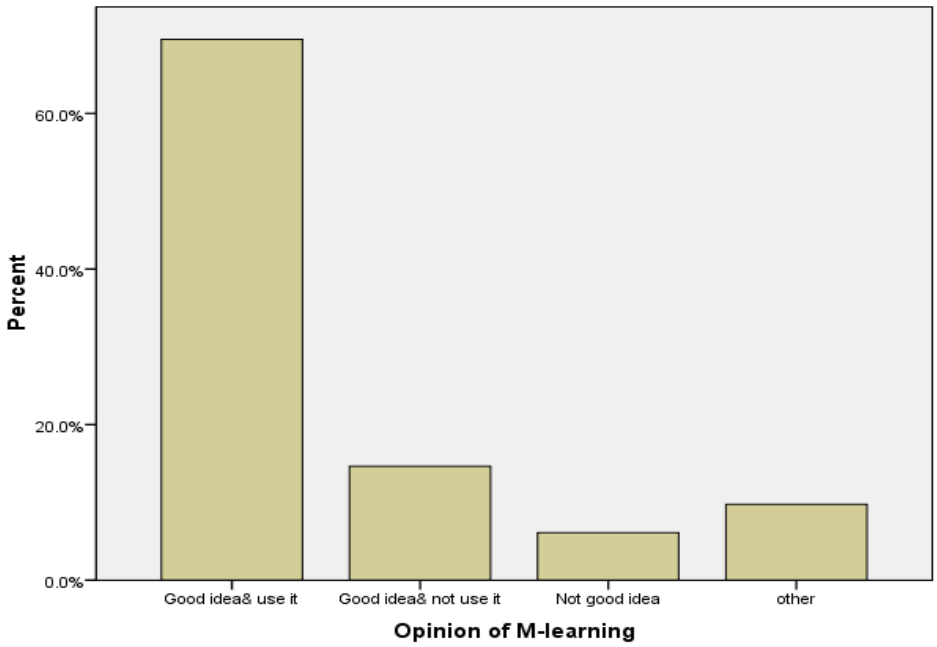


**Figure 4.3: Students' Opinion about M-learning**

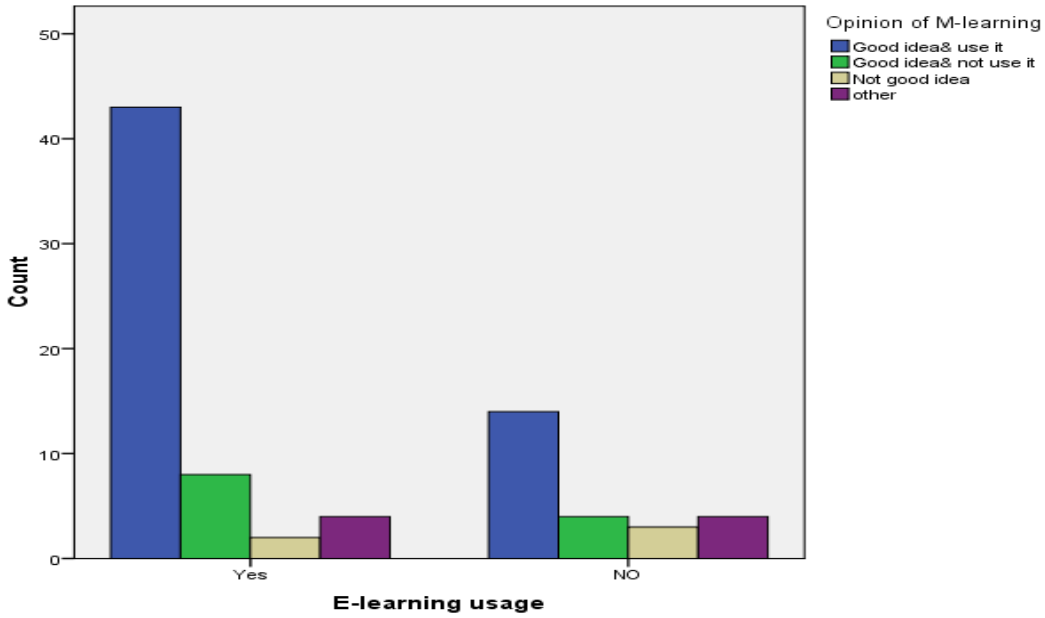


**Figure 4.4: E-learning Usage and the Opinion about M-learning**

### 4.4.3 Students' Preference for M-learning Services

To determine the preference for mobile services, students were given a list of expected services and they had to decide how they felt about the usefulness of each one for learning mathematics. Table 4.4 shows that a high percentage of students expected M-learning to be useful for accessing educational content online and offline (91.5% and 84.5% respectively). It can also be seen that more positive weight was given to accessing supporting educational information via the World Wide Web. In contrast, receiving

supporting educational information via SMS/MMS had a neutral response from nearly half of the students. The percentages for the latter two services indicate that students predict that M-learning will improve communication among students themselves and between students and their instructors.

**Table 4.4: Students' Preferences for M-learning Services**

| Type of M-learning services | Useful % | Neutral % | Not Useful % |
|---|---|---|---|
| 1.To access educational content online | 91.5 | 7.3 | 1.2 |
| 2. To access educational contents offline | 84.5 | 11.7 | 3.8 |
| 3.To access supporting educational information via WWW | 75.6 | 23.2 | 1.2 |
| 4. To receive supporting educational information via SMS/MMS | 41.5 | 46.3 | 12.2 |
| 5.To collaborate with other students | 67.1 | 28.0 | 4.9 |
| 6.To collaborate with instructors | 65.4 | 26.5 | 8.1 |

### 4.4.4 Results Obtained from the Two Open-Ended Questions

The aim of the open-ended questions was to explore the difficulties of implementing M-learning in learning and teaching mathematics. On the basis of this, students were asked this question: 'in your opinion, what are the challenges that might face implementing M-learning in your department?'. The data obtained from the open-ended questions (25 answers were provided by students) were analysed using thematic analysis. The researchers used the following steps to conduct thematic analysis: familiarisation with datasets, generating initial codes, searching for themes, reviewing themes and refining themes (Silverman, 2011). In response to this question, students underlined the challenges of implementing M-learning in the following ways:

1. *M-learning is a new learning system which is not popular and students are not familiar with it*. A high percentage of the students have not heard of M-learning. Their comments echo their concerns 'Not being popular', 'It is a new, different and unfamiliar concept', and 'Not everyone will be able to access this tool'.
2. *Availability of the appropriate mobile device and the cost of internet charges*. A lot of students think that the availability of suitable devices is the main challenge of implementing M-learning, which requires every student to have a high definition

device that allows connection to the internet. Students wrote 'Not all students have phones that can access the Internet, may be unfair for them', 'Not everyone will be able to access this tool', and the students who do not have suitable devices will lose out on the learning process: 'those who cannot use it because they do not have the appropriate device, will be left out and may not always be up-to-date with the contents of the course'. In the students' opinion, these devices might be expensive in addition to the cost of internet charges. Students reported, 'everybody would have to have a certain range of phones which in my opinion are quite expensive as some people do have a usual non-Smartphone mobile phone', 'People may not have smart phones etc. or internet charges are too high if access is required a lot'; 'the fact that many departmental tutors may over-rely on this expecting each and every student to have a Smartphone that is compatible with the internet such as the iPhone for example. Adding to this, the fact that it will be fairly costly'.

3. *M-learning might affect lecture attendance*. Some students predict that M-learning will make university students unconcerned about attending lectures. One student said 'people will not bother to go to lectures, another mentioned the fact that 'not enough people will be using it. Also it could make students lazier, because then the teaching will be provided at any time, and some could use it as an excuse to not turn up to lectures. Plus the standard of M learning is not really a substitute to discuss concepts personally'.
4. *Ensuring a high level of technical support for implementing M-learning*. Some students think that adequate technical support would be essential in trying to implement mobile learning technologies in the learning process. M-learning needs to convert the learning material to other format to be used on the mobile device. Students stated: 'There might be technical difficulties, such as lecture notes having a hard time to upload on the mobile device'; 'It may also be difficult to convert certain files to a specified mobile file so everybody can use it. This would also require the maths files to be used on all smart phones'; 'may take some time to implement and many will not prefer it to emails or u-link. It may be seen as a waste of more time rather than saving people time'.
5. *Lecturers' attitude towards implementing M-learning*. This factor might play a significant role in the adoption of M-learning. Some students think that lecturers do not want to apply this technology or might face some difficulties in trying to use it effectively as this new technology may require a lot of effort to implement it. Their comments illustrate this point well: 'Teachers will not be able to give enough

support to students about it. Teachers will not want to learn how to use it', 'I do not believe lecturers will want to take the time to effectively make two sets of lecture notes and make them as presentable and clear as a mobile application would need them to be'. In addition, some lecturers like to keep the traditional approach in teaching and may be reluctant to change their approach: 'Tutors who are reluctant to change. For example, those that do the same lectures year-in year-out with no change and those still use overhead projectors rather than adapting to more efficient technologies. That the entire staffs have 100% trust in the system, if people hold back then it will not work as intended. For example, tutors who delay putting material on U-Link in the belief that somehow that will bring students to lectures, but how can we come to lectures when we cannot read up on previous lectures – we are just going to be lost'.

Finally, at the end of the questionnaire students were asked to describe how they imagined M-learning system would work. Nine answers were provided by students. The analysis of the data was the same as the previous open-ended question. Students' responses to this question were as follows:

1. *Students expected M-learning to allow course lectures (represented in PowerPoint format) to be available online and offline using the mobile devices*. One student described M-learning working as follows: 'If all lectures were in the form of a clear/ large PowerPoint then there would be congruency across the modules which would aid learning and when it is uploaded to U-link it would also be uploaded to a mobile app (which enables saving of each for use where there is no internet - similar to spotify with music) at the same time. This would enable students to study whilst they are out for example on trains and buses etc. and would be enormously helpful. It would be a lot of work and involve a complete change on the way the course works but would be a good change'. Another interesting view provided by a student stated: 'I think M-learning would be best in the form of an application from which you can access your modules (like U-link) and in each application there are a series of flashcards for each lecture'.
2. *M-learning services can be viewed as an additional method that supports traditional class*. One student reported: 'It is also important that M-Learning does not "replace" lectures. Instead of using the same material covered in lectures, use different material that students can gain from using both M-learning and attending lectures; the same way that seminars compliment their respective lectures.

Organizing the material such as that is not a bombardment of information like a textbook. Don't make M-Learning a virtual library where we come and go but to allow for an easy and comfortable social environment for discussion. Allow M-Learning to be used offline'; 'Nowadays, the majority of students have smartphones (iPhones, Blackberry, Android phones etc.) and as they constantly use their phones, additional lectures may encourage them to use them via a phone'.

3. *Some students' opinions indicate that M-learning needs to be fully researched before being implemented as a learning tool*. 'It is an interesting concept but probably needs to be tested for effectiveness on a smaller scale before it is considered for application into an educational curriculum'; 'make it popular'; 'if the system was one where the student can ask questions and get answers via their mobile I agree, but putting learning material on mobiles... not such a good idea'.

## 4.5 Discussion

The results obtained from this study indicate that the majority of students own smart phones, a few students have tablet PCs or PDAs and the remaining students have ordinary mobile phones. Students do access the internet via their mobile devices inside and outside the campus regularly and their thoughts about the price of accessing the internet suggest that they did not think that the price was too expensive for accessing these types of services.

The results also show that students who do use E-learning resources are more positive in their attitude towards the value of M-learning. Furthermore, this positive attitude is evident among students who have an interest in using new technologies for their studies and see the benefits of M-learning for accessing additional learning materials.

It is widely known that all mobile devices, such as smart phones, allow connection to a range of mathematics applications for topics such as calculus (differentiation and integration), algebra (solving linear equations) and also providing students with experiential and interactive way to learn mathematics. Students can learn more effectively if information and lectures viewed in smaller and easy move units.

In addition, students look to M-learning as a complementary support to the traditional lecture. They expected M-learning to offer them additional lecture material which can be uploaded to their mobile devices to enable them to study while they are travelling or away

from the University campus. They considered M-learning to be a method for saving time, providing convenient access to course materials and making lectures more interesting.

However, in spite of these comments, some participants thought the opposite due to design and technical issues such as the small size of the mobile device screen, the long time it can take to download the application and the connection to the internet. Some students think they will not be able to use M-learning because they do not have suitable devices. These issues need to be considered by M-learning developers. Technical decisions need to be made in terms of how to develop the learning materials and make them available on a cross-platform mobile devices setting.

Overall, the results from this study can be summarized and evaluated to previous M-learning studies as follows*:*

1. The most popular mobile devices used by students were smart phones with advanced computing and connectivity to the internet. The most popular learning activities using these devices were accessing the university timetable, U-link, using mobile applications to find tutorials for difficult mathematical questions (i.e. *Wolfram Calculus Course Assistant*) and to download scientific calculators.

2. Students' usage of E-learning affects their perspective of M-learning. Students who use E-learning platform in their study are more willing about implementing M-learning and have a positive attitude towards its services. This result agrees with previous studies (Georgieva, Trifonva and Georgiev, 2006; Trifonova, Georieva and Ronchetti, 2006).

3. Students should be notified about the benefits of M-learning as a high proportion of them do not know what it means and how it works. More support should be given to attract the students into M-learning activities. This echoes a suggestion recommended by Lam et al. (2011).

4. The majority of students predict that M-learning will be a complementary system for the traditional class-based learning by providing extra different materials, and it will not replace the traditional leaning process. This feedback is in line with Motiwalla (2007) and Ally (2009).

5. Students feel that they are capable of implementing M-learning and to this extent they might not need training to utilize M-learning applications. A similar result was found by Jacob and Issac (2008a).

6. A high percentage of students agree that M-learning will make the learning process interesting and flexible. M-learning would save students time. In addition, it will improve the communication between the students and their lecturers. These results are in line with Jacob and Issac (2008a), Ismail et al. (2010) and Al-Fahad (2009).

7. Students expect their university to pay extra attention in terms of technical support and infrastructure preparation to ensure a successful implementation of M-learning. This result is similar to that found by Lam et al. (2011) and Economides and Grousopoulou (2009).

8. Students suggest doing a pre-test for M-learning before implementing it as a new learning application. This will set out the effectiveness of this new technology in the learning process. Lecturers' attitude towards M-learning and lack of technical support might affect its implementation. These parameters are very important while designing the M-learning phase (Corbeil and Valdes-Corbeil, 2007; Lam et al., 2011).

## 4.6 Conclusion

Despite the small-scale nature of this study, the findings might be considered more inductive than representative. The purpose of this study was to formulate an overall view of students' readiness to move towards utilizing M-learning in their studies. It also attempted to identify the factors that affect the implementation of this technology in learning and teaching at the undergraduate level.

M-learning facilitates the collaboration between students and allows them to engage in learning activities. In addition, M-learning improves students' accessibility to learning materials by offering a flexible environment to learn anytime, anywhere. This flexibility might reduce students' unproductive time and encourage them to interact more with their lecturers and fellow students. The participants showed a positive attitude towards the benefits of M-learning. They expressed a belief that M-learning is not a complicated process, and they expect it will offer them a lot of services to help them in their study.

Previous studies have been sceptical about the availability of the mobile device and its price. A very important factor to ensure the success of M-learning system will be the choice of device used by students. It was found that a large proportion of participants already have modified mobile devices. However, some students thought that these devices might not be suitable to utilize M-learning, as M-learning needs technology to convert learning materials to specific mobile device systems.

The results revealed that students are not fully ready to implement M-learning in their studies but they were willing to use it. In addition, lecturers' attitudes toward M-learning affect their acceptance; lecturers might not like utilizing M-learning in their teaching methods. However, students and lecturers might take advantage of M-learning in the near future if the universities deploy successful strategies that increase students' awareness of M-learning and overcome the challenges identified.

This points to the need for more effort to adapt this technology in teaching and learning methods. It is recommended that more technical infrastructure be established in university campuses to assist students' learning via their mobile devices. It would also be advisable to provide students and lecturers with more information about the benefits of M-learning using workshops and seminars. Moreover, a series of training courses should be organized for the lecturers in order to integrate them in M-learning administration. The way forward is to develop and evaluate a model that takes into consideration the concerns and issues raised by the students in this study.

# CHAPTER 5: FACTORS INFLUENCING STUDENTS' ACCEPTANCE OF M-LEARNING – AN INVESTIGATION IN HIGHER EDUCATION

## 5.1 Overview

The results obtained from chapter four reveal that a high percentage of students are not familiar with M-learning and are not fully ready to implement it. However, they are willing to use M-learning in their studies, as they think that it is not a complicated process and will offer them a lot of services. Therefore, there is a need to enhance their acceptance of this new educational system and explore all the factors that increase their acceptance. The objective of this study presented in this chapter was to investigate the factors influencing university students' acceptance of M-learning, in addition to ascertaining whether prior experience of mobile devices affects university students' acceptance of M-learning. In this chapter, a discussion of the research model and hypotheses is provided. Next, the research methodology is described. The statistical technique using SEM is explained. Finally, the results of the data analysis are presented followed by discussion of the findings and the conclusion

## 5.2 Research model

Venkatesh et al. (2003) indicated that IT use behaviour was well explained by the UTAUT, and it may be possible to reach the practical limits of the ability to explain users' acceptance for new technology. In addition, they recommended that future research test their model by discovering new constructs that can add to the predication of intention to use and behaviour. M-learning system which allows the learners to conduct learning activities can be considered as IT phenomenon and can be investigated within technology acceptance models (Wang, Wu and Wang, 2009).

After considering the factors that might affect users' acceptance of M-learning as shown by literature review and a previous study undertaken by the author (Abu-Al-Aish, Love and Hunaiti, 2012), two additional constructs were added to UTAUT in order to investigate the factors that might affect university students' acceptance of M-learning: quality of service and personal innovativeness. In addition, the social influence construct was oriented in UTAUT to explore lecturers' influence on the behavioural intention.

As M-learning is still in its infancy and there is no implementation of this technology in Brunel University, the effect of the above constructs was investigated with regard to behaviour intention (use behaviour and facilitating conditions were not investigated in this study). As the majority of students fall within the same age cohort and a high percentage of them are males, the impacts of age and gender were not tested. Also, as we investigated the acceptance of M-learning in voluntary usage context, voluntariness of use was also eliminated.

The research model to be tested in this study is shown in Figure 5.1. In this model, we hypothesized that performance expectancy (PE), effort expectancy (EE), personal innovativeness (PI), quality of service (QoS) and lecturers' influence (LI) would be factors affecting the behavioural intention (BI) to use M-learning. We also tested if experience of mobile devices would moderate the influence of these factors on behavioural intention.

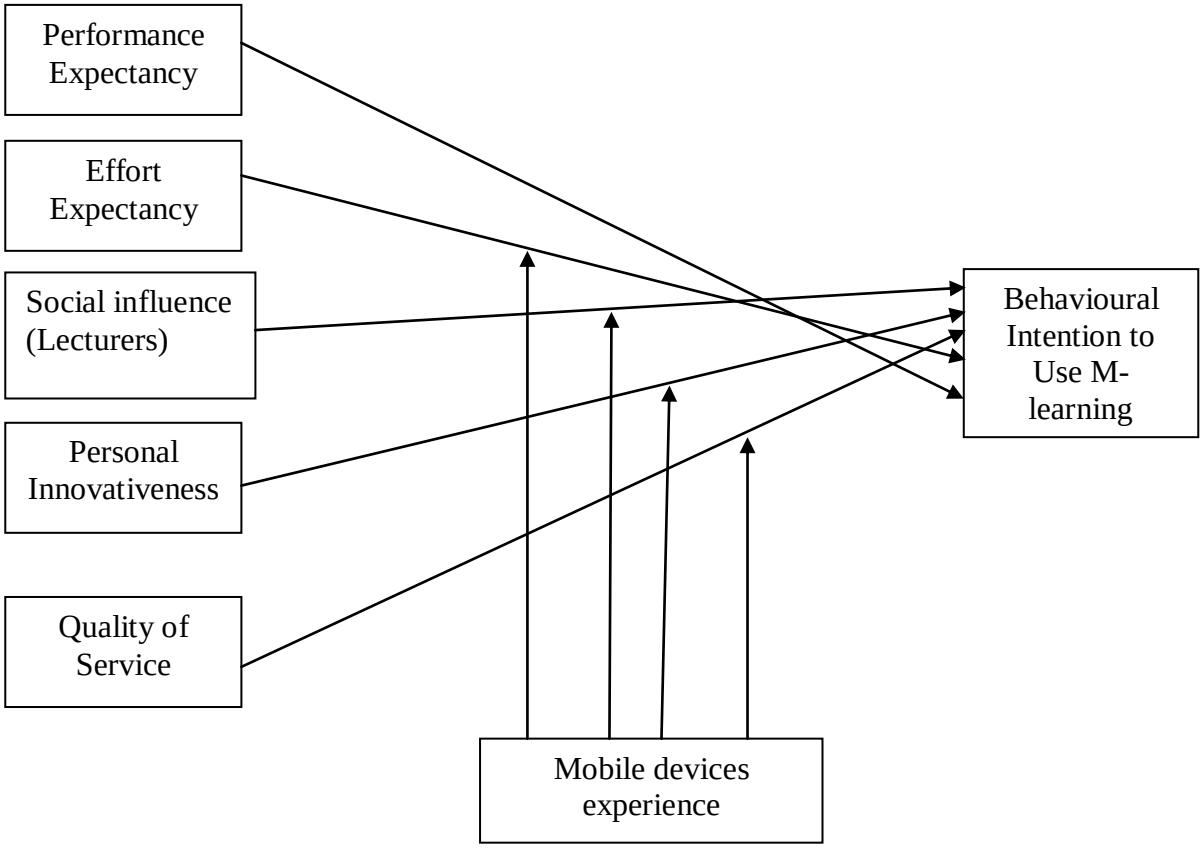


**Figure 5.1: Research Model**

## 5.3 Research Dimensions and Hypotheses

In this section the constructs of the proposed model are discussed.

### 5.3.1 Performance Expectancy (PE)

Venkatesh et al. (2003) defined performance acceptance as the extent to which a person believes that using an information system would help him or her to benefit in terms of job performance. They also arranged five constructs from the previous models that refer to performance expectancy: perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT) and outcome expectations (SCT). In addition, they also indicated that performance expectancy in each previous model is the strongest predictor of behavioural intention to use IT. Davis (1989) demonstrated that perceived usefulness is the most frequent factor used to decide a higher or lower adoption rate. Applying performance expectancy to an M-learning context proposes that students will find M-learning useful because they learn at their convenience and quickly. It will also improve their learning productivity (Wang, Wu and Wang, 2009). This research attempted to study which performance expectancy of M-learning will influence student behavioural intention to use M-learning. This led to testing the following hypothesis:

H1: Performance expectancy will have a positive effect on behavioural intention to use M-learning.

### 5.3.2 Effort Expectancy (EE)

Venkatesh et al. (2003) defined effort expectancy as the degree of ease that an individual thinks they will have when using an information system. The three constructs from the previous models that relate to the concept of effort expectancy are perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT). This means that the ease of use of a designed information system is one of the key factors of accepting information technology (Wu, Tao and Yang, 2008). Prior researches suggest that individuals' expectations of system use might be different because of gender, age and experience. They support the idea that concepts related to effort expectancy will be stronger determinants of individual intention for women (Venkatesh and Morris, 2000; Venkatesh, Morris and Ackerman, 2000; Vankatesh et al. 2003), particularly those who are older (Morris and Vankatesh, 2000) and who have little experience with the system (Venkatesh et al. 2003).

Based on UTAUT, it was expected that students' acceptance of M-learning system would depend on whether or not it is easy to use. Therefore, it is hypothesized that:

H2: Effort expectancy will have a positive effect on behavioural intention to use M-learning.

### 5.3.3 Lecturers' Influence (LI)

Lecturers' influence is derived from social influence, which is defined as the extent to which a person perceives it is important that others believe he or she should use the new information system (Venkatesh et al., 2003). Social influence is represented as a subjective norm (TRA, TAM2, TPB and C-TAM-TPB), related to social factors (MPCU) and image (IDT) (Venkatesh et al., 2003). Prior studies indicate that social influence is a direct determinant of individual's behavioural intention to use new technology (Mathieson, 1991; Moore and Benbasat, 1991; Thompson, Higgins and Howell, 1991; Harrison, Mykytyn, and Riemenschneider, 1997; Venkatesh and Davis, 2000). Social influence was divided into two dimensions: superior influence and peer influence (Igbaria, Schiffman and Wieckowski, 1994).

This study incorporates one critical aspect of (superior) social influence and examines its effect on students' acceptance of M-learning. In this study, superior influence refers to the lecturers' influence, which is defined as the extent to which immediate faculty members or instructors directly encourage or motivate their students to use M-learning services. Several studies indicate that supervisors influence a person's acceptance, both in terms of usage (Igbaria, Schiffman and Wieckowski, 1994; Karahanna and Straub 1999), and in terms of communication (Leonard-Barton and Deschamps, 1988). Lecturers' influence is an important construct to encourage students to adapt new technologies in their learning setting. This led to testing the following hypothesis:

H3: Lecturers' influence has a positive effect on behavioural intention to use M-learning.

### 5.3.4 Quality of Service (QoS)

Many researches in HCI (Nielson, 1993; Kuan, Vathanophas and Bock, 2003) and usability research (DeLone and McLean, 1992; Rai, Lang and Welker, 2002) define quality of service in terms of reliability and response, content quality and security. The majority of definitions of quality of service have concentrated on customers' perception and their satisfaction of the services being offered. Parasuraman, Zeithaml and Berry (1988) defined

consumer expectation of quality of service as what they think a service provider *should* offer rather than what they *would* offer. Zeithaml (1988) defined quality of service as users' assessment of the overall superiority of the service. The excellence of services being provided to users can affect the level of acceptance of new technology (Xin, 2004). Lee (2010) indicated that students' perception of online support service quality might be considered as a key factor affecting their behavioural intention towards the acceptance of E-learning. Thus this study tested the following hypothesis:

H4: Quality of service has a positive effect on behavioural intention to use M-learning.

### 5.3.5 Personal Innovativeness (PI)

Personal innovativeness originated from IDT and is adapted in the field of IT (Agarwal and Prasad, 1998). Agarwal and Prasad (1998) define it as the individuals' willingness to try out any new information technology. IDT suggests that individuals with a high level of innovativeness are more willing to adopt positive ideas and changes in new IT and have more capacity to deal with uncertainty compared with those with a lower level (Lu, Yao and Yu, 2005). If individuals are more likely to try new IT, then they can act as change agents and opinion leaders for new IT implementation in organizational settings (Agarwal and Prasad, 1998). Several studies investigated the effect personal innovativeness on a new IT behavioural intention (Hung and Chang, 2005; Lu, Yao and Yu, 2005; Thompson, Compeau and Higgins, 2006; Lian and Lin, 2008; Fang, Shao and Lan, 2009). For the adoption of mobile technology in a learning context, most students do not have much experience or knowledge to help them form a clear perception belief. It was expected that students with high personal innovativeness would be more risk taking and have a more positive intention to use M-learning in their study. Therefore the following hypothesis was tested:

H5: Personal innovativeness has a positive effect on behavioural intention to use M-learning.

## 5.4 Pilot Test

The questionnaire was pilot tested to evaluate its construct validity and reliability. Reliability is the degree to which measures are free from error and reflect results consistently. The questionnaire was pilot tested with 12 students who enrolled in a usability engineering course. Reliability of the data from pilot study was assessed using

Cronbach's alpha. Based on the results obtained some items were reworded and adjusted. Demographic data of the participants are shown in Table 5.1.

Cronbach's alpha was used to test the reliability of the constructs. The coding for the questions was from 1 (Strongly Disagree) to 5 (Strongly Agree). Some questions were in negative construction toward M-learning acceptance. The researcher had to reverse the coding for these questions. Upon the correction of the coding, reliability alpha became as shown in Table 5.2.

**Table 5.1: Demographic data from the pilot study**

| **Variable** | | **Frequency** | | **Percentage** |
|---|---|---|---|---|
| *Gender* | Male | 10 | | 83.3 |
| | Female | 2 | | 16.7 |
| *Use of E-learning* | Yes | 12 | | 100 |
| | No | - | | - |
| *E-learning knowledge* | Very Poor | - | | - |
| | Poor | - | | - |
| | Moderate | 1 | | 8.3 |
| | Good | 7 | | 58.3 |
| | Very good | 4 | | 33.3 |
| *Mobile device* | Mobile phone | 1 | | 8.3 |
| | Smart phone | 10 | | 83.3 |
| | PDA | - | | - |
| | Tablet PC | 1 | | 8.3 |
| *Use of M-learning* | Yes | 7 | | 58.3 |
| | No | 5 | | 41.7 |
| *M-learning knowledge* | Very Poor | - | | - |
| | Poor | 1 | | 8.3 |
| | Moderate | 5 | | 41.7 |
| | Good | 4 | | 33.3 |
| | Very good | 2 | | 16.7 |
| *Experience using mobile device* | | | | |
| *Device* | N/A | <1 yr. | 1-3 yrs. | 3-5 yrs. |
| Mobile phone | - | - | 5 | 7 |
| Smart phone | 3(25.0%) | 2(16.7%) | 3(25.0%) | 4(33.3%) |
| PDA | 12(100%) | - | - | - |
| Tablet PC | 10(83.3%) | 2(16.7%) | - | - |
| *Frequency of using M-learning services (times per day)* | | | | |
| | N/A | 1-5 | 5-10 | >10 |
| Messaging | - | 3(25%) | 2(16.7%) | 7(58.3%) |
| Internet browsing | 1(8.3%) | 3(25%) | 3(25%) | 5(41.7%) |
| Games/music | 3*25%) | 5(41.7%) | 1(8.3%) | 3(25%) |
| Learning/education | 3(25%) | 5(41.7%) | 3(25%) | 1(8.3%) |

**Table 5.2: Reliability Analysis of the Pilot Study**

| Scale construct | Number of Items | Cronbach's alpha |
|---|---|---|
| Performance Expectancy | 5 | 0.733 |
| Effort Expectancy | 4 | 0.878 |
| Lecturers' influence | 3 | 0.818 |
| Quality of services | 6 | 0.710 |
| Personal innovativeness | 3 | 0.791 |
| Behavioral Intention | 5 | 0.967 |
| **All** | **26** | **0.918** |

As shown in Table 5.2, all Cronbach's alphas exceeded 0.70 for all constructs, which indicates the consistency between the multiple measurements of each construct (DeVellis, 2003; Sekaran, 2000; Hair et al., 2010). The results of the pilot study allowed the research to proceed to the main study.

## 5.5 Research Methodology

This section discusses the methodology used to conduct this study. Explanation of the participants, instrument and procedure are provided.

### 5.5.1 Participants

The study was conducted at the School of Information Systems, Computing and Mathematics, Brunel University, UK, in February 2012. Students from different undergraduate levels were asked to complete an online questionnaire.

A total of 183 responses were obtained. Nine questionnaires were discarded due to being incomplete or unreliable. Data were reported from 174 participants (125 males, 49 females; aged 18-26). Participant characteristics are shown in Table 5.3.

**Table 5.3: Characteristics of Participants**

| Characteristic | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| *Gender* | | | |
| Male | 125 | 71.8 | 71.8 |
| Female | 49 | 28.2 | 100.0 |
| *Course* | | | |
| CS | 91 | 52.3 | 54.0 |
| FC | 9 | 5.2 | 57.5 |
| IS | 49 | 28.2 | 85.6 |
| MA | 25 | 14.4 | 100.0 |
| *Age* | | | |
| <20 | 114 | 65.5 | 65.5 |
| 20-22 | 47 | 27.0 | 92.5 |
| >20 | 13 | 7.5 | 100.0 |
| *E-learning knowledge* | | | |
| Moderate | 15 | 8.6 | 8.6 |
| Good | 98 | 56.3 | 64.9 |
| Very Good | 61 | 35.1 | 100.0 |
| *Experience of using Mobile phone* | | | |
| <1 yr. | 3 | 1.7 | 1.7 |
| 1-3 yrs. | 18 | 10.3 | 12.1 |
| 3-5 yrs. | 153 | 87.9 | 100.0 |
| *Experience of using Smart phone* | | | |
| <3 yrs. | 111 | 63.8 | 63.8 |
| >3 yrs. | 63 | 36.2 | 100.0 |
| *Using M-learning* | | | |
| Yes | 81 | 46.6 | 46.6 |
| No | 93 | 53.4 | 100.0 |
| *Frequency of using M-learning* | | | |
| N/A | 26 | 14.9 | 14.9 |
| 1-5/day | 111 | 63.8 | 78.7 |
| 5-10/day | 25 | 14.4 | 93.1 |
| >10/day | 12 | 6.9 | 100.0 |
| *M-learning knowledge* | | | |
| Poor | 23 | 13.2 | 16.7 |
| Moderate | 78 | 44.8 | 61.5 |
| Good | 47 | 27.0 | 88.5 |
| Very Good | 20 | 11.5 | 100.0 |

CS: Computer Science, FC: Financial Computing, IS: Information Systems, MA: Mathematics.

### 5.5.2 Research Instrument

A questionnaire was designed in the first semester of the academic year 2011/2012 to investigate the factors influencing students' acceptance of mobile learning and to explore if gender and mobile devices experience differences exist in the acceptance of M-learning. The questionnaire consisted of four pages. Page one contains a brief description of the research, objective, and definitions of the concepts being used in the questionnaire. Page

two contains questions about the participants' demographic background (i.e. gender, age), E-learning experience, mobile devices experience, frequency of using mobile devices and M-learning knowledge. Pages three and four contain a group of five-point Likert scale questions investigating the influence of performance expectancy, effort expectancy, lecturer's influence, quality of service and personal innovativeness on students' behavioural intention to accept M-learning.

### 5.5.3 Procedure

The final questionnaire consisted of 26 items measuring six constructs. The items were derived from different research areas and were adapted to orient them to an M-learning context. This study used a convenience sample technique to collect the data (Creswell, 2012). The questionnaire was distributed to second-year students in the School of Information, Computing and Mathematical Science, Brunel University. Students from different classes were invited to participate and complete the questionnaire in their class. A brief description about the research objectives and a definition of M-learning were given by the researcher before students completed the questionnaire. In addition, students were informed that all the data and participants' details would be kept anonymous, and that they could withdraw at any time from the study.

## 5.6 Data Analysis and Results

This section explains the statistical techniques used in analysing the data collected. In addition, the section presents the results obtained.

Table 5.4 presents the mean, standard deviation, skewness and kurtosis for each item in the questionnaire. (For questionnaire items, see appendix 2).

The maximum acceptable limits of observation values up to ±1 for the skewness and up to ±3 for the kurtosis were used (Hair et al., 2006). The skewness and kurtosis statistics were found between the acceptable ranges, which indicated no deviation from data normality.

The data analysis method consisted of two steps. Step one contained the assessment of the measurement model to examine whether the model is a good fit with the data collected, based on the satisfactory results (i.e. after the construct reached the required measurement standard). Step two (hypotheses testing) could then be undertaken.

**Table 5.4: Mean, Standard Deviation, Skewness and Kurtosis of the items**

| Variable | Mean | S.D. | Skewness | Kurtosis | Theoretical range |
|---|---|---|---|---|---|
| **Performance Expectancy** | | | | | |
| PE1 | 3.57 | 0.72 | 0.18 | 0.57 | 1-5 |
| PE2 | 3.65 | 0.76 | 0.04 | -0.65 | 1-5 |
| PE3 | 3.77 | 0.76 | 0.25 | 1.77 | 1-5 |
| PE4 | 3.67 | 0.85 | -0.10 | -1.67 | 1-5 |
| PE5 | 3.69 | 0.83 | 0.02 | 0.69 | 1-5 |
| **Effort Expectancy** | | | | | |
| EE1 | 3.82 | 0.62 | -0.16 | 0.13 | 1-5 |
| EE2 | 3.85 | 0.67 | -0.05 | -0.29 | 1-5 |
| EE3 | 3.90 | 0.74 | -0.36 | -0.02 | 1-5 |
| EE4 | 3.96 | 0.72 | 0.06 | -1.08 | 1-5 |
| **Lecturers' influence** | | | | | |
| LI1 | 4.01 | 0.76 | -0.40 | -0.21 | 1-5 |
| LI2 | 3.99 | 0.80 | -0.59 | 0.05 | 1-5 |
| LI3 | 3.87 | 0.75 | -0.12 | -0.51 | 1-5 |
| **Quality of Services** | | | | | |
| QoS1 | 3.88 | 0.74 | -0.15 | -0.41 | 1-5 |
| QoS2 | 4.23 | 0.79 | -0.51 | -1.01 | 1-5 |
| QoS3 | 4.06 | 0.90 | -0.26 | -1.39 | 1-5 |
| QoS4 | 4.33 | 0.64 | -0.43 | -0.68 | 1-5 |
| QoS5 | 3.75 | 0.81 | -0.04 | -0.33 | 1-5 |
| QoS6 | 4.22 | 0.72 | -0.45 | -0.63 | 1-5 |
| **Personal Innovativeness** | | | | | |
| PInn1 | 4.51 | 0.64 | -0.95 | -0.18 | 1-5 |
| PInn2 | 4.37 | 0.71 | -0.68 | -0.75 | 1-5 |
| PInn3 | 4.40 | 0.69 | -0.94 | 0.53 | 1-5 |
| **Behavioural Intention** | | | | | |
| BI1 | 3.71 | 0.85 | -0.19 | -0.58 | 1-5 |
| BI2 | 3.69 | 0.76 | 0.20 | -0.66 | 1-5 |
| BI3 | 4.12 | 0.70 | -0.38 | -0.19 | 1-5 |
| BI4 | 3.78 | 0.73 | 0.27 | -0.90 | 1-5 |
| BI5 | 3.74 | 0.77 | 0.09 | -0.64 | 1-5 |

Many researchers indicated the benefit of the two-step approach rather than one-step (Kline, 2005; Hair et al., 2006; Schumacker and Lomax, 2010; Zarmpou et al., 2012). A measurement model specifies how measurement variables (observed) come together to underline the latent variables (constructs), while the structure model specifies the relationship between theoretical latent variables (Hair et al. 2006).

### 5.6.1 Measurement Model

An exploratory factor analysis was conducted at the beginning of the analysis using principle components extraction with Varimax rotation to extract six factors using SPSS 16. Confirmative factor analysis was then conducted using AMOS 16 to assess the measurement model in terms of factors loading, reliability of measures, convergent validity and discriminant validity.

Convergent validity can be evaluated using three criteria recommended by Fornell and Larcker (1981): (1) factor loading greater than 0.50 considered highly significant; (2) composite reliability should be greater than 0.8; (3) average variance extracted should exceed 0.5.

As shown in Table 5.5, the results indicate that all items fit their respective factors quite well. All the factor loadings are above the threshold of 0.50. Three items, including items PE4, QoS3 and QoS5 were eliminated due to to its standardized factor loadings value, which was less than 0.50. The Cronbach's alpha values range from .718 to .847, which are all over the .7 level. The composite reliability values (CR) were above 0.8 and the average extracted variances (AVE) were all above the recommended .5 level, thereby indicating good internal consistency (Fornell and Larcker, 1981).

To examine the discriminant validity, this study compared the square root of the average variance extracted for each construct and the correlation between this construct and any other construct (Fornell and Larcker, 1981). If the square root of the AVE of a construct is greater than the off-diagonal elements in the corresponding rows and columns, this reveals that each construct is more closely related to its own measurements than to those of other constructs (Fornell and Larcker, 1981). As shown in Table 5.6, the square roots of the AVE of all constructs are greater than the correlation estimate with the other constructs. In summary, the measurement model exhibits adequate reliability, convergent validity and discriminant validity.

**Table 5.5: Results for the measurement model**

| *Construct* | Factor extracted | Cronbach's alpha | Standardized factor loading | Squared multiple correlations | CR | AVE |
|---|---|---|---|---|---|---|
| *Performance expectancy* | 0.740 | | 0.721 | 0.520 | 0.8428 | 0.5027 |
| PE1 | 0.770 | 0.778 | 0.584 | 0.340 | | |
| PE3 | 0.750 | | 0.620 | 0.380 | | |
| PE5 | 0.810 | | 0.875 | 0.770 | | |
| PE2 | | | | | | |
| *Effort expectancy* | | | | | | |
| EE1 | 0.740 | | 0.627 | 0.390 | 0.9080 | 0.5371 |
| EE3 | 0.850 | 0.820 | 0.795 | 0.630 | | |
| EE4 | 0.810 | | 0.745 | 0.560 | | |
| EE2 | 0.820 | | 0.754 | 0.570 | | |
| *Lecturers' influence* | | | | | | |
| LI1 | 0.880 | | 0.850 | 0.720 | 0.883 | 0.602 |
| LI2 | 0.870 | 0.812 | 0.820 | 0.670 | | |
| LI3 | 0.800 | | 0.640 | 0.410 | | |
| *Quality of service* | | | | | | |
| QoS2 | 0.840 | | 0.790 | 0.620 | 0.830 | 0.500 |
| QoS4 | 0.740 | 0.718 | 0.600 | 0.360 | | |
| QoS6 | 0.710 | | 0.640 | 0.410 | | |
| QoS1 | 0.700 | | 0.710 | 0.500 | | |
| *Personal innovativeness* | 0.910 | | 0.910 | 0.830 | 0.920 | 0.670 |
| PInn2 | 0.890 | 0.847 | 0.840 | 0.710 | | |
| PInn1 | 0.820 | | 0.680 | 0.460 | | |
| PInn3 | | | | | | |
| *Behavioural intention* | | | | | | |
| BI2 | 0.840 | 0.834 | 0.730 | 0.530 | 0.890 | 0.507 |
| BI1 | 0.790 | | 0.680 | 0.460 | | |
| BI5 | 0.780 | | 0.750 | 0.560 | | |
| BI4 | 0.760 | | 0.700 | 0.490 | | |
| BI3 | 0.700 | | 0.700 | 0.490 | | |

*CR: Composite Reliability, AVE: Average Variance Extracted*

**Table 5.6: Correlation Matrix and Discriminant Validity**

| Variables | PE | EE | LI | QoS | PI | BI | Mean | SD |
|---|---|---|---|---|---|---|---|---|
| PE | **0.709** | | | | | | 3.67 | 0.57 |
| EE | 0.448 | **0.732** | | | | | 3.88 | 0.56 |
| LI | 0.301 | 0.489 | **0.776** | | | | 3.96 | 0.66 |
| QoS | 0.399 | 0.500 | 0.461 | **0.707** | | | 4.08 | 0.50 |
| PI | 0.316 | 0.426 | 0.324 | 0.454 | **0.819** | | 4.42 | 0.59 |
| BI | 0.553 | 0.672 | 0.490 | 0.493 | 0.565 | **0.712** | 3.81 | 0.59 |

The bold numbers on the diagonal represent the square root of AVE; off-diagonal elements are the correlation estimates. Correlation is significant at the 0.01 level (2-talied).

### 5.6.2 Structural Model and hypotheses testing

Before testing the hypotheses, the Maximum Likelihood Method was used to conduct the analysis through obtaining a number of goodness of fitness indices for the model fitness. The early model-fit indices shown that chi square ($\chi 2$) value was 22.65 (df =10, p= 0.012), comparative fit index (CFI) was 0.38, and the root mean square residual (REMSA) was 0.26, which indicates poor-fit indices which indicates that there is a room for refinement. Figure 5.2 shows the proposed structural model.

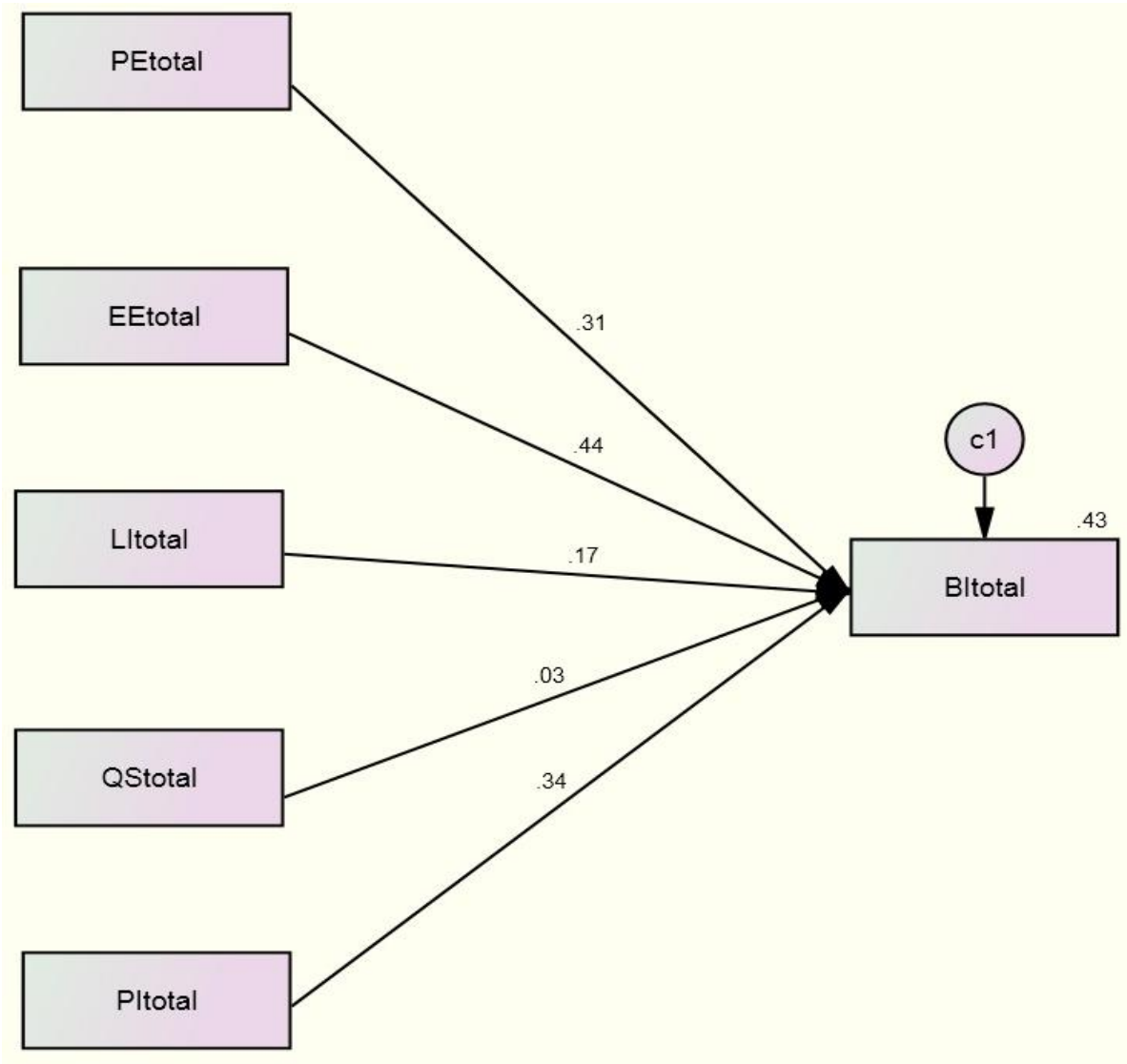


**Figure 5.2: Proposed Structural Model**

After checking the modified indices, positive correlations were created between independent variables to enhance the study model, as shown in Table 5.7.

**Table 5.7: Correlation Created after Modification of Indices**

| | | | Estimate |
|---|---|---|---|
| LI | ↔ | QoS | .461 |
| PE | ↔ | EE | .243 |
| QoS | ↔ | PI | .454 |
| EE | ↔ | LI | .442 |
| EE | ↔ | QoS | .430 |
| EE | ↔ | PI | .373 |
| LI | ↔ | PI | .324 |

The overall goodness-of-fit were examined at another time and achieved the following results. Table 5.8 shows model-fit indices and as well as the recommended threshold

**Table 5.8: Model-Fit Indices**

| Fit indices | Recommended value | Values obtained |
|---|---|---|
| $\chi 2$/d.f | ≤ 3.00 | 1.01 |
| GFI | ≥ 0.90 | 0.939 |
| AGFI | ≥ 0.80 | 0.942 |
| NFI | ≥ 0.90 | 0.901 |
| CFI | ≥ 0.90 | 0.998 |
| TLI | ≥ 0.90 | 0.990 |
| RMSEA | ≤ 0.08 | 0.027 |

($\chi 2$/d.f) the ratio of chi square to degree of freedom , GFI, goodness-of -fit index, AGFI adjusted goodness - of-fit , NFI, normalized fit index , CFI, comparative fit index, RMSR, the root mean square residual.

As shown in Table 5.8, all model-fit indices exceeded their respective common acceptance level, as suggested by previous research; the measurement model exhibited a fairly good fit with the data collected. So, we can carry on testing the model hypothesis.

We proposed to examine the path coefficient of the structure model. Table 5.9 shows presents the results of the model testing, including the standardized regression coefficient and the critical ratio. The findings indicated significant support for all hypotheses: H1, H2, H3, H4, H5 were all supported; all performance expectancy, effort expectancy, lecturers'

influence, quality of service and personal innovativeness had a positive effect on behavioural intention to use M-learning, with (β=.273, .37, .23, .25, .30) respectively (P < 0.05). Effort expectancy was found to be the most influential predictor of mobile learning acceptance (β=.37), and lecturers' influence was found to be the lowest influential predictor of mobile learning. The model tested in this study accounted for 55.0% of behavioural intention to use M-learning. Figure 5.3 shows the results for the revised model.

**Table 5.9: Path Coefficients and t-values of the Hypotheses**

| The relationship or path | Standardized regression coefficient | Critical ratio or (*t*-value) | P-value | Significance |
|---|---|---|---|---|
| PE→BI | 0.273 | 2.1(>1.96) | 0.02 | Yes |
| EE→BI | 0.37 | 2.20 | 0.01 | Yes |
| LI→BI | 0.23 | 1.98 | 0.03 | Yes |
| QoS→BI | 0.25 | 2.05 | 0.02 | Yes |
| PI→BI | 0.30 | 2.08 | 0.02 | Yes |

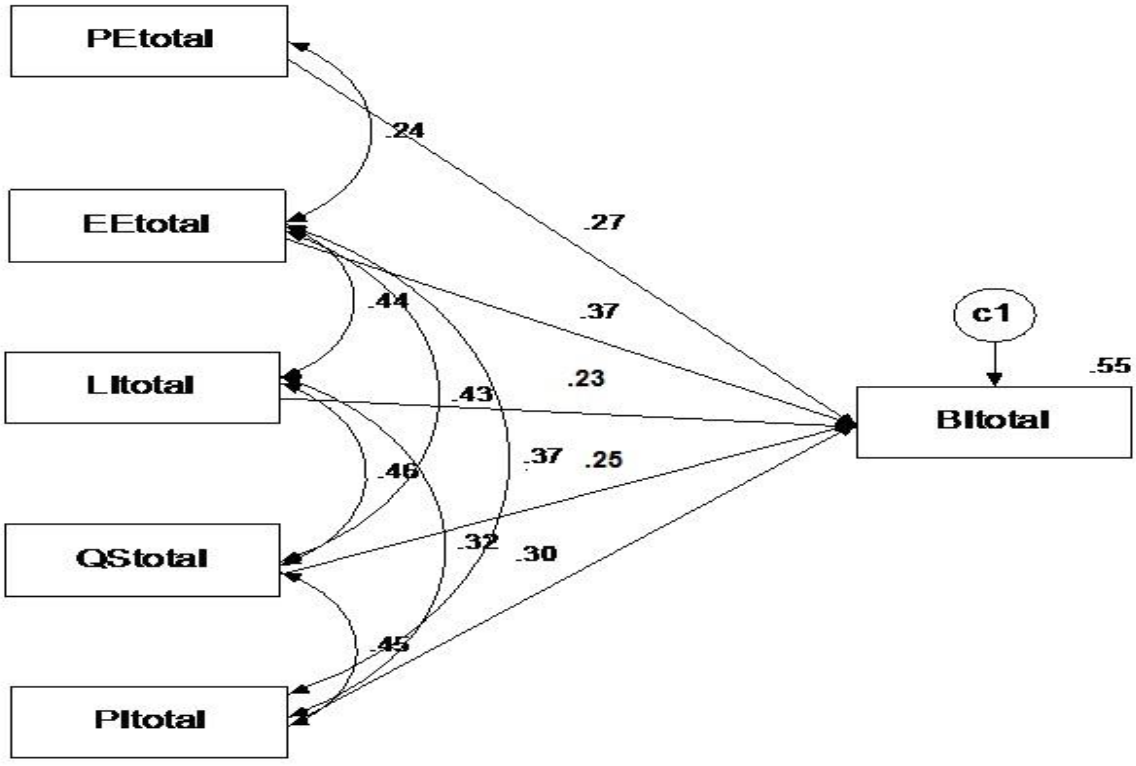


**Figure 5.3: Revised Structural Model**

### 5.6.3 Influences of Moderator Variable

The effect of students' prior experience of mobile devices as moderators in the acceptance of M-learning is clear. In order to find out about the impact of moderators on the influence of determinants toward behaviour intention, two groups of hypotheses were using AMOS' multiple-group analysis. The objective of comparing between or among groups is to investigate whether there are any significant differences between or among them. If these groups (experiences) are not significantly different, this suggests that the experience moderator (two groups: less than 3 years' experience compared to more than 3 years' experience) does not affect the influence of predictors toward behaviour intention.

To explore the experience differences, we divided the survey respondents into two groups: group one with three years or less experience, and group two more than three years' experience. Four AMOS model comparisons were carried out to examine factor invariance between the two groups, as shown in Table 5.10.

The ratio between chi square value (CMIN) and the degrees of freedom (DF) fell out of the acceptable range (0-2) for all four models, as shown in Table 5.10, except for the unconstrained and structural weights models. The values of CMIN/DF were 2.12, and 2.31, which are more than 2, and this means that both models have a significant difference due to mobile devices experiences. This test indicates that the model has an invariant across the two sample groups (less than three years' experience compared to more than three years' experience).

**Table 5.10: Chi Square Fit statistic for the Tested Models**

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Unconstrained | 36 | 12.75 | 6 | 0.042 | 2.12 |
| Structural weights | 31 | 25.41 | 11 | 0.033 | 2.31 |
| Structural co-variances | 19 | 5.666 | 23 | 1.000 | .246 |
| Structural residuals | 18 | 5.736 | 24 | 1.000 | .239 |
| Saturated model | 42 | .000 | 0 | | |
| Independence model | 12 | 31.817 | 30 | .376 | 1.061 |

Running the structural model estimates for each group separately resulted in the following fit statistics for the less than three years' experience group: CMIN/df ratio = 1.76; CFI = .94; RMSEA = .004; NFI = 0.92; GFI = 0.94; TLI = 0.94; and the model accounts for 54%

of the variance in behavioural intention. For the second experiences group (more than three years' experience) the fit statistics of CMIN/df ratio = 1.98; CFI = .96; RMSEA = .02; NFI = 0.95; GFI = 0.95; TLI = 0.96; and the model accounts for 65% of the variance in behavioural intention. This indicates adequate fit indices for each group separately.

Having established an acceptable model fit for both groups, the next step was to run the multiple group covariance analysis. The estimates (coefficients) output and critical ratio (t-value) are reported in Table 5.11.

**Table 5.11: Structural Weights for two Groups of Mobile Devices Experiences**

| | **<3 years, n =111** | | | **>3 years , n= 63** | | |
|---|---|---|---|---|---|---|
| | **Estimate** | ***t*-value** | **P** | **Estimate** | ***t*-value** | **P** |
| PE → BI | 0.26 | 2.81 | 0.01 | 0.34 | 2.82 | 0.01 |
| EE → BI | 0.41 | 4.69 | 0.00 | 0.33 | 2.73 | 0.01 |
| LI → BI | 0.28 | 3.04 | 0.00 | 0.24 | 1.97 | 0.05 |
| QoS → BI | 0.22 | 2.35 | 0.02 | 0.30 | 2.45 | 0.01 |
| PI → BI | 0.26 | 2.81 | 0.01 | 0.25 | 1.98 | 0.05 |

As indicated in Table 5.10, the structural weights for the first experience group (i.e. three year experience or less) were statistically significant for all links in the model PE-BI. EE-BI, LI-BI, QoS-BI and PI-BI ($P < 0.05$); the structural loading values were 0.26, 0.41, 0.28, 0.22 and 0.26, respectively.

On the other hand, for the second group (i.e. more than three years' experience), the structural weights for the PE-BI, EE-BI, LI-BI, QoS-BI and PI were all statistically significant ($P < 0.05$); the structural loading values were 0.34, 0.33, 0.24, 0.30 and .25, respectively.

## 5.7 Discussion

The purpose of this study was to investigate the factors that affect student behavioural intention towards the adoption of M-learning in higher education. Based on UTAUT and consistent with prior studies, this study extends the use of UTAUT in the acceptance of M-learning context by adding two constructs to the original model: quality of service and

personal innovativeness, and to explore if prior experience of mobile devices differences influences acceptance of this new technology.

The results indicate that the proposed model adequately explains and has the ability to predict student behavioural intention to adopt M-learning. Performance expectancy, effort expectancy, lecturers' influence, quality of service and personal innovativeness were all significant determinants of behavioural intention to adapt M-learning. In addition, the two suggested constructs (quality of service and personal innovativeness) were significant for all students' responses ($\beta$= 0.25, P < 0.05 and $\beta$= .30, P < 0.05, respectively).

Consistent with previous research in the field of technology acceptance, performance expectancy and effort expectancy have a significant, positive influence on behavioural intention to use M-learning (Vankatesh et al., 2003; Jairak, Praneetpolgrang and Mekhabunchij, 2009; Wang, Wu and Wang, 2009). Performance expectancy was found to significantly influence behavioural intention to use M-learning (Wang, Wu and Wang 2009; Chong et al., 2011). It seems that students' with high performance expectancy (who believe that using an M-learning system will be beneficial to them in their studies) have a tendency to accept M-learning rather than students' with lower performance expectancies. Effort expectancy was also proven to be a significant influence on student intention to use M-learning (Wang, Wu and Wang 2009; Liu, Li and Carlsson, 2010; Chong et al., 2011). The results of the study indicate that effort expectancy was the strongest predictor of behavioural intention to use M-learning ($\beta$= 0.37). This result means that university students who feel that M-learning is easy to use are more likely to adopt and use it in their studies.. This indicates that M-learning designers should provide higher education with easy to operate and user-friendly M-learning applications (Wang, Wu and Wang, 2009,).

Lecturers' influence, which derived from social influence, was found to have a significant effect on behavioural intention to use M-learning. As the study investigates the acceptance of M-learning in universities, the impact of social influence from the lecturers' perspective was investigated. Lecturers' acceptance and their attitude toward M-learning influence their students' ideas about this new technology and will motivate them to adopt it (or not). Furthermore, lecturers can introduce M-learning to early adopters who like to improve their personal innovation in IT more than others (Agarwal and Prasad, 1998). This is in agreement with previous research results (Igbaria, Schiffman and Wieckowski 1994; Karahanna and Straub, 1999). However, it should be noted that studies suggesting this strategy are relatively dates, and came prior to the widespread deployment and use of the

internet from the late 1990s onwards; it can be assumed that the vast majority of current students in higher education worldwide already possess relatively advanced IT skills and readiness.

Quality of service was also found to be a significant influence on behavioural intention to adopt M-learning as students will be willing to adopt an M-learning system when the quality of service being provided is perceived as being good and beneficial for their studies. Furthermore, educations institutes and M-learning applications designers need to consider the quality of service while designing learning materials, including interface design, reliability, accessibility and interactivity of the system. The overall quality of service will increase the learners' satisfaction, where the last has positive influence on behavioural intention to use M-learning. This supports the findings of previous studies (Al-Mushasha and Hassan, 2009; Chong et al., 2011; Park, Nam and Cha, 2011).

Personal innovativeness, which refers to the individual willingness to adopt new technology, was also found to have a significant influence on behavioural intention to use M-learning. This suggests that an effective strategy should be devised to motivate students at the early stage of the adoption of M-learning, which was also suggested by previous studies (Liu, Li and Carlsson, 2010; Zampou et al., 2012).

Finally, the results indicate that significant experience differences exist in terms of the effects of the constructs on behavioural intention. Students' experience of mobile devices moderates the effects of effort expectancy, lecturers' influence, quality of service and personal innovativeness on behavioural intention. The results also found that effort expectancy, lecturers' influence and personal innovativeness are stronger predictors of M-learning acceptance for students with three years or less of mobile devices experience rather than the students with more than three years of mobile devices experience. This is in agreement with Vankatesh et al. (2003), who found that effort expectancy and social influence will influence the behavioural intention for IT usage stronger at an early stage of experience. However, quality of service on the acceptance of M-learning was found to be a stronger determinant of the second group (more than three years of experience) than the three years or less of mobile devices experience.

## 5.8 Conclusion

This study investigated the factors influencing university students' intention to use M-learning and indicated how mobile devices experience moderates the influence of these

factors on behavioural intention. The results show that 55% of the intention to accept M-learning in higher education context was explained by the proposed model. All factors in the proposed model (performance expectancy, effort expectancy, lecturers' influence, quality of service and personal innovativeness) were found to have significant influence on behavioural intention to use M-learning. The study has also showed the applicability of UTAUT in explaining students' acceptance for M-learning. Furthermore, it extends the UTAUT in the context of M-learning by adding quality of service and personal innovativeness to the structure of UTAUT. The effects of effort expectancy, lecturers' influence and personal innovativeness were stronger for students with three years or less of experience than ones with more three years of experience. However, the effect of quality of service was found to be stronger for the second group (more than three years of experience) than for those with three years or less of experience.

As M-learning still in its relatively early stage of implementation, it is important for practitioners and educators to understand what factors make students accept or oppose this new technology. As with any technology, M-learning needs to be easy to use and access, and it has to enhance students' performance expectancy. University students might accept M-learning if they think this technology will help them in future employment. Therefore, universities have to motivate students (especially those unfamiliar with mobile devices) about the benefit of M-learning in university studying.

Lecturers and faculty members have a significant influence on students' acceptance of M-learning. Therefore, there is a need to motivate university lecturers, increase their awareness towards M-learning and provide them with sufficient training. In addition, personal innovativeness has been found to be a strong factor which affects behavioral intention to use M-learning, as innovative students usually have positive beliefs toward using new technology. Furthermore, the quality of service offered by M-learning system needs be user-friendly in order attract more students to use M-learning.

In conclusion, the results indicate that higher education institutions need to develop strategic plans and provide guidelines considering students' acceptance in order to include all critical success factors for the sustainable deployment of M-learning. The results of this study can provide insight into what factors need to be considered for designing an M-learning system in higher education.

# CHAPTER 6: TOWARD A SUSTAINABLE DEPLOYMENT OF M-LEARNING – A CONCEPTUAL MODEL IN HIGHER EDUCATION

## 6.1 Overview

The results obtained from chapters four and five reveal that M-learning implementation faces some challenges and obstacles in terms of management adoption, lecturers' attitudes, technical support and quality of services to offer. Therefore, there is a need for more effort from universities, lecturers and students in order to overcome all these challenges and ensure the success of M-learning system.

The main objective of this study presented in this chapter is to develop and evaluate a sustainable M-learning deployment model for higher education with pre- and post-deployment stages. Including all key issues and critical success factors that are essential to ensure successful deployment. In this chapter a discussion of the research methodology conducted in this study is provided, followed by an explanation of the statistical technique. Finally, the results of the data analysis are presented followed by discussion of the findings and conclusion.

## 6.2 Research Methodology

This section covers the creation, components and evaluation of the proposed conceptual deployment model proposed in this paper.

### 6.2.1 Methodology for Creating the Conceptual Model

The Model has been designed based on an analysis of the existing literature on M-learning implementation, as well as the results obtained from two previous studies undertaken by the researcher and collaborators to determine the student readiness for mobile learning (Abu-Al-Aish, Love and Hunaiti, 2012) and to investigate the factors that affect students' acceptance of M-learning (Abu-Al-Aish and Love, 2013).

The conceptual model for M-learning deployment is a road map that will guide higher education institutes towards a seamless deployment of an M-learning environment. The model consists of two stages, pre- and post-deployment stages, and will not contain a fully

implemented M-learning service. However, the model will utilize M-learning as a part of an E-learning system. The model is described in Figure 6.1.

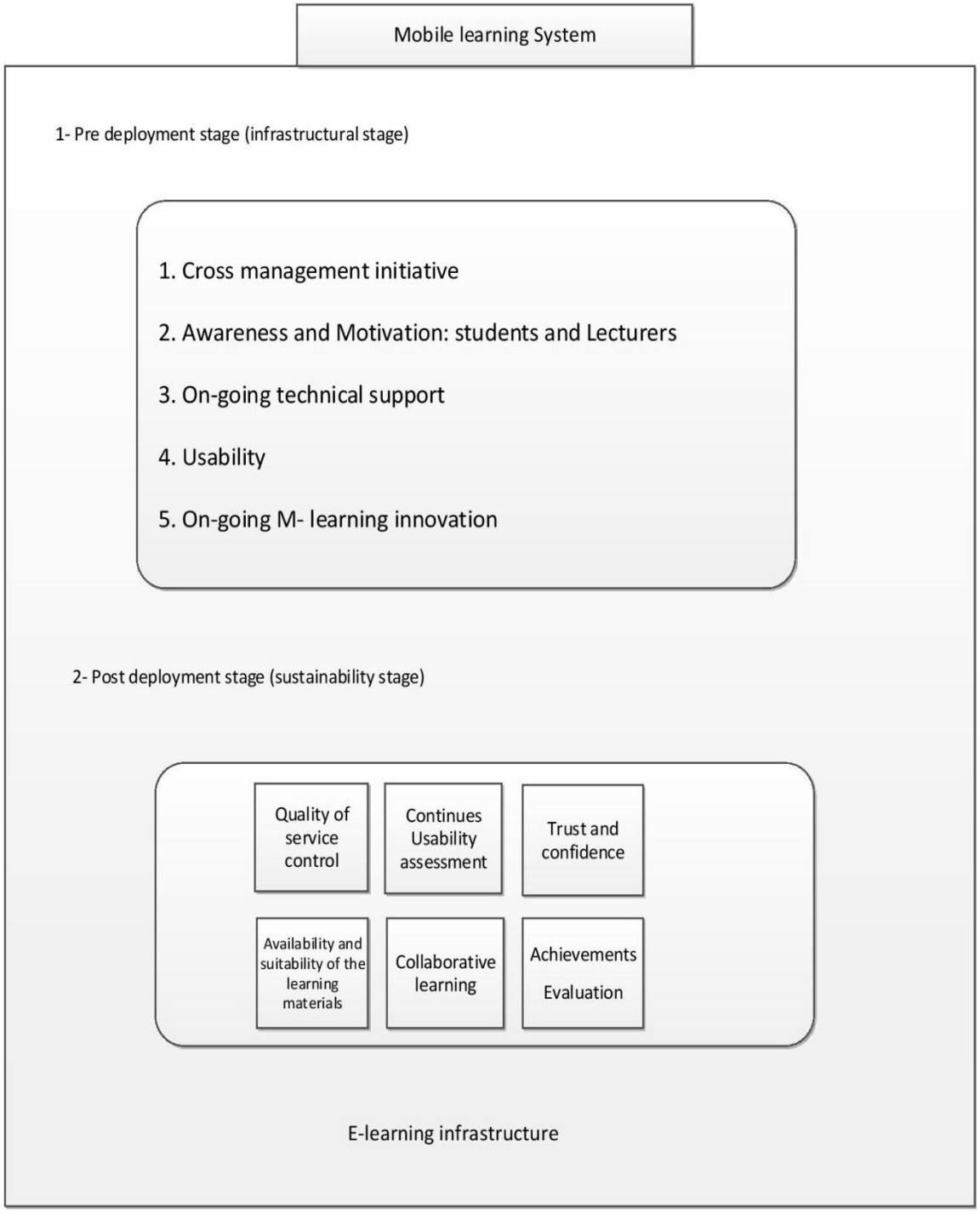


**Figure 6.1: Initial Proposed Model Presented for Evaluation**

### 6.2.2 Model Components

*1. Cross-management initiative and support*

Introducing mobile learning in any organization will customarily face change resistance. Therefore, there is a need of a buy-in from top management to allocate resources to support

the project. West and Schofield (2012) indicated that university management needs to adopt the initial strategy design for M-learning. Naismith and Corlett (2006) pointed out that successful mobile learning projects need good institutional support, well-designed plans and the provision of sufficient resources in terms of training staff and providing technical support. Furthermore, university management has to support the creation of learning resources, assess students' usability and conduct course evaluation in order to examine students' perceptions of success (Marshall and Mitchell, 2002).

*2. Awareness and motivation: students and lecturers*

Both students and lectures should be aware of the benefits and the uses of any M-learning application before they are asked to start using that application. Motivation refers to the extent to which the M-learning environment motivates students to engage with their learning and supports lecturers to develop innovative ways of using the devices to complement traditional teaching methods (Barker et al., 2005).

*3. On-going technical support*

M-learning is an advanced system integrating multiple technologies (mobile devices, wireless network etc.), therefore there is a need to provide technical support for the users. Support is needed to deal with device failures and provide on-going system improvement. Furthermore, this technical support should be provided to all end users (both lecturers and students) (West and Schofield, 2012).

*4. Usability and continuous assessment*

Howarth, Smith-Jackson, and Hartson (2009) defined usability as the effectiveness, efficiency, and satisfaction with which users of a certain application are capable of achieving specific goals. Nielsen (1993) indicated that usable systems need to be easy to learn (learnability), efficient to use (efficiency), easy to remember (memorability), not error-prone (errors) and satisfactory in use (satisfaction). Usability assessment of mobile technology and the effectiveness of its blending with the mobile learning remains a high priority to evaluate the success of the system (Vavoula and Sharples, 2009).

*5. On-going M-learning innovation*

One requirement for deploying a new learning system is that the system needs to accommodate and involve the fast developments in the world of mobile technology (Emerging Practice in a Digital Age Case Studies, 2011b). M-learning is a vital technology

and it is continually being developed and becoming more advanced; due to numerous research interests and the attraction from an incredible number of developers, it is changing rapidly all the time and it becomes difficult to rely on one supported device, as mobile devices differ in screen size, memory and flash technology. Therefore, there is a need to find mobile learning solution that can be compatible with several device types. Furthermore, universities should choose a platform (i.e. Adrroid, Apple iOS) which is suitable for its training and learning and teaching programme (Heiphetz, 2011).

*6. Quality of service control*

Users of any technology are affected by the quality and nature of the service. Therefore, controlling the quality of M-learning service will maintain and improve the service that M-learning has to offer. Moreover, it is necessary to provide a quality management process for M-learning systems in order to ensure a certain degree of quality (Pocatilu and Boja, 2009).

Quality of M-learning service need to be assessed from both technical and pedagogical aspects. There are a number of characteristics that can be used to assess M-learning quality of service from the technical side, such as mobility, reliability, network connectivity and speed of wireless connection. The format of M-learning content needs to be compatible and work across the different types of mobile platforms. From a pedagogical perspective, M-learning services need to provide a pedagogical design suitable for learner types and needs, and must furnish users with up to date content and be highly interactive (Parsons and Ryu, 2006).

*7. Trust and confidence*

Trust and confidence within M-learning management itself and between management and lecturers as well as between students and lecturers is very important in maintaining the sustainability of the system. Trust also activates the communication between the stakeholders increases their willingness to share ideas and open up communication channels between them. In addition, trust will allow students to share some responsibility for the devices being used in order to allow them to participate in effective formal learning (Ng and Nicholas, 2012).

*8. Availability and suitability of the learning materials*

It is important to make learning materials available for M-learning. Furthermore, it is also vital to think about structuring the learning materials and define what is suitable for mobile devices (West and Schofield, 2012). Learning materials designers need to consider the methods of how learners can actually learn and what different types of learning they have used. More attention has to be paid to examining the curriculum and deciding the best way to involve the learning application with that curriculum (McEwan and Cairncross, 2004).

M-learning materials need to be interactive, highly visual, engaging, effective for learners and easy downloadable by the students whenever they have the chance to engage in some learning activities (Bradley et al., 2009). In addition, there is a need to ensure that the learning materials contain face-to-face sessions and provide the learning process with additional examples, explanation and feedback questions (Gedik et al., 2012). Furthermore, there is also a need to construct suitable learning materials that are pedagogically rich, offering meaningful learning experience and facilitate the successful transfer of the required knowledge (Al-Bahadili, Issa and Abuhamdeh, 2011).

*9. Collaborative learning*

Collaborative learning is considered as one of the most important motivating factors for the successful use of mobile technologies in education. Zurita and Nussbaum (2004) indicated that collaborative learning using wireless technology can avoid the weaknesses in coordination, communication, organisation, negotiation, interactivity, and mobility that can occur in the more traditional learning processes. Collaborative learning components are considered as critical success factors that determine the successful adoption of mobile learning (Barker et al., 2005). Collaboration and communication are very important in an educational context. Students should communicate between themselves and with their lecturers to complete the learning chain.

*10. Achievements and evaluation*

Achieving goals is a big factor that motivates learners. Traxler and Kukulska-Hulme (2005) indicated that achievement and evaluation analysis are key to the sustainability of mobile learning for several reasons; first, achievement and evaluation test the effectiveness of M-learning projects. Second, it provides some indicators about the benefit and cost success of the projects. Marshall and Mitchell (2002) indicated that feedback collected from end of course evaluations helps in updating the tools and techniques used in the

learning system, ensures continual improvement and allows learning results to be the main factors for any new project. McEwan and Cairncross (2004) highlighted that the evaluation of using learning applications needs to be monitored as on-going process. This will provide lecturers with better understanding of how best way to utilize new learning technologies in their classroom.

## 6.4 Pilot Study

A pilot study was conducted for both students and lecturers in order to assess the validity and reliability of the questionnaire constructs.

### 6.4.1 Students' Pilot Study

The students' questionnaire was pilot tested to evaluate its construct validity and reliability. The questionnaire was pilot tested with 12 students from School of Information Systems, Computing and Mathematical Science. Table 6.1 provides the demographic data from students in the pilot study. The reliability of the data from pilot study was assessed using Cronbach's alpha. Table 6.2 presents the results of the reliability alpha.

As shown in Table 6.2, all Cronbach's alphas exceed 0.70 for all constructs. This reveals the consistency between the multiple measurements of each construct (DeVellis, 2003; Sekaran, 2000; Hair et al., 2010). In addition, some items were reworded and adjusted. The results of the pilot study allowed the researcher to go further for the main study.

**Table 6.1: Students' Demographical Data from the Pilot Study**

| Variable | Frequency | Percentage |
|---|---|---|
| *Gender* | | |
| Male | 8 | 66.7 |
| Female | 4 | 33.3 |
| *Use of M-learning* | | |
| Yes | 6 | 50.0 |
| No | 6 | 50.0 |
| *M-learning knowledge* | | |
| Poor | 4 | 33.3 |
| Moderate | 3 | 25.0 |
| Good | 4 | 33.3 |
| Very good | 1 | 8.3 |

**Table 6.2: Cronbach's Alpha for Each Construct**

| Scale construct | Number of items | Cronbach's alpha |
|---|---|---|
| On-going technical support | 3 | 0.72 |
| On-going mobile learning innovation | 3 | 0.78 |
| Teaching and learning specialists support | 3 | 0.74 |
| Cross management initiative | 3 | 0.77 |
| Quality of service control | 3 | 0.75 |
| Usability assessment | 4 | 0.79 |
| Collaborative learning | 3 | 0.80 |
| Trust and Confidence | 3 | 0.74 |
| Achievements Evaluation | 3 | 0.76 |
| Availability and suitability of learning materials | 3 | 0.84 |

### 6.4.2 Lecturers' Pilot Study

A small-scale pilot study consisting of five graduate teaching assistants who do teaching in Brunel University was carried out prior to conducting survey research with lecturers, in order to test the feasibility of the chosen research design and methods for the survey.

Participants were asked to fill in the questionnaire then to complete a short form to find out if the instructions were clear, if all questions were clear and to add any comments. Based on the pilot study findings, it was clear that the research methods were feasible and no modifications were implemented.

## 6.5 Model Validation

The proposed model was validated by a sample of students and lecturers in Brunel University, UK.

### 6.5.1 Participants

148 students and 28 lecturers took part in this study, which was conducted at the end of the academic year 2012/2013 at Brunel University, UK, which University is implementing the E-learning system in all of its departments.

### 6.5.2 Research Instrument

Two questionnaires were designed for both students and lecturers to evaluate and refine the proposed conceptual model. The items of the questionnaire were derived from related research area which investigates the challenges, assessing and promoting the implementation of M-learning and E-learning in higher education (Traxler and Kukulska-Hulme, 2005; Holsapple and Lee-Post, 2006; Demirkan, Goul and Gros, 2010; Kalyani, Pandeya and Singh, 2012; Ng and Nicholas, 2012). The students' questionnaire consisted of three parts. Part one contained a brief description of the research, and how the model was constructed. Part two contained questions about the participants' demographic information (i.e. gender, age), usage of M-learning and M-learning knowledge. Part three contained 34 questions answerable with a five-point Likert scale, ranging from 1-Strongly Disagree to 5-Strongly Agree, to investigate students' thoughts about the factors that affect the deployment of M-learning (e.g. the interface design of the M-learning system needs to attract the learners' attention).

The lecturers' questionnaire consisted of four parts. Part one explained the aims and the objectives of the research, part two consisted of general questions about the lecturers (positions, experience and familiarity with M-learning), part three contained eleven questions answerable with a five-point Likert scale to evaluate the pre- and post-deployment stages of M-learning (i.e. the successful deployment of an M-learning system needs support from all levels of university management), and part four consisted of eleven Likert-type questions as a general evaluation of the model (i.e. the proposed framework will support the continuous updating of M-learning systems and services). In addition, two open-ended questions were added to both students' and lecturers' questionnaires in order to encourage the participants to express their opinions about the obstacles that might face the University when deploying this technology in its teaching and learning, and also to add any other factors in accordance to their departments or end-user need which might affect the deployment of M-learning.

### 6.5.3 Procedure

The students' questionnaire was distributed to second-year students in the School of Information, Computing and Mathematical Science, Brunel University. Students from different classes were invited to participate and complete the questionnaire in their class, and the researcher gave a brief description about the research objectives, the definition of

M-learning and its benefits before students filled in the questionnaire. Also, students were informed that all the data and participants' details would be kept anonymous, and that they could withdraw at any time from the study. In addition, to get more participants for the study, the same questionnaire was sent online to all undergraduate students of the same school.

As this research is considering M-learning as complementary and extension to the existing e-learning system, those people with e-learning experience would be able to indicate and reflect on the propose idea of M-learning.

For the lecturers' questionnaire, a presentation for the proposed model was designed in PowerPoint which explained the objective of the research, findings from previous studies, the methodology for creating the model and the model itself. The final lecturers' questionnaire consisted of 22 items; five items measuring the constructs of the pre-deployment stage (infrastructure stage), six items for the post-deployment stage (sustainability stage), and eleven items to evaluate the whole model. In addition, the two open-ended questions left a free space to encourage the lecturers to write their suggestions and recommendations. The presentation and the link for the questionnaire were sent by email to the lecturers.

## 6.6 Data Analysis and Results

The questions and their responses were coded and analysed using SPSS Version 16.

### 6.6.1 Students' Results

A total number of 148 students from the School of Information, Computing and Mathematical Science participated in the study. As shown in Table 6.3, 61.4% of respondents were male and 38.5% were female, with ages between 18 and 28. Half of the participants came from Computer Science and the remained came from subjects related to Information System and Mathematics. 61.2% of the participants declared that they utilized M-learning in their studies, and the majority of them described their knowledge in M-learning as moderate to good.

Cronbach alpha test was conducted in order to assess the reliability of the obtained data. Cronbach alpha values are, however, quite sensitive to the number of items in the scale. When dealing with a short scale (e.g. scales with less than ten items), it is common to find low values for Cronbach's alpha. In this case, it may be better to examine the mean inter-

item correlation for the items. Briggs and Cheek (1986) recommend an optimal range for the inter-item correlated of 0.2 to 0.4 (Pallant, 2010). For the students' questionnaire there were 34 items measuring 11 scales, with 3 items for each scale. The results of inter-item correlation for each scale are reported in Table 6.4.

**Table 6.3: Demographic Data of Students**

| Characteristic | Frequency | Percent |
|---|---|---|
| *Gender* | | |
| Male | 91 | 61.5 |
| Female | 57 | 38.5 |
| *Age* | | |
| <20 | 34 | 22.9 |
| 20-22 | 95 | 64.2 |
| 22-28 | 19 | 12.9 |
| *Course* | | |
| BC | 16 | 10.8 |
| CS | 77 | 52.0 |
| FC | 5 | 3.4 |
| FM | 3 | 2.0 |
| IS | 28 | 18.9 |
| MA | 19 | 12.8 |
| *Using M-learning* | | |
| Yes | 91 | 61.5 |
| No | 57 | 38.5 |
| *M-learning knowledge* | | |
| Very poor | 4 | 2.7 |
| Poor | 22 | 14.9 |
| Moderate | 48 | 32.4 |
| Good | 60 | 40.5 |
| Very good | 14 | 9.5 |

BC: Business Computing, CS: Computer Science, FC: Financial Computing, FM: Financial mathematics, IS: Information Systems, MA: Mathematics.

**Table 6.4: Mean, Standard deviation and Inter-Item Correlation of Students' Questionnaire**

| | Items | Mean | Standard Deviation | Inter-Item Correlation |
|---|---|---|---|---|
| 1. | M-learning needs support from university management to be a success. | 4.0946 | .63179 | 0.461 |
| 2. | University management has to provide the appropriate structure to manage M-learning content and infrastructure | 3.9797 | .62237 | |
| 3. | University management needs to work with other educational institutions to develop workable mobile learning policies. | 3.9459 | .73571 | |
| 4. | Teaching and learning specialists should raise awareness between students and lecturers of M-learning and provide them with the appropriate skill to use it. | 3.9662 | .61074 | 0.330 |
| 5. | Teaching and learning specialists need to design a range of learning activities that engage and motivate students in their study. | 4.2905 | .64157 | |
| 6. | Teaching and learning specialists should develop learning objects to help lecturers in deploying M-learning within their teaching and learning strategies. | 4.0203 | .66465 | |

| | Items | Mean | Standard Deviation | Inter-Item Correlation |
|---|---|---|---|---|
| 7. | Students need prompt and effective technical support as required when using the M-learning system. | 3.9459 | .65760 | 0.344 |
| 8. | The technical infrastructure should make course materials available on students' mobile devices**.** | 4.4595 | .59907 | |
| 9. | There should be on going technical support to maintain M-learning tools and service delivery. | 4.2500 | .61583 | |
| 10 | The University needs to keep up-to-date on changes in M-learning technology provision. | 4.3176 | .74721 | 0.378 |
| 11. | The university should upgrade the M-learning system when it is necessary. | 4.2973 | .61123 | |
| 12. | The university should work with mobile technology companies to develop learning applications suitable for on-going changes in learning and teaching styles. | 4.0000 | .69985 | |
| 13. | The M-learning system should be easy to use. | 4.6014 | .55622 | 0.384 |
| 14. | The interface design of the M-learning system needs to attract the learners' attention. | 4.3514 | .58163 | |
| 15. | The M-learning system interface should facilitate learning. | 4.4122 | .58238 | |
| 16. | The assessment of M-learning usability in terms of accessibility, interactivity and interface design will affect the success of M-learning deployment | 4.3581 | .58333 | |
| 17. | It is important to control the quality of the M-learning service in order to ensure the success of the system deployment. | 4.2838 | .54761 | 0.283 |
| 18. | The quality of M-learning service needs to be defined at the right level for diverse students groups. | 4.1216 | .64845 | |
| 19. | The quality of the M-learning service needs to be up to date and meet students' needs. | 4.5068 | .58898 | |
| 20. | The M-learning system should provide a collaborative learning environment between students and lecturers. | 4.0676 | .60229 | 0.358 |
| 21. | Effective communication between students and lecturers will increase by using an M-learning system. | 3.8378 | .89636 | |
| 22. | The M-learning system should enable students to provide feedback on their teaching and learning experiences. | 3.8514 | .84407 | |
| 23. | Enhancing trust and confidence among members of the M-learning management team as well as between teachers and students will improve people's willingness to use the M-learning system. | 3.7162 | .72881 | 0.289 |
| 24. | Every person involved in the M-learning system should have some form of ownership of the system. | 3.4054 | .71750 | |
| 25. | A level of trust between all M-learning system users will open up communication and increase the sharing information. | 3.7297 | .68606 | |
| 26. | M-learning outcomes need to be reviewed regularly to ensure that stated goals and learning objectives are being met. | 4.0135 | .58305 | 0.375 |
| 27. | Course evaluations should be conducted in order to check student perceptions of M-learning. | 3.8243 | .72578 | |
| 28. | The M-learning system should be regularly monitored to see if it has become embedded as on-going provision in the university. | 3.9797 | .73280 | |
| 29. | Making M-learning materials more engaging and suitable for learning and teaching will improve the sustainability of M-learning. | 4.1554 | .61404 | 0.340 |
| 30. | M-learning Materials should be designed to enhance the learning experience and meet learning outcome requirements. | 4.2703 | .65564 | |
| 31. | M-learning content needs to be readily available in formats that are easily accessible from various types of | 4.5811 | .59492 | |

| | Items | Mean | Standard Deviation | Inter-Item Correlation |
|---|---|---|---|---|
| | mobile devices. | | | |
| 32. | M-learning system can be easily implemented within the current E- learning system strategy. | 3.9189 | .64432 | 0.447 |
| 33. | Blending M-learning into the E-learning platform will minimize university resistance. | 3.5608 | .68240 | |
| 34. | Blending M-learning into E-learning platform will solve the problem of lack of M-learning infrastructure in university campuses. | 3.8108 | .75908 | |

The one-sample *t*-test is used for comparing a mean with single standard value (Foster, 2001). The purpose of the one-sample *t*-test is to determine whether there is sufficient evidence to conclude that the mean of the population from which the sample is taken is different from the specified value (Elliott and Woodward, 2007). This study will test the following hypotheses:

$H_0$: $\mu \leq 3$ (the population mean is equal or less than the hypothesized value 3 which is the scale average)

$H_1$: $\mu > 3$ (the population mean is greater than 3).

A one sample t-test was performed to test the hypothesis that the mean of the students' score is greater than 3 the neutral point of the Likert scale which range from 1 to 5. The normality test was conducted as in SPSS (Pallant, 2010). The p-values of the Kolmogorov-Smirnov statistic is .200, which is greater than 0.05. This indicates that it is acceptable to assume that the Qmean (the mean of each question) distribution is normal (or bell-shaped) (Pallant, 2010). The normality test results are shown in Table 6.5.

**Table 6.5: Tests of Normality (Students Data)**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | Df | Sig. | Statistic | Df | Sig. |
| Qmean | .099 | 34 | .200* | .981 | 34 | .798 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

As displayed in Figure 6.2, that the histograms of the students' scores mean show reasonably normal distribution. This is also supported by the examination of the normal probability plots (Normal Q-Q Plot) (Figure 6.3). A reasonably straight line suggests a normal distribution. In addition, the Detrended Normal Q-Q Plots (Figure 6.4) show that

there is no real clustering of the points, with most collecting around zero line (Pallant, 2010). The test of normality reveals that the data is normally distributed.

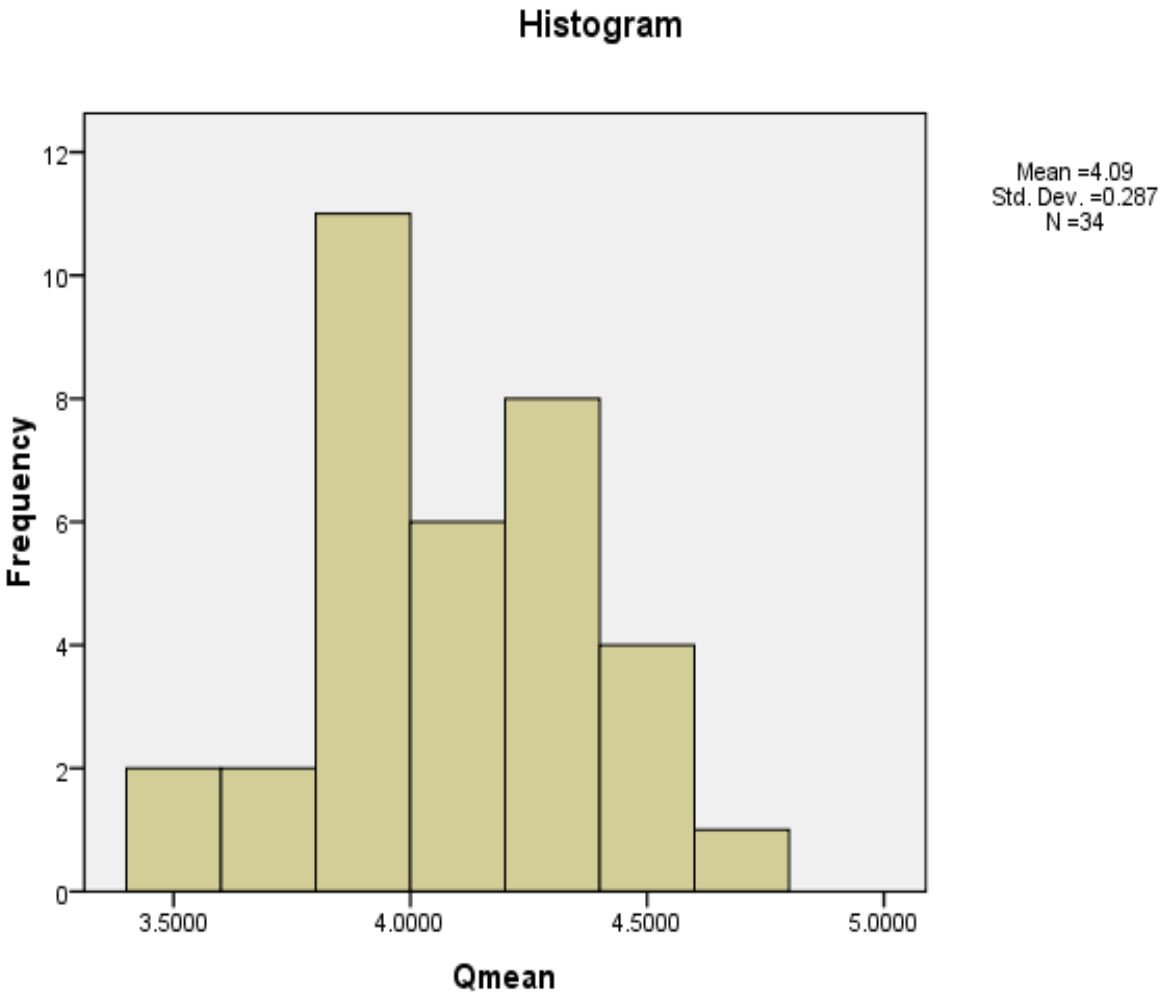


**Figure 6.2: Histogram of the Qmean (students' data)**

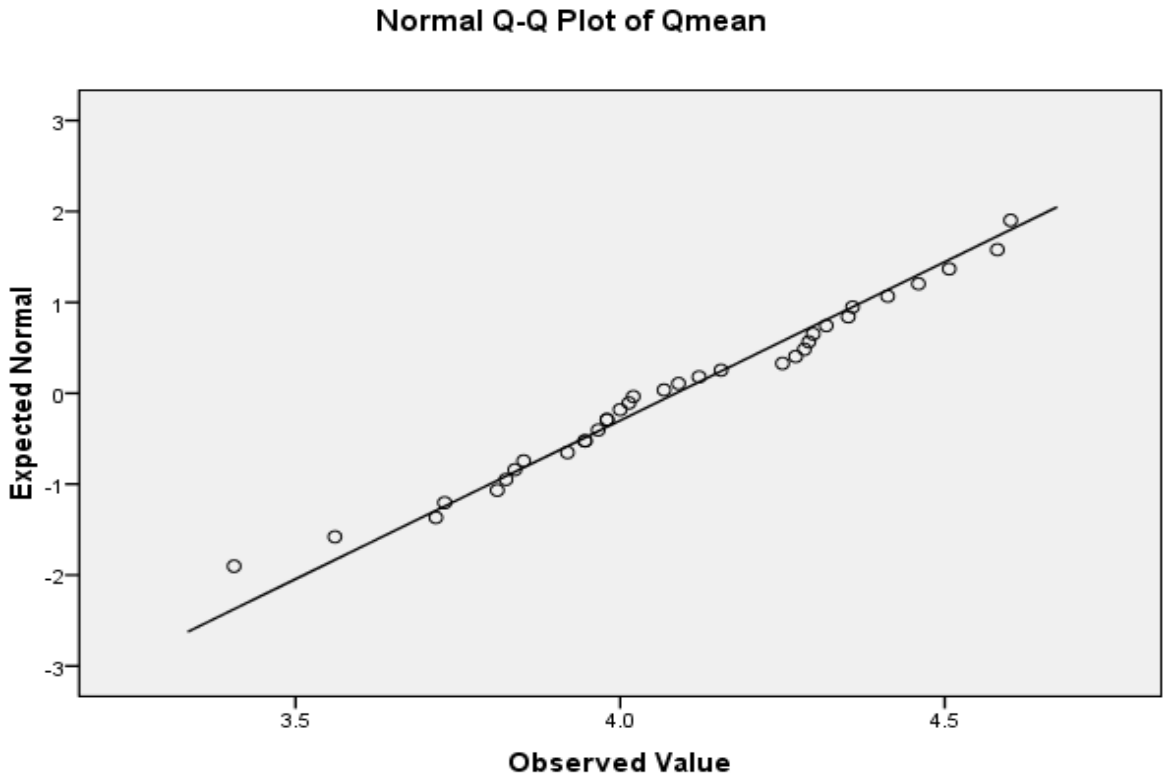


**Figure 6.3: Normal Q-Q plot of total Qmean (students' data)**

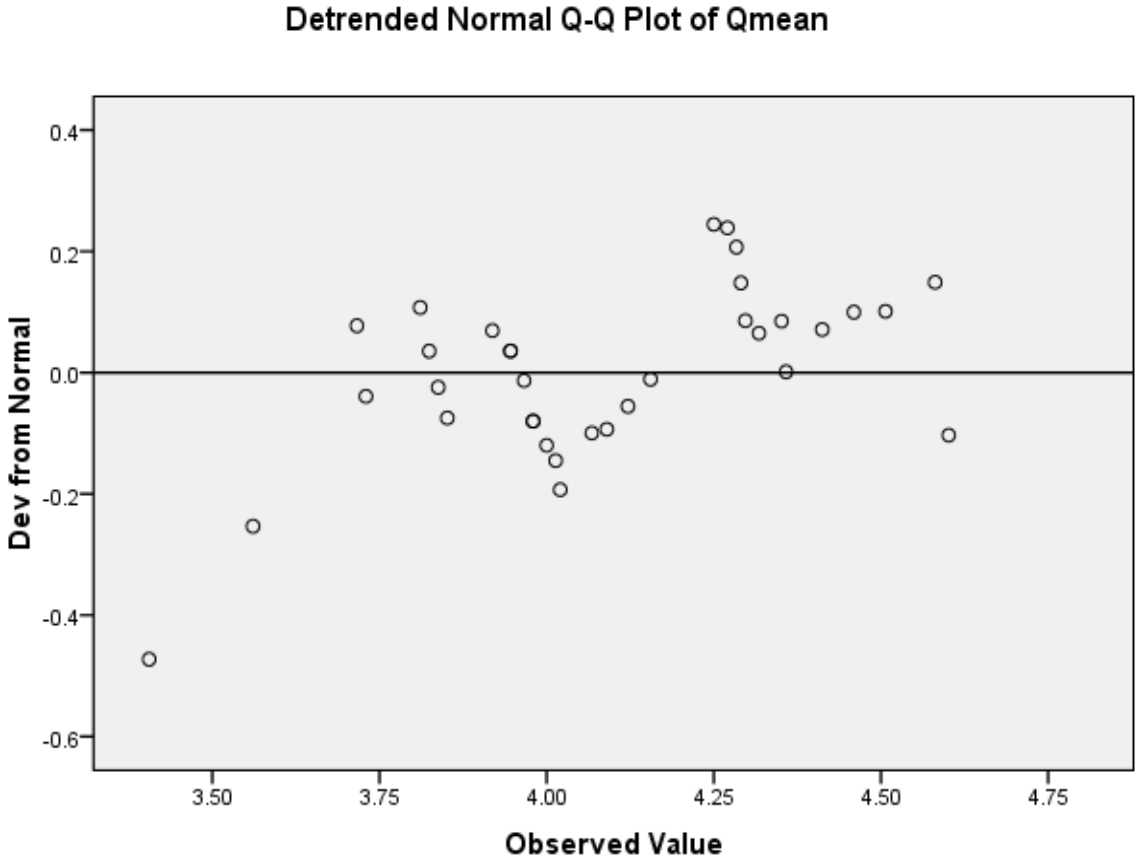


**Figure 6.4: Detrended Normal Q-Q plot of Qmean (students' data)**

Applying the one sample t-test, the mean students' score (Mean=4.086, SD=0.287, N=34) was significantly different from the hypothesized value of 3, t (33) =22.098, p=0.00. The previous results indicated that students agree with all items. Tables 6-6 and 6-7 show the results of the t-test.

**Table 6.6: One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Qmean | 34 | 4.085915 | .2865396 | .0491411 |

**Table 6.7: One-Sample Test**

| | Test Value = 3 | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | |
| | T | Df | Sig. (2-tailed) | Mean Difference | Lower | Upper |
| Qmean | 22.098 | 33 | .000 | 1.0859147 | .985936 | 1.185893 |

Table 6.8 shows that a 95% confidence interval on the students' scores mean using *t* distribution with 33 degrees of freedom is (3.976, 4.179). Since this interval does not contain the test value 3, there is significant evidence that the students' scores mean is greater than 3.

Also, p-value is less than 0.05 and t-value is positive which rejects the null hypothesis and approves the alternative one.

**Table 6.8: Descriptive Statistics of Students' Scores Mean**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Qmean | Mean | | 4.085915 | .0491411 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.985936 | |
| | | Upper Bound | 4.185893 | |
| | 5% Trimmed Mean | | 4.091992 | |
| | Median | | 4.043950 | |
| | Variance | | .082 | |
| | Std. Deviation | | .2865396 | |
| | Minimum | | 3.4054 | |
| | Maximum | | 4.6014 | |
| | Range | | 1.1960 | |

| | | | |
|---|---|---|---|
| | Interquartile Range | .4003 | |
| | Skewness | -.178 | .403 |
| | Kurtosis | -.284 | .788 |

### 6.6.2 Lecturers' Results

In order to address the validity of the proposed model, it was reviewed and assessed by a group of lecturers in Brunel University, UK, who are working and publishing concerning the electronic and mobile learning area. A total of 28 lecturers participated in the assessment. As shown in Table 6.9, 75% of the lecturers were male, while 25% were female. Regarding experience, 28.6% of the participants had experience in their field for more than 10 years, with the same percentage for 2-5 years. 25% had experience of less than 2 years, and 17.9% between 5 and 10 years. In terms of familiarity with M-learning, 39.3% of the participants declared that they had a very good level, 32.1% moderate while 28.6% assessed themselves to be at a good level. Cronbach's alpha was conducted in order to assess the reliability of the data collected. Table 6.10 presents the mean results obtained from the data.

**Table 6.9: Demographic Data of Lecturers**

| Characteristic | Frequency | Percent |
|---|---|---|
| *Gender* | | |
| Male | 7 | 25.0 |
| Female | 21 | 75.0 |
| *Position* | | |
| Lecturer | 7 | 25.0 |
| Senior lecturer | 4 | 14.4 |
| Assistant professor | 13 | 46.4 |
| Professor | 4 | 14.3 |
| *Years of experience* | | |
| <2 | 7 | 25.0 |
| 2-5 | 8 | 28.6 |
| 5-10 | 5 | 17.9 |
| >10 | 8 | 28.6 |
| *Familiarity with M-learning* | | |
| Moderate | 9 | 32.1 |
| Good | 8 | 28.6 |
| Very good | 11 | 39.3 |

**Table 6.10: Mean, Standard Deviation and Cronbach's Alpha of Lecturers' Questionnaire**

| | Items | Mean | Standard Deviation | Cronbachs alpha |
|---|---|---|---|---|
| | ***Pre-deployment stage (infrastructure)*** | | | |
| 1. | The successful deployment of an M-learning system needs support from all levels of university management. | 4.5714 | .50395 | 0.748 |
| 2. | Teaching and learning specialists should raise awareness between students and lectures of M-learning, motivate them and provide them with the appropriate skill to use it. | 4.4643 | .50787 | |
| 3. | It is important to provide users with prompt and effective technical support to facilitate the deployment of M-learning. | 4.6786 | .47559 | |
| 4. | The university needs to keep up-to-date with developments in M-learning. | 4.6429 | .48795 | |
| 5. | The M-learning system should be user-friendly and attracts the learners' attention. | 4.7857 | .41786 | |
| | ***Post-deployment stage (sustainability stage)*** | | | |
| 6. | It is important to control the quality of an M-learning service in order to ensure the success of the system deployment and use. | 4.3214 | .61183 | 0.780 |
| 7. | A sustainable M-learning system needs to be used in a collaborative learning environment to enable communication and sharing of information between users. | 4.3571 | .62148 | |
| 8. | The assessment of M-learning usability in terms of accessibility, interactivity and interface design will affect the success of M-learning deployment. | 4.6429 | .48795 | |
| 9. | Enhancing trust and confidence among members of M-learning management as well as between teachers and students will improve willingness to use M-learning technology. | 4.2143 | .68622 | |
| 10. | Making M-learning materials more engaging and suitable for learning and teaching will improve the sustainability of M-learning. | 4.3214 | .61183 | |
| 11. | In order to keep M-learning sustainable there is a need to evaluate the impact of the system in terms of meeting students learning outcome requirement. | 4.3929 | .49735 | |
| | ***General evaluation of the framework*** | | | |
| 12. | Using the proposed framework will ensure the M-learning system meets user's needs. | 3.8214 | .61183 | 0.890 |
| 13. | The proposed framework can be easily implemented within the current E- learning system strategy. | 3.6786 | .66964 | |
| 14. | Blending M-learning into the E-learning platform will minimize university resistance. | 4.0714 | .76636 | |
| 15. | Blending M-learning into E-learning platform will solve the problem of lack of M-learning infrastructure in university campuses. | 3.9286 | .66269 | |
| 16. | Using the proposed framework will increase awareness and build confidence in using M-learning among lecturers and students. | 4.2857 | .59982 | |
| 17. | The proposed framework will support the continuous updating of M-learning systems and services. | 3.9286 | .60422 | |
| 18. | Using the proposed framework will help design learning materials that support the diversity of learning styles. | 4.0000 | .72008 | |
| 19. | The proposed framework will aid faculty members utilize M-learning in their teaching by complementing the existing courses with value –added features. | 4.1429 | .65060 | |
| 20. | The proposed framework will support the building and | 3.9286 | .85758 | |

| | Items | Mean | Standard Deviation | Cronbachs alpha |
|---|---|---|---|---|
| | maintaining of the M-learning system. | | | |
| 21. | Using the proposed framework will enable M-learning users to provide feedback on their teaching and learning experiences. | 4.0000 | .60858 | |
| 22. | The proposed framework will ensure an effective administrative system for the deployment of M-learning. | 3.8929 | .62889 | |

A one sample t-test was performed to test the hypothesis that the mean of the lecturers' score is greater than 3 the neutral point of the likert scale which ranged from 1 to 5. To assess the normality of the distribution of the scores, normality test was conducted in SPSS (Pallant, 2010). The p-values of the Kolmogorov-Smirnov statistic is .200, which is greater than 0.05. This indicates that it is acceptable to assume that the Qmean (the mean of each question) distribution is normal (or bell-shaped) (Pallant, 2010). The normality test results are shown in Table 6.11.

Figure 6.5 shows that the histograms of the lecturers' scores mean appears reasonably normally distributed. This is also supported by the examination of the normal probability plots (Normal Q-Q Plot) (Figure 6.6). A reasonably straight line suggests a normal distribution. In addition, the Detrended Normal Q-Q Plots (Figure 6.7) shows that there is no real clustering of the points, with most collecting around the zero line (Pallant, 2010). The test of normality reveals that the data is normally distributed.

Appling the one sample t-test, the mean lecturers' score (Mean = 4.231, SD = 0.318, N = 22) was significantly different from the hypothesized value of 3, t (21) =18.335, p=0.00. The previous results indicated that lecturers agree with all items. Tables 6-12 and 6-13 show the results of the *t* test.

**Table 6.11: Tests of Normality (Lecturers' Data)**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | Df | Sig. | Statistic | Df | Sig. |
| Qmean | .132 | 22 | .200* | .960 | 22 | .484 |

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

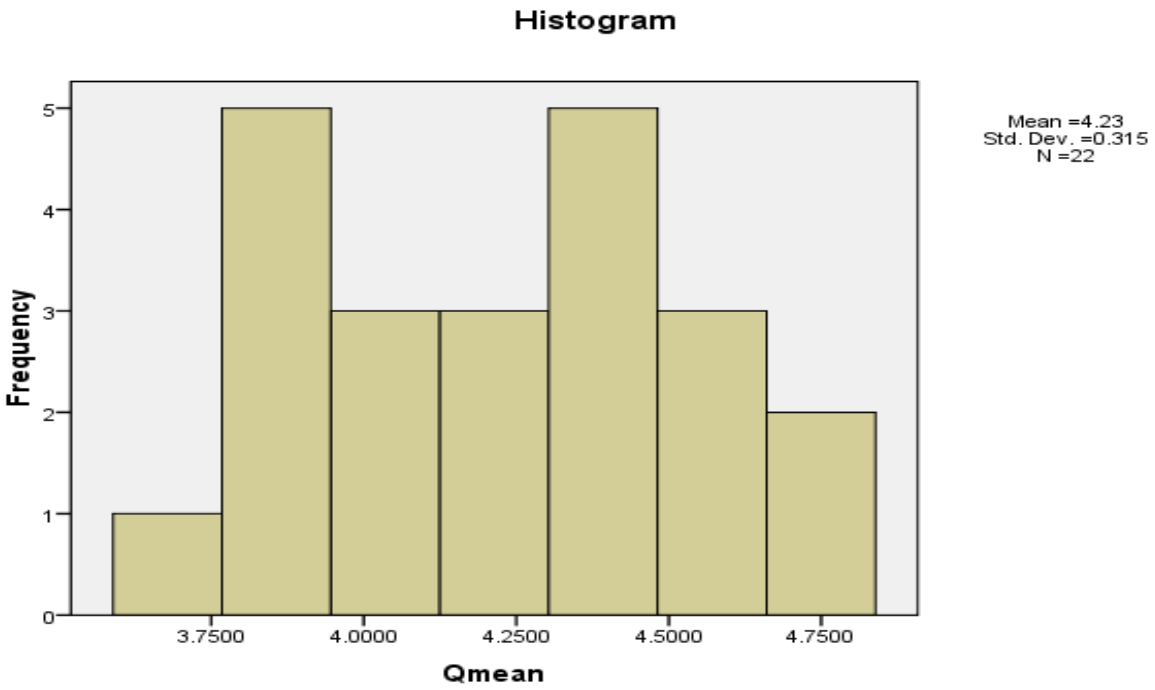


**Figure 6.5: Histogram of the Qmean (lecturers' data)**

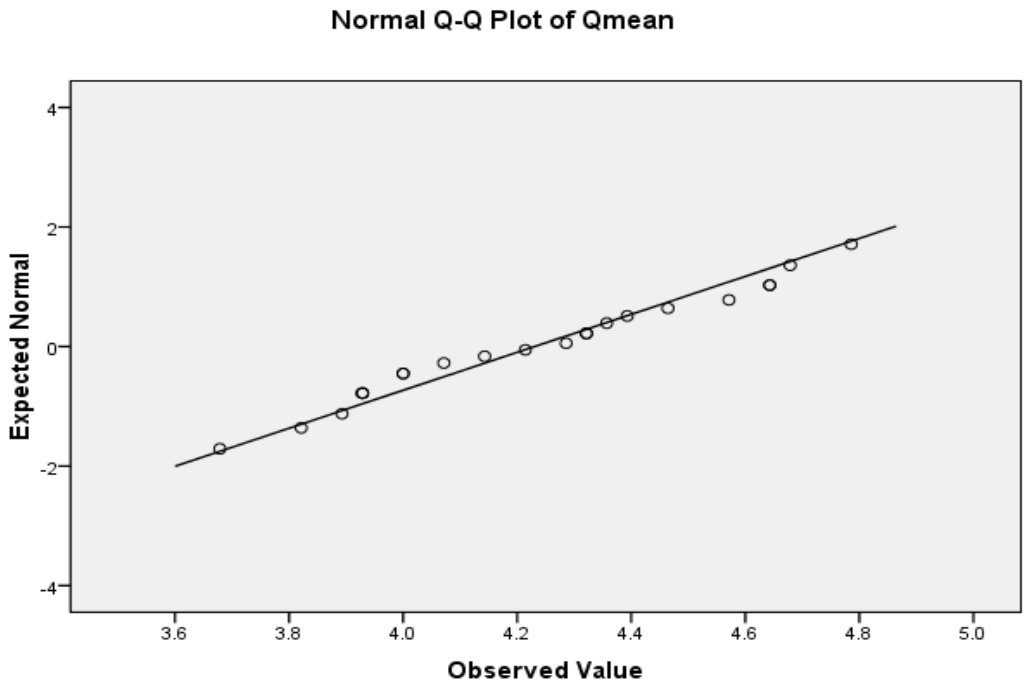


**Figure 6.6: Normal Q-Q plot of total Qmean (lecturers' data)**

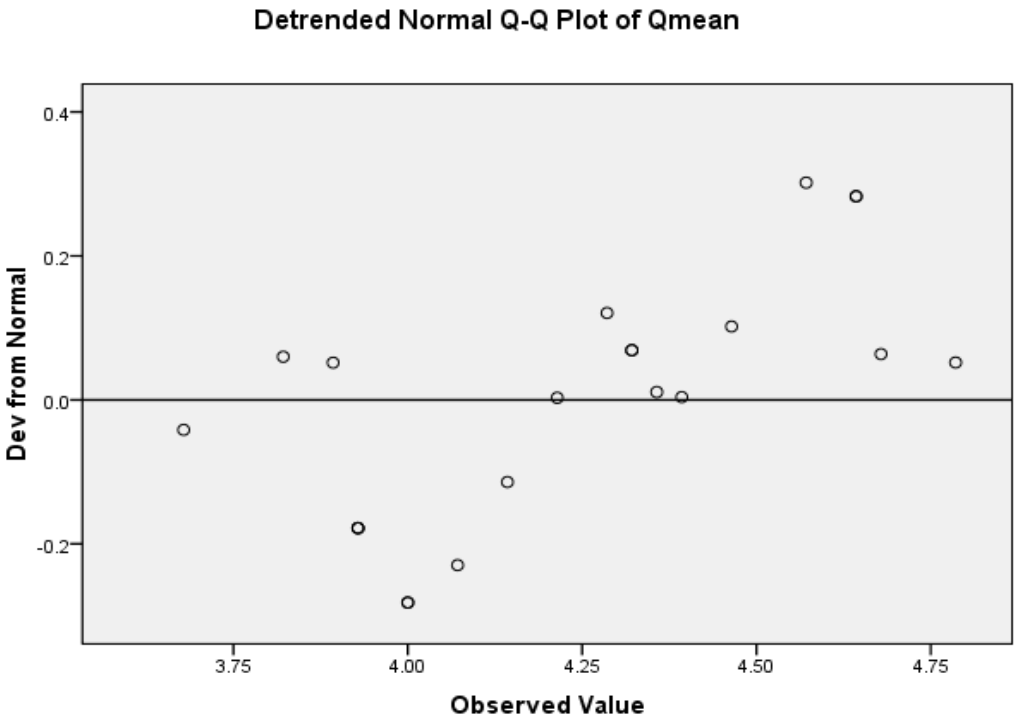


**Figure 6.7: Detrended Normal Q-Q plot of Qmean (lecturers' data)**

**Table 6.12: One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Qmean | 22 | 4.230527 | .3147870 | .0671128 |

**Table 6.13: One-Sample Test**

| | Test Value = 3 | | | | | |
|---|---|---|---|---|---|---|
| | T | Df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Qmean | 18.335 | 21 | .000 | 1.2305273 | 1.090959 | 1.370096 |

Table 6.14 shows that a 95% confidence interval on the lecturers' scores mean using *t* distribution with 21 degrees of freedom is (4.091, 4.370). Since this interval does not contain the test value 3, there is significant evidence that the lecturers' scores mean is

greater than 3. Also, we can see that the p-value is less than 0.05 and t-value is positive, which rejects the null hypothesis and approves the alternative one.

**Table 6.14: Descriptive Statistics of Lecturers' Scores Mean**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Qmean | Mean | | 4.230527 | .0671128 |
| | 95% Confidence Interval for Mean | Lower Bound | 4.090959 | |
| | | Upper Bound | 4.370096 | |
| | 5% Trimmed Mean | | 4.230167 | |
| | Median | | 4.250000 | |
| | Variance | | .099 | |
| | Std. Deviation | | .3147870 | |
| | Minimum | | 3.6786 | |
| | Maximum | | 4.7857 | |
| | Range | | 1.1071 | |
| | Interquartile Range | | .5625 | |
| | Skewness | | .126 | .491 |
| | Kurtosis | | -1.055 | .953 |

### 6.6.3 Results From the two Open-Ended Questions

The aim of the open-ended questions was to explore the obstacles that might face the deployment of M-learning and to encourage participants to suggest other factors that add value to the proposed model. Both students' and lecturers' answers were thematically analysed using the following steps (Silverman, 2011):

1. Familiarisation with datasets through noting initial comments and ideas.
2. Generating initial codes through coding the whole dataset.
3. Searching for themes through collecting similar codes into potential thematic clusters.
4. Reviewing themes and check if generated themes work in relation to the dataset
5. Refining themes through refining themes specifications and linkages.

Table 6.15 below shows the frequency of each theme suggested by the lecturers and students to be added to the refined model.

**Table 6.15: Frequency of themes identified by lecturers and students for inclusion**

| Themes identified | Frequency Lecturers' responses (Total response =28) | Frequency Students' responses (Total response =148) |
|---|---|---|
| Cost of Implementation of M-learning | 11 | 14 |
| Lack of awareness, knowledge and skills | 8 | 13 |
| Lack of training | 9 | 10 |
| Availability of technical infrastructure | 9 | 12 |
| Lecturers resistance to change | 6 | - |
| Availability of suitable mobile devices with internet connection | 5 | 10 |
| Compatibility issues | 8 | 12 |
| Meet users' needs | 3 | 15 |
| Availability of high quality learning resources | 4 | 7 |
| Usability issues | 5 | 22 |

*6.6.3.1 Students' most identified obstacles*

1. *Cost of implementation of M-learning*: 'cost of implementing the system'; 'mobile devices cost money –students do not have'.

2. *Awareness and motivation*: 'attracting students from norm, encouraging to access while on the move. This can be emphasized by lecturers but mainly through Blackboard learning'; 'the popularity of the services, no good deploying M-learning when not a lot of people are going to use it'.

3. *Availability of suitable mobile devices with internet connection*: 'if the users have the required mobile to use M-learning (i.e. iPhone, Android etc.)'.

4. *Usability issues*: 'designing the system to encourage people to regularly use M-learning to assist them'; 'The M-learning system needs to be easy to navigate'; 'look slightly simplistic'.

5. *Meet users' needs*: 'a reliable system that provides the users with all the relevant information where needed'; 'creating an M-learning system which will assist different departments effectively'; 'lack of communication between end-users and university'.

6. *Compatibility issues*: students indicated that mobile devices have different operating systems; ‘compatibility across different devices’; ‘the different mobile devices platforms, which are regularly updated’.

7. *Availability of suitable learning contents*: ‘further online resources relating to module content to gain a wider understanding on subjects’, ‘contents should be available for students whenever they wanted to download’.

8. *Up to date M-learning system*: ‘keep the system up to date with changes in technology’; ‘up to date with the new technology’.

*6.6.3.2 Lecturers’ most identified obstacles*

1. *Cost of implementation of M-learning*: ‘M-learning implementation might face financial problems at the initial stage’.

2. *Lack of training*. One lecturer mentioned: ‘lack of training and insufficient amount of guidelines for the optimal usage of the system’.

3. *Availability of technical infrastructure*: ‘M-learning is an advanced application of multiple technology integration. Hence technical infrastructure is a crucial part of its deployment’.

4. *Lack of awareness, knowledge, understanding and skills*: ‘staff/stakeholder engagement. Lack of understanding consequently leading to lack of uptake. If staff were aware of the benefit, for example. If they could see how it would directly benefit them, they might be more enthusiastic’; ‘the main problem is that no one has through of a useful purpose for using M-learning that cannot be done for more effectively via face-to-face’.

5. *Lecturers’ resistance to change*: ‘lecturers do not like to change their current traditional practices in teaching and learning’; ‘the attitude of senior staff toward teaching and learning is still neutral. Ambitious staff need to focus on their research’.

6. *Meet users’ needs*: ‘we have a large scale of students with different learning styles, capability and special needs’.

7. *Compatibility between mobile devices/software-hardware issues*: ‘M-learning content needs to be suitable to download on multiple handheld devices, as students don’t all have the same device. If the contents were only created for, say, Apple products, those who don’t have an iPhone for example would be penalised’.

8. *Availability of high quality learning resources*: ‘high quality of learning resources otherwise students will not use them and potentially damage will be done to their willingness to engage in this mode of learning in future’; ‘tutorials, explanation made available for mobile devices will give students additional learning opportunities and increased flexibility’.

*6.6.3.3 Students’ and lecturers’ concerns and recommendations*

1. *Lack of university support for M-learning design and development*: ‘M-learning is not a priority in most universities learning and teaching strategies’; ‘for staff, there is simply no intensive to change. Investing in time to understand and embed technology not enhance such M-learning in modulus will certainly not enhance your career progression’.

2. *Lack of staff time to understand how to embed new technology like M-learning*: ‘if someone does all the work for lecturers it save them time (as in Computer-Aided assessment, CAA) then some staff will adopt M-learning, but not otherwise’.

3. *M-learning will reduce the communication between students and lecturers*: ‘I would like students to have the additional opportunities afforded, but would not like to see the face-to-face opportunities removed as a consequence’. One student indicated: ‘students will be more communicative with the M-learning interface compared to communicating with their lecturers’.

4. *M-learning will cause a lack of focus on the old E-learning system*. One student stated that: ‘developers will put so much more effort to developing M-learning and they will stop developing the old E-learning system’.

5. *Distraction of the purpose of M-learning*. One student indicated: ‘students are constantly using their phone, if they are using it in lectures/seminars then the students may go into something other than the M-learning’.

## 6.7 Discussion

The participants of this research were divided into two categories; School of Information Systems students of Brunel University, and a group of lecturers who work and publish in M-learning. The proposed model tried to build a road map to help universities and colleges in deploying usable and sustainable M-learning system within their teaching and learning environment. In this section, the contribution of the participants will be discussed; factors that affect the deployment of M-learning will be identified and participants' recommendations and concerns will be presented.

The results indicated that participants have a positive evaluation of the model; the participants' questionnaires were designed to investigate lecturers and students thoughts about the factors which affect M-learning system deployment and how they feel about M-learning being offered in universities. Based on obtained results, the scores mean for the students' questions varied between 3.40 and 4.60 (out of 5), and the mean for all questions was 4.09 which is over 3 (the midpoint of the Likert scale). This means that the factors explained in both infrastructure and sustainable stages will affect the deployment of M-learning from students' perspectives. Lecturers' results show that the scores mean occurred between 3.68 and 4.79, and the mean for all questions was 4.23, which is over the scale average of 3. This emphasises that all lecturers agree with the factors involved in the model. However, participants clarified in their answers for open questions some obstacles that might hinder the deployment of M-learning.

The cost of implementation of M-learning was the main obstacle suggested by participants. This is an important issue in the pre-deployment stage of designing M-learning (Ng and Nicholas, 2012). There is a need to consider all aspects including infrastructure costs, training and connectivity. In addition to the significant initial funding to buy mobile devices tools and internet connection, there is a need to provide on-going technology services and maintenance (Naismith et al., 2004). Muyinda et al. (2010) suggested that future research work needs to be done to determine the unit cost of implementing M-learning.

Availability of suitable mobile devices with internet connection was also identified by the participants, especially students. A very important factor to ensure the success of M-learning system is the choice of device that will be used by the students (Abu-Al-Aish, Love and Hunaiti, 2012). Mobile devices used in M-learning need to be high definition in term of capacity, functionality and internet coverage..

The results also showed that the compatibility of mobile devices is another issue that affects the use of M-learning system. There is no unique platform across mobile devices. Compatibility was pointed from both lecturers and students to be a strong obstacle. There are many mobile devices with different platform (i.e. Android, Apple etc.). Therefore, M-learning applications need to be compatible with multiple handheld devices. Looi et al. (2010) indicated that mobile devices must allow compatible software when accessing common resources. There is a need to provide a group of educational software tools that are suitable for different types of mobile devices. If the content is designed to fit only one platform then those students who do not have that device would be isolated.

Participants suggested adding 'users need' as a factor to the proposed model. M-learning should be designed in a way that can meet users' needs and course-required pedagogical outcomes (Al-Bahadili, Issa and Abuhamdeh, 2011). Users' needs might depend on different cultural backgrounds, educational levels and skills, and lecturers need to design effective learning materials. Introducing M-learning into higher education will require a significant level of training for both students and lecturers (Ng and Nicholas, 2012). Students need training to enhance M-learning usability, and lecturers need training on how to develop their own teaching contents and how to upload them on the connected M-learning platform.

Finally we have to consider lecturers' resistance to change. Lecturers who have long utilized the traditional method in their teaching will be ambivalent about the design of the M-learning context. They generally have a reflexive preference for continuing to use their 'tried and tested' traditional teaching methods (West and Schofield, 2012). Therefore, there is a need to motivate them to adapt this new educational technology in their teaching strategies. This can be done by providing real-life examples of ways in which the benefits of M-learning are apparent (West and Schofield, 2012). In addition, it is recommended that university management should encourage faculty members to adopt M-learning by reducing their teaching load and providing them with sufficient financial enhancement and other incentives.

## 6.8. Model refinement

Based on the results obtained from open-ended questions, new factors were added to the model. In the pre-deployment stage the following factors were added: cost, availability of suitable device and internet, compatibility, and meet users' needs. For the post-deployment

stage the following factors were added: training and tackling lecturers' resistance to change.

Below is an explanation of the new factors suggested by participants:

1. Cost

Deployment of M-learning system need to purchase mobile devices associated with infrastructure, payment of connectivity, training costs for lecturers and students and developing M-learning content suitable for all mobile devices (Naismith and Corlett, 2006). Therefore, there a need to provide cost effective implementation solutions in order to reduce organization budgets investing in M-learning deployment.

2. Availability of suitable mobile device and internet.

The availability of suitable mobile devices used by students and lectures is a critical factor for the successful deployment of M-learning (Trifonova, Georieva and Ronchetti, 2006). Not all students have top-end phones. Mobile devices need to be high definition in term of functionality, internet coverage and navigation speed. Therefore, there is a need to investigate the variety in functionality between mobile devices, and to ensure the reliability and low cost of internet connectivity when using M-learning system, as high costs of using mobile networks may decrease students' willingness to utilize M-learning system (Emerging Practice in a Digital Age Case Studies, 2011a).

3. Offer Compatibility M-learning applications.

Mobile devices have different operating systems (i.e. Android, BlackBerry, Symbian and iPhone). Therefore, there is a need to develop M-learning applications that are compatible to all available devices. Looi et al. (2010) pointed out that mobile devices must offer compatible software when accessing general education resources or materials.

4. Meet users' needs.

Mobile learning system need to be designed in a way that can meet the diversity needs of all users'. Students might come from different cultures; with different educational level and skills, disabilities (Basham, Meyer and Perry, 2010). Students and lecturers might need pedagogical or technical support. Marshell and Mitchell (2002) in their E-learning maturity model indicated that students and lecturers needs have to be taken in account when

determining requirements. Therefore, it will be a success factor to investigate the users' needs in the pre stage of M-learning deployment.

5. Training.

Introducing new technology in any organization requires training for all users. Therefore, implementing M-learning in university environment needs to provide continuous training for students and lecturers to enhance their usability with mobile technology and enable new instruction activities (Naismith et al., 2004).

6. Tackling lecturers' resistance to change.

University lecturers may be resistant to change and they may want to continue use their traditional teaching methods. Therefore, there is a need to motivate and enhance them to adopt this technology. This can be done by conducting learning events that address the benefits of using M-learning technology, provide real-life examples of M-learning applications, celebrating successful M-learning experiments and revisiting traditional methods in teaching and examining how to develop them using mobile technology (West and Schofield, 2012).

Some of the lecturers suggested moving some factors out of the pre-deployment stage, since they considered that these factors should be presented in both stages, such as on-going technical support, management/institution initiative and support and on- going M-learning innovation. Therefore, it was decided that all previous factors will be displayed in the model to feed both stages (pre- and post-deployment),

Based on the previous results and literature on mobile learning implementation, pre-deployment stage was refined to include the following factors:

- Provide cost-effective solutions
- Conduct awareness and motivation campaigns to both students and lecturers
- Availability of suitable mobile devices and Internet
- Offer compatible M-learning applications
- Tackle usability issues
- Meet users' needs

These factors are essential for the infrastructure and preparation stage. Based on the previous results, post-deployment sustainability stage was refined to include the following factors:

- Quality of Service Control
- Availability and sustainability of the learning materials
- Continues usability assessments
- Trust and confidence
- Collaborative learning
- Training
- Tackling lecturers' resistance to change
- Achievements evaluation

The refined model is illustrated in figure 6.8. The eight elements on the right side of the model are placed in a circle and sustainability is the centre of the circle; which means that the continuity review of these eight factors should be taken regularly in order maintain the sustainability. They are separate entities but together they achieve sustainability.

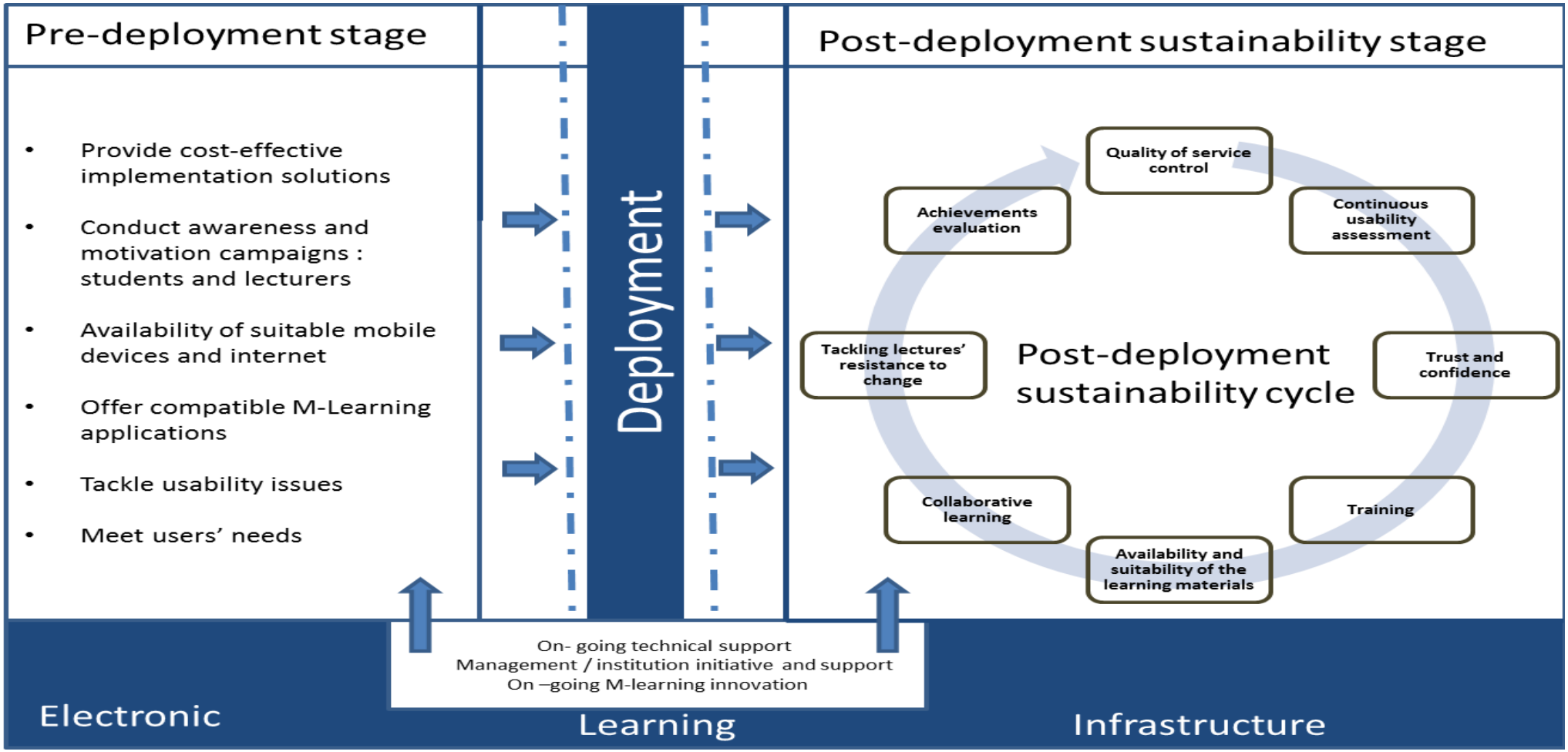


**Figure 6.8: Refined Model**

## 6.9 Conclusion

This study was carried out with the objective of creating a model that can be used as a road map for both pre- and post-deployment stages of M-learning. The factors which have been used to construct the initial model were evaluated by 148 undergraduate students and 28 M-learning experts. Both students and lecturers agreed with the model and suggested adding other factors that modify the initial model. These factors include cost of implementation, availability of suitable devices, compatibility issues, and users' needs (added to the pre-deployment stage); and training and tackling lecturers' resistance to change (added to the post-deployment stage). In response to their comments and recommendations, the initial conceptual model was refined.

This refined conceptual model gives a wide overview of all elements that need to be addressed in an M-learning environment and fills the gap related to linking both pre- and post-implementation phases to ensure successful sustainability. Furthermore, the results were obtained from both parts of the M-learning equation and represent the concerns and ideas of both students and lecturers.

# CHAPTER 7: CONCLUSION

## 7.1 Overview

This chapter summarises the outcomes of the research conducted to achieve the objectives of this PhD thesis. Research objectives and questions are presented followed by the contributions of the research. Discussion of the limitations and future work are also explained.

## 7.2 Research Objectives

The main aim of this research work is to study and analyse the factors that affect the adoption and implementation of M-learning in the higher education environment in order to develop a sustainable M-learning model successfully. Specifically, the first objective of this study is to investigate the readiness of Brunel University students toward using mobile learning in their studies and to establish what factors might influence their readiness. The second objective is to determine the factors that influence university students' acceptance of M-learning in higher education environment. Finally, the third objective is to propose and develop a model with pre and post stages that can be used to foster the sustainable deployment of M-learning within teaching and learning strategies in higher education institute.

Revisiting the study's objective, this study was undertaken to seek answers the following research questions:

RQ1a: What is the level of students' readiness for M-learning system?

RQ1b: What are students' expectations towards mobile learning services and the challenges that might affect the implementation of this new technology?

RQ2: What are the factors influencing students' acceptance towards M-learning in higher education?

RQ3a: What are the key issues and critical success factors that are essential to ensure successful deployment of M-learning?

RQ3b: How can the identified factors be worked (or considered) into the development of a sustainable M-learning model for higher education environment?

## 7.3 Research Findings

In order to respond to all of the research questions, literature and research in M-learning aspects were reviewed. From the literature, there is evidence that E-learning system has many advantages in higher education and has successfully used as vital platform of learning media in classroom and distance learning. With the spread of mobile internet and wireless technology, these tools could add value to E-learning system by extending the capability of E-learning to provide a flexible, portable and independent learning environment. M-learning can work on and off the campus, and help distance learning students to learn while they are outside the university.

Previous literature clearly demonstrates that M-learning enhances university teaching and learning and will play significant role in the future of the higher education environment. However, it remains a new technology system. The adoption and implementation of M-learning in higher education instituions needs to be investigated carefully, regarding to the capability of universities, and the perceptions and acceptance of users. This research aimed to give insight in the area of M-learning adoption and implementation in higher education.

To answer the first question (a and b), a survey was utilized in chapter four to investigate students' readiness for M-learning, their expectations about M-learning services and what challenges they think will face the implementation of this technology. The study found that a big proportion of participants already had smart phones. However, some students thought that these devices might not be suitable to utilize M-learning, as M-learning needs technology to convert learning materials to specific mobile device systems.

Moreover, the results of the survey show that students were not familiar with M-learning and they were not fully ready to implement this technology due to the issues of the infrastructure support and the compatibility in converting courses materials to the mobile devices system. Other issues identified by the students included whether the lecturers accept the adoption of M-learning. Lecturers' attitudes towards this new format, and their vision and skills, play a significant role in the successful implementation of M-learning. Students might get advantages of M-learning in the near future if a strategy is tailored to their readiness and that of their lecturers.

To answer the second questions, a hypothesised model depending on UTAUT was tested in chapter five using SEM. The results showed that a 55% intention to accept M-learning in the higher education context was explained by the proposed model, which incorporates two factors: quality of service and personal innovativeness to the components of UTAUT. All factors in the proposed model where found to have significant effects on behavioral intention to use M-learning (see Figure 7.1).

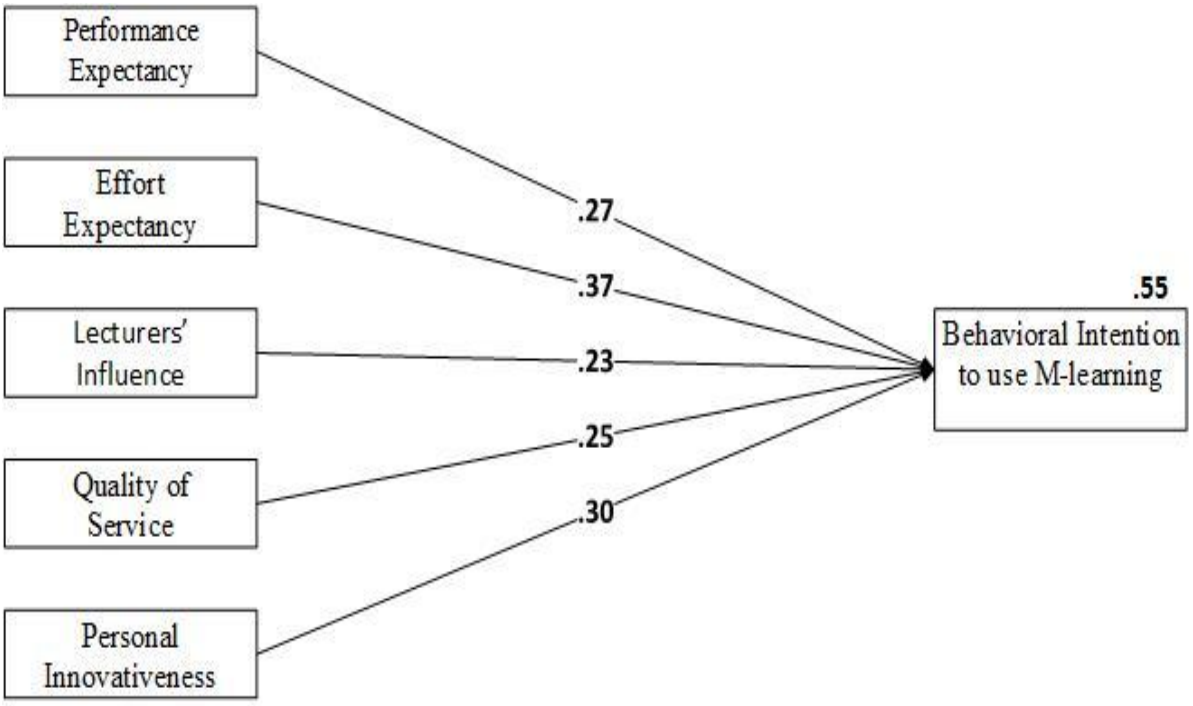


**Figure 7.1: Acceptance Model with Correlation Coefficient**

The findings indicated that in order to promote student acceptance of M-learning, M-learning systems designers should pay attention to developing mobile applications and course content for M-learning which are easy to use easy, access and enhance students' performance expectancy.

In addition, the quality of service offered needs to be user-friendly, meet all students' needs and be up-to-date, as this will attract more students to use M-learning. Furthermore, personal innovativeness has been found to be a strong factor which affects behavioural intention to use M-learning, as innovative students usually have more positive beliefs about using new technology. Additionally, some students might need to be motivated to adopt M-learning.

Furthermore, lecturers and faculty members have a significant influence on students' acceptance of M-learning. They can promote students' acceptance of M-learning by adding

value to their traditional methods of course delivery using this format. However, lecturers need to be familiar with M-learning (conceptually and practically), and be ready to be involved in the implementation plans.

To answer the third question (a and b), a study was conducted as described in chapter six with the objective to create a model that can be used as a road map for both pre- and post-deployment stages of M-learning. The factors used to construct the initial conceptual model were derived from first and second studies in addition to the literature review. The model was evaluated by 148 undergraduate students and 28 M-learning experts. Both students and lecturers agreed with the model and suggested adding other factors that modify the initial model.

## 7.3 Contribution of the Research

This research and its findings have some contributions and significant implications to the area of M-learning acceptance and deployment.

From the first study, the results contribute to the literature by assessing the readiness of students towards M-learning. From students' perspective, the results revealed the challenges that might face students in utilizing M-learning in their learning. The results gave insight in the students' expectations of the future of M-learning services. This directs M-learning scholars to devote more effort to adapting this technology in existing teaching and learning methods.

From the second study, with regard to the theoretical contribution, the study developed and assessed an acceptance model in M-learning context based on UTAUT. Empirically, the model evaluates the impacts of perceived usefulness, perceived ease of use, lecturer influence, quality of service and personal innovativeness on behavioral intention to use M-learning. The second study added to the theory of M-learning and technology acceptance, which in addition to UTAUT constructs incorporate other factors such as quality of service and personal innovativeness. All of these aspects need to be considered when designing and developing M-learning systems.

The refined conceptual model (Figure 7.2) gives a wide overview of all elements that need to be addressed in an M-learning environment and fills the gap related to linking pre- and post-implementation phases to ensure successful sustainability. Furthermore, the results

were obtained from both parts of the M-learning equation and represent the concerns and ideas of both students and lecturers.

This refined conceptual deployment model can work as a road map for future deployment of M-learning projects and help both management and practitioners to make decisions and ensure a seamless shift toward this new technology in higher education. However, in order to define the final shape of the model, the designed factors need to be revised once the model has been used in a real M-learning project. This conceptual model can give guidelines for where resources should be applied. Universities can use this model as a reference to build their IT decision and strategic plan.

The findings of this research may motivate other researchers to conduct further studies to investigate and explore other factors that could influence the successful deployment of M-learning in higher education environment. Furthermore, other researchers need to pay attention to develop solutions to defeat all hurdles facing the deployment of this new technology.

## 7.4 Limitations of the Research

- The participants of this research were taken from one single public higher education institute (Brunel University, UK). Thus the results cannot be generalised to all higher education institutes, including private and open education.
- The participants were students from one school (i.e. School of Information Systems, Computing and Mathematical Science). The results cannot be generalised for all university subjects. It might be presumed that students and faculty members at a technological/mathematical higher education institution might be more familiar with mobile and learning technologies than those from arts and humanities departments.
- The research has been done in a University which does not implement M-learning system in its teaching and learning methods. This issue has affected the outcomes of this research. Students used their basic knowledge and perceptions about M-learning to comment on the research questions.
- As the M-learning system is not implemented in Brunel University, this study does not investigate the actual use of M-learning; it depended on prediction of the use.

- The evaluation of the conceptual model was undertaken by students and lecturers. Other stakeholders like school management, technical support and M-learning designers were not involved in this evaluation.
- The questions in the second study were derived from the previous literature review in M-learning acceptance. However, some of these questions were leading and were designed positively.
- This research utilized the quantitative data collection procedure with some open-ended questions; qualitative methods were not widely utilized in this research.
- The conceptual model was created based on studies conducted in one higher educational institution in the UK. If other institutions attempted to use this model somewhere else (e.g. in developing or non-European countries), other factors might need to be considered (e.g. the techno-cultural milieu; the UK has well-developed internet and mobile infrastructure, combined with low uncertainty avoidance and markedly widespread use of online methods of communication).

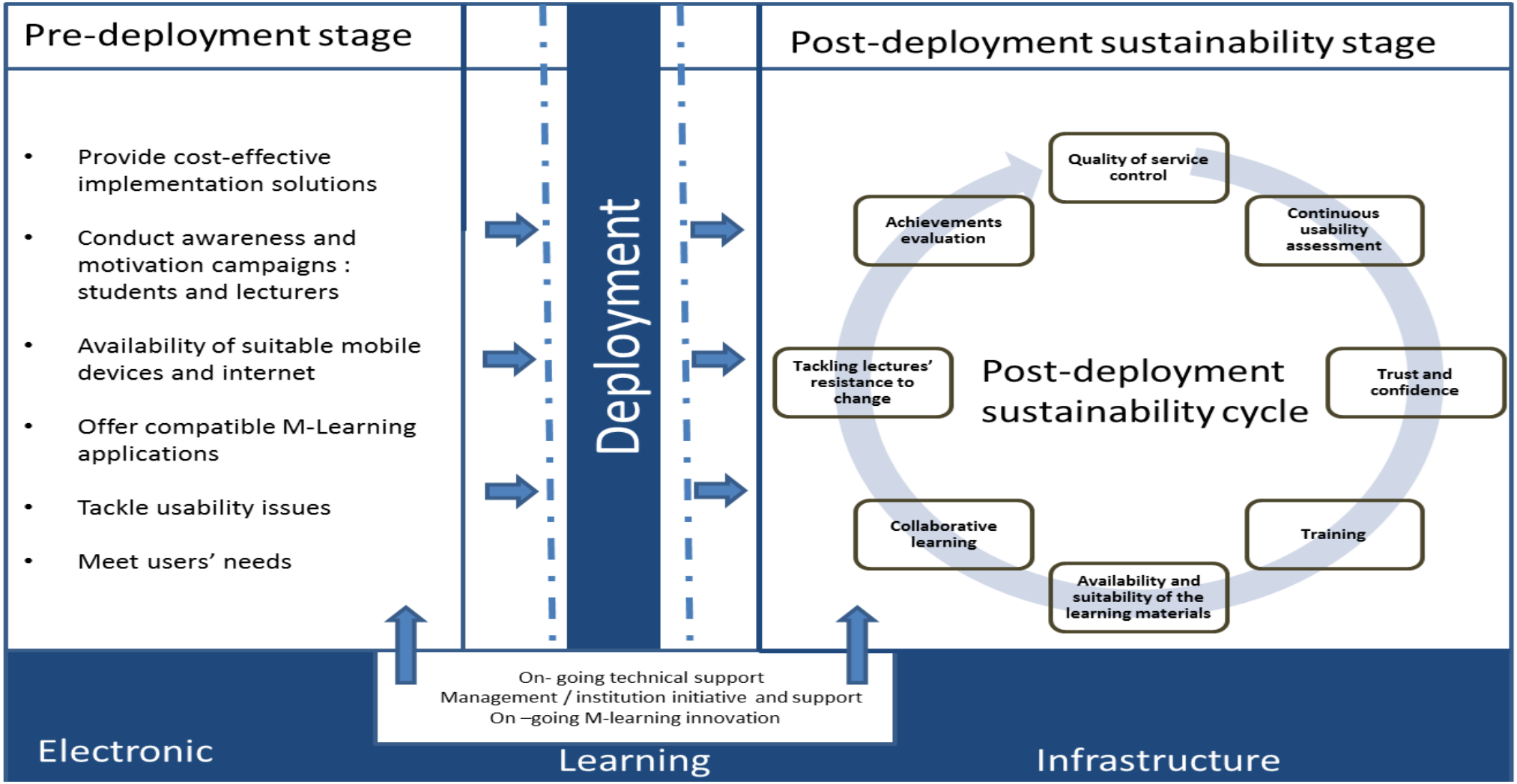




**Figure 7.2: Refined Conceptual Model for Sustainable M-learning Deployment**

## 7.5 Recommendations and Future Work

Overall, participants were willing to use M-learning. This compels researchers in the M-learning field to endeavour to adapt this technology in teaching and learning methods. We recommend that more technical infrastructure should be put in university campuses to assist students' learning via their mobile devices. It would also be advisable to provide students and lecturers with more information about the benefits of M-learning using workshops and seminars. Moreover, a series of training courses should be organized for lecturers in order to familiarize and integrate them with M-learning administration. The following are some suggestions for future research on the area of implementing M-learning in higher education:

- Since this research is limited to studying the adoption and implementation of M-learning at the School of Information Systems, Computing and Mathematical Science, Brunel University, extended research should engage other students from different subjects and different universities (private and open universities). This could add significant value to the generalizability of the research.
- Since the sample of the research was limited to School of Information Systems, Computing and Mathematical Science, Brunel University, where the number of males is greater than the number of females, further research work is needed to investigate the issues related to gender differences (i.e. the effect of gender in the acceptance and deployment of M-learning).
- The research investigated students' readiness and acceptance toward M-learning. It would be useful to investigate lecturers' readiness and acceptance about M-learning. This investigation is necessary in order to achieve better understand for all part of M-learning equation.
- Future work can utilize other technology acceptance theories to understand students' needs and the factors that affect their acceptance.
- Evaluation of the conceptual model was conducted among students and lecturers. It would be of great value to involve all stakeholders (i.e. leadership and management, technical support, mobile application designers), to reduce potential bias in the resultant data.
- Future research work may try to find solutions for the challenges discovered in the proposed conceptual model in order to ensure a successful deployment of M-learning.

- Future research can work to extend the conceptual model globally to other countries' higher education institutes (particularly developing countries). In this direction, other factors for the model might need to be considered regarding to cultural and economic aspects.
- Future research might extend the investigation of M-learning deployment models and compare it with other educational technology models (e.g. E-learning and distance learning) in order to get a broader analysis that enables researchers to develop new M-learning deployment strategies.
- The model has been created based on studies conducted in one higher educational institute in UK. If other institutes attempt to use this model somewhere else, other factors might be need to be considered.
- The way forward is to develop and evaluate M-learning applications that take into consideration the concerns and issues raised by the students and lecturers in this research.
- Future work can extend the conceptual model to involve the design phases and to consider the real purposes of blending mobile technology in learning and teaching process.

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# Appendix 1: Questionnaire of Students' Readiness for M-learning

## *Participant Information Sheet*

My name is Ahamd Abu-Al-Aish, I'm a PhD student in the Department of Mathematics (Brunel University), Ny research topic is mobile learning for mathematics education.

This survey is trying to investigate the readiness of School of Information Systems, Computing and mathematical Science in Brunel University to move towards offering mobile learning to its students.

The results of the study will form a part of my doctoral dissertation, and will be published in national and international journals and presented at conferences.

The survey is investigating the availability of the devices, the willingness to use mobile learning and the participants' opinions about this technology.

It is not compulsory for someone to take part in this questionnaire, and participants can withdraw at any time without consequence.

All data and participants' personal details will be kept anonymous. If you have any concerns or complaints regarding the ethical aspects of this project please contact siscm.srec@brunel.ac.uk or Dr Laurence Brooks, Tel. No. 01895 266010.

### *Definitions*

E-learning - learning that is accomplished over the Internet, a computer network, via CD-ROM, interactive TV or satellite broadcasts. It can be self-paced or instructor-led and includes media in the form of texts, images, animation, streaming video and audio.

Mobile learning (M-learning): learning which takes place via wireless devices such as Smart Phones, PDAs and Tablet PCs. These devices are able to move with the learner to allow learning to take place anytime, anywhere.

### *How long will take to answer this survey?*

The survey will take approximately 10 minutes to complete.

★★★★

Please answer the questions as accurately as you can.

## *Personal Information*

Gender:…….....

Age:……

Level:……..

Course Title:……

1. What kind of mobile device do you have?
   - ❑ Mobile phone for calls and text
   - ❑ Smart phone with advanced computing ability and connectivity
   - ❑ PDA
   - ❑ Tablet PC
   - ❑ Other devices, please specify……
2. Do you have a constant accessibility to the internet?
   - ❑ Yes
   - ❑ No
3. How often do you use the internet from your mobile device?
   - ❑ Everyday
   - ❑ every week
   - ❑ monthly
   - ❑ Rarely
4. Do you access the internet using the campus wireless network?
   - ❑ Yes
   - ❑ No
5. Do you access the internet outside the university (e.g. your home, public library and internet cafe)?
   - ❑ Yes
   - ❑ No
6. Do you pay to access the internet?
   - ❑ Yes
   - ❑ No
7. If yes, what is your opinion on the price of accessing the internet via your mobile device?
   - ❑ High price
   - ❑ Normal price
   - ❑ Low price

**8.** Have you used any educational application on your mobile device?

- ❑ Yes
- ❑ No

Please explain your answer

**9.** If yes, have you used your mobile devices to learn mathematics?

- ❑ Yes
- ❑ No

Please explain your answer

**10.** Do you think it is useful to access your mathematics lectures online using your mobile device?

- ❑ Yes
- ❑ No

Please explain your answer

**11.** Do you use E-Learning platform (computer supported /mediated learning) to learn mathematics?

- ❑ Yes
- ❑ No

Please explain your answer

**12.** Have you heard about Mobile Learning (M-Learning)?

- ❑ Yes
- ❑ No

**13.** What is your opinion of M-Learning?

- ❑ Good idea and I would like to use it,
- ❑ Good idea but I would not like to use it,
- ❑ I do not think it is a good idea.
- ❑ Others

Please explain your answer

**On a scale of 1 to 5 indicate with X how strongly you agree or disagree with each statement.**

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| **1.** I feel I am not capable of using mobile technology applications**.** | ❑ | ❑ | ❑ | ❑ | ❑ |
| **2.** I need training to understand how to use a new mobile application**.** | ❑ | ❑ | ❑ | ❑ | ❑ |
| **3.** I believe that using a mobile device to learn mathematics will increase the flexibility to learn inside and outside the classroom | ❑ | ❑ | ❑ | ❑ | ❑ |
| **4.** I believe implementing and using M-Learning as part of teaching and learning mathematics will make the educational process easier and more enjoyable | ❑ | ❑ | ❑ | ❑ | ❑ |
| **5.** I think that using M-learning will help me to get good grades. | ❑ | ❑ | ❑ | ❑ | ❑ |
| **6.** I believe that implementing M-Learning in the educational process will increase communication between teachers and students. | ❑ | ❑ | ❑ | ❑ | ❑ |
| **7**. Implementing M-Learning will enable me to have independent learning | ❑ | ❑ | ❑ | ❑ | ❑ |
| **8.** I think that M-Learning will improve The quality of the curriculum | ❑ | ❑ | ❑ | ❑ | ❑ |
| **9.** It is not easy to find a hot spot to connect to the internet on your mobile phone or laptop. | ❑ | ❑ | ❑ | ❑ | ❑ |
| **10.** I do not think there is enough technical Support to implement M-learning. | ❑ | ❑ | ❑ | ❑ | ❑ |
| **11.** I believe that implementing M-learning is a complicated process. | ❑ | ❑ | ❑ | ❑ | ❑ |

For which of the following services you find mobile learning might be useful for learning maths:

| Mobile devices services | Useful | Neutral | Not Useful |
|---|---|---|---|
| 1. to access educational content online | | | |
| 2. to access educational content offline | | | |
| 3. to access supporting educational information (math concepts, examples) via WWW | | | |
| 4. to receive supporting educational information via SMS/MMS. | | | |
| 5. to collaborate with others students | | | |
| 6. to collaborate with instructors | | | |

In your opinion what are the challenges that might face implementing M-learning in your department?

Are there any other comments you would like to add in relation to the concept of using M-Learning tools and application to help teach mathematics to undergraduate students?

Thank you very much

# Appendix 2: Questionnaire for M-learning Acceptance

## *Participant Information Sheet*

My name is Ahamd Abu-Al-Aish, I am a PhD student at the School of Information Systems, Computing and Mathematics, Brunel University, and my research topic is 'Mobile Learning for Higher Education'.

Based on the Unified Theory of Acceptance and the use of Technology (UTAUT), this project is trying to investigate the factors M-learning acceptance for higher education.

The survey is going to ask you about your E-learning experiences, knowledge of M-learning and your attitude towards M-learning.

The results of this study will form a part of my doctoral dissertation, and will be published in national and international journals, and will be presented at conferences.

It is not compulsory to take part in this questionnaire, and participants can withdraw at any time without consequences.

All data obtained from participants and their personal details will be kept anonymous.

If you have any concerns or complaints regarding the ethical aspects of this project, please contact siscm.srec@brunel.ac.uk or Professor Zidong Wang, Tel. No. 01895 266021.

### *Definitions*

E-Learning - learning that is accomplished over the Internet, a computer network, via CD-ROM, interactive TV or satellite broadcasts. It can be self-paced or instructor-led and includes media in the form of texts, images, animation, streaming video and audio.

Mobile Learning (M-Learning): learning which takes place via wireless devices such as Smart Phones, PDAs and Tablet PCs. These devices are able to move with the learner to allow learning to take place anytime, anywhere.

### *How long will take to answer this survey?*

The survey will take a proximately 10 minutes to complete.

★★★★

Please answer the questions as accurately as you can.

### *Personal Information*

Gender:…….....**.....**

Age:……

Course Title:……..

**14.** Do you use an E-learning system (all forms of electronically supported learning and teaching include Web-based learning, computer-based learning)

1.❑ Yes 2.❑ No

**15.** How would you describe your general learning via computer and internet?

1.❑ Very Poor 2.❑ Poor 3.❑ Moderate 4.❑ Good 5.❑ Very good

**16.** Experience using mobile devices

| Mobile phone | Smart phone | PDA | Tablet PC | |
|---|---|---|---|---|
| ❑ | ❑ | ❑ | ❑ | N/A |
| ❑ | ❑ | ❑ | ❑ | Less than 1 year |
| ❑ | ❑ | ❑ | ❑ | 1-3 years |
| ❑ | ❑ | ❑ | ❑ | 3-5 years |

**17.** Frequency of using mobile services (times per a day)

| Messaging | internet browsing | Games/Music | Learning/Education | |
|---|---|---|---|---|
| ❑ | ❑ | ❑ | ❑ | N/A |
| ❑ | ❑ | ❑ | ❑ | 1-5 |
| ❑ | ❑ | ❑ | ❑ | 5-10 |
| ❑ | ❑ | ❑ | ❑ | more than 10 |

**18.** Do you use an M-learning system in your studies?

1.❑ Yes 2.❑ No

Please explain which one do you use ……

**19.** How would you describe your general M-learning knowledge?

1.Very Poor 2. Poor 3.❑ Moderate 4.❑ Good 5.❑ Very Good

On a scale of 1 to 5 indicate with an X how strongly you agree or disagree with each of the following statements.

| **Strongly Disagree** | **Disagree** | **Neither Agree nor Disagree** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|
| **1.** | **2.** | **3.** | **4.** | **5.** |

***Performance Expectancy (PE)***

Q1**.** I find M-learning useful for my studies**.** 1. 2. 3. 4. 5.

Q2. Using M-learning would enable me to achieve learning tasks more quickly**.** 1. 2. 3. 4. 5.

Q3. Using M-learning in my studying would

not increase my learning productivity. 1. 2. 3. 4. 5.

Q4. Mobile learning could improve my collaboration with classmates 1. 2. 3. 4. 5.

Q5. Using M-learning would not improve my performance in my studies. 1. 2. 3. 4. 5.

***Effort Expectancy (EE)***

Q6. I would find an M-learning system flexible and easy to use . 1. 2. 3. 4. 5

Q7. Learning to operate an M-learning system does not require much effort. 1. 2. 3. 4. 5.

Q8. My interaction with an M-learning system would be clear and understandable. 1. 2. 3. 4. 5.

Q9. It would be easy for me to become skillful at using an M-learning system. 1. 2. 3. 4. 5.

***Lecturers' Influence (LI)***

Q10. I would use M-learning if it was recommended to me by my lecturers. 1. 2. 3. 4. 5.

Q11. I would like to use M-learning if my Lecturers' supported the use of it. 1. 2. 3. 4. 5.

Q12. Lecturers in my Department have not been helpful in the use of M-learning systems 1. 2. 3. 4. 5.

***Quality of Services (QoS)***

Q13. It is important for M-learning services to increase the quality of learning. 1. 2. 3. 4. 5.

Q14. I would prefer M-learning services to be accurate and reliable. 1. 2. 3. 4. 5.

Q15. It is not important for M-learning services to be secure to use. 1. 2. 3. 4. 5.

Q16. It is important for M-learning to focus on the speed of browsing the internet and obtaining information quickly. 1. 2. 3. 4. 5.

Q17. Communication and feedback between lecturers and students would not be easy. using M-learning systems. 1. 2. 3. 4. 5.

Q18. It is preferable that M-learning services

| | | | | | |
|---|---|---|---|---|---|
| are easy to navigate and download. | 1. | 2. | 3. | 4. | 5. |

| ***Personal Innovativeness (PInn)*** |
|---|

| | | | | | |
|---|---|---|---|---|---|
| Q19. I like to experiment with new information technologies. | 1. | 2. | 3. | 4. | 5. |
| Q20. When I hear about a new information technology I look forward to examining it. | 1. | 2. | 3. | 4. | 5. |
| Q21. Among my colleagues, I am usually the first to try out a new innovation in technology. | 1. | 2. | 3. | 4. | 5. |

| ***Behavioural Intention (BI)*** |
|---|

| | | | | | |
|---|---|---|---|---|---|
| Q22. I plan to use M-learning in my studies. | 1. | 2. | 3. | 4. | 5. |
| Q23. I predict that I will use M-learning frequently. | 1. | 2. | 3. | 4. | 5. |
| Q24. I intend to increase my use of m-learning services in the future | 1. | 2. | 3. | 4. | 5. |
| Q25. I will enjoy using M-learning systems. | 1. | 2. | 3. | 4. | 5. |
| Q26. I would recommend others to use M-learning systems. | 1. | 2. | 3. | 4. | 5. |

***Please add any further comments that you would like to make with regards to the concept of M-learning acceptance and the adoption of this new technology in your department.***

**Thank you very much**

# Appendix 3: Evaluation of the Conceptual Model – Students Questionnaire

## *Participant Information Sheet*

My name is Ahamd Abu-Al-Aish, I am a PhD student at the School of Information Systems, Computing and Mathematics, Brunel University, and my research topic is 'Mobile Learning for Higher Education'.

Based on the results obtained from my first and second studies, this study is trying to explore the factors that affect the deployment of M-learning in higher education and build a framework to overcome all challenges facing the implementation of this technology.

The survey is going to ask you about M-learning challenges and your thoughts about the deployment of M-learning in higher education.

The results of this study will form a part of my doctoral dissertation, and will be published in national and international journals, and will be presented at conferences.

It is not compulsory to take part in this questionnaire, and participants can withdraw at any time without consequences.

All data obtained from participants and their personal details will be kept anonymous.

If you have any concerns or complaints regarding the ethical aspects of this project, please contact siscm.srec@brunel.ac.uk or Professor Zidong Wang, Tel. No. 01895 266021.

### *Definitions*

**Mobile Learning (M-Learning):** learning which takes place via wireless devices such as Smart Phones, PDAs and Tablet PCs. These devices are able to move with the learner to allow learning to take place anytime, anywhere.

### *How long will take to answer this survey?*

**The survey will take approximately 10 minutes to complete.**

★★★★

Please answer the questions as accurately as you can.

***General Information***

**Gender:…….....**

**Age:……**

**Course Title:……..**

**20. Do you use an M-learning system in your studies?**

1. Yes 2. No

Please explain which one do you use ……

**21. How would you rate your general M-learning knowledge?**

1. Very Poor 2. Poor 3. Moderate 4. Good 5. Very Good

In the following section, please indicate to what extent you agree or disagree the following statements regarding on scale of 5 (1=strongly disagree, 2=disagree, 3=Neutral, 4=agree and 5=strongly agree), please answer the following questions based on your own opinions and experience (circle the appropriate number).

| Cross-management initiative |
|---|

1. M-learning needs support from university management to be a success.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

2. University management has to provide the appropriate structure to manage M-learning content and infrastructure.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

3. University management needs to work with other educational institutions to develop workable mobile learning policies.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| Awareness and Motivation: Students and Lecturers |
|---|

4. Teaching and learning specialists should raise awareness between students and lecturers of M-learning and provide them with the appropriate skill to use it.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

5. Teaching and learning specialists need to design a range of learning activities that engage and motivate students in their study.

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

6. Teaching and learning specialists should develop learning objects to help lecturers in deploying M-learning within their teaching and learning strategies.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| On-going technical support |
|---|

7. Students need prompt and effective technical support as required when using the M-learning system.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

8. The technical infrastructure should make course materials available on students' mobile devices**.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

9. There should be on going technical support to maintain M-learning tools and service delivery.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| On-going mobile learning innovation |
|---|

10. The University needs to keep up-to-date on changes in M-learning technology provision.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

11. The university should upgrade the M-learning system when it is necessary.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

12. The university should work with mobile technology companies to develop learning applications suitable for on-going changes in learning and teaching styles.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| Usability and continuous assessment |
|---|

13. The M-learning system should be easy to use.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

14. The interface design of the M-learning system needs to attract the learners' attention.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

15. The M-learning system interface should facilitate learning.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

16. The assessment of M-learning usability in terms of accessibility, interactivity and interface design will affect the success of M-learning deployment.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| Quality of service control |
|---|

17. It is important to control the quality of the M-learning service in order to ensure the success of the system deployment.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

18. The quality of M-learning service needs to be defined at the right level for diverse students groups.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

19. The quality of the M-learning service needs to be up to date and meet students' needs.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| Collaborative learning |
|---|

20. The M-learning system should provide a collaborative learning environment between students and lecturers.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

21. Effective communication between students and lecturers will increase by using an M-learning system.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

22. The M-learning system should enable students to provide feedback on their teaching and learning experiences.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| Trust and Confidence |
|---|

23. Enhancing trust and confidence among members of the M-learning management team as well as between teachers and students will improve people's willingness to use the M-learning system.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

24. Every person involved in the M-learning system should have some form of ownership of the system.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

25. A level of trust between all M-learning system users will open up communication and increase the sharing information.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree*

| Achievements Evaluation |
|---|

26. M-learning outcomes need to be reviewed regularly to ensure that stated goals and learning objectives are being met.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

27. Course evaluations should be conducted in order to check student perceptions of M-learning.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

28. The M-learning system should be regularly monitored to see if it has become embedded as on-going provision in the university.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| Availability and suitability of learning materials |
|---|

29. Making M-learning materials more engaging and suitable for learning and teaching will improve the sustainability of M-learning.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

30. M-learning Materials should be designed to enhance the learning experience and meet learning outcome requirements.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

31. M-learning content needs to be readily available in formats that are easily accessible from various types of mobile devices.

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

| M-learning as a complementary of E-learning |
|---|

32. M-learning system can be easily implemented within the current E- learning system strategy.

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

33. Blending M-learning into the E-learning platform will minimize university resistance.

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

34. Blending M-learning into E-learning platform will solve the problem of lack of M-learning infrastructure in university campuses.

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

1. **In your opinion, what are the most obstacles that might face university toward deployment M-learning in its teaching and learning setting?**

2. **What other factors would you like to add in accordance to your department or end-user needs?**

***Thank you very much for your assistance and co-operation***

# Appendix 4: Evaluation of the Conceptual Model – Lecturers Questionnaire

## *Participant Information Sheet*

My name is Ahamd Abu-Al-Aish, I am a PhD student at the School of Information Systems, Computing and Mathematics, Brunel University, and my research topic is 'Mobile Learning for Higher Education'.

Based on the results obtained from first and second studies of my research. This study aims to explore the factors that affect the deployment of M-learning in higher education and build a framework to overcome the challenges facing the implementation of this technology.

The survey is going to ask you about M-learning challenges and your thoughts about the deployment of M-learning in higher education.

The results of this study will form a part of my doctoral dissertation, and will be published in national and international journals, and will be presented at conferences.

It is not compulsory to take part in this questionnaire, and participants can withdraw at any time without consequences.

All data obtained from participants and their personal details will be kept anonymous.

If you have any concerns or complaints regarding the ethical aspects of this project, please contact siscm.srec@brunel.ac.uk or Professor Zidong Wang, Tel. No. 01895 266021.

### *Definitions*

**Mobile Learning (M-Learning):** learning which takes place via wireless devices such as Smart Phones, PDAs and Tablet PCs. These devices are able to move with the learner to allow learning to take place anytime, anywhere.

### *How long will take to answer this survey?*

**The survey will take a proximately 10 minutes to complete.**

★★★★

Please answer the questions as accurately as you can.

**General Information**

**1. Gender**

1. Male 2. Female

**2.** Your **current position.....**

**3. Years of experience**

1. Less than 2 year 2. 2 - 5years 3. 5-10 years 4. More than 10 years

**4.** How would you rate your **familiarity with M-learning?**

1. Very Poor 2. Poor 3. Moderate 4.Good 5. Very good

In the following section, please indicate to what extent you agree or disagree the following statements regarding on scale of 5 (1=strongly disagree, 2=disagree, 3=Neutral, 4=agree and 5=strongly agree), please answer the following questions based on your own opinions and experience (circle the appropriate number).

Pre deployment stage (infrastructure)

1. **The successful deployment of an M-learning system needs support from all levels of university management.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

2. **Teaching and learning specialists should raise awareness between students and lectures of M-learning, motivate them and provide them with the appropriate skill to use it.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

3. **It is important to provide users with prompt and effective technical support to facilitate the deployment of M-learning.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

4. **The university needs to keep up-to-date with developments in M-learning.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**5. The M-learning system should be user-friendly and attracts the learners' attention.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

Post deployment stage (sustainability stage)

**6. It is important to control the quality of an M-learning service in order to ensure the success of the system deployment and use.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**7. A sustainable M-learning system needs to be used in a collaborative learning environment to enable communication and sharing of information between users.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**8. The assessment of M-learning usability in terms of accessibility, interactivity and interface design will affect the success of M-learning deployment.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**9. Enhancing trust and confidence among members of M-learning management as well as between teachers and students will improve willingness to use M-learning technology.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**10. Making M-learning materials more engaging and suitable for learning and teaching will improve the sustainability of M-learning.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**11. In order to keep M-learning sustainable there is a need to evaluate the impact of the system in terms of meeting students learning outcome requirement.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

## *General evaluation of the framework*

**12. Using the proposed framework will ensure the M-learning system meets user's needs.**

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

*please explain your answer*

.....
.....

**13. The proposed framework can be easily implemented within the current E-learning system strategy.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

14. **Blending M-learning into the E-learning platform will minimize university resistance.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

15. **Blending M-learning into E-learning platform will solve the problem of lack of M-learning infrastructure in university campuses.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**16. Using the proposed framework will increase awareness and build confidence in using M-learning among lecturers and students.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

*please explain your answer*

.....
.....

**17. The proposed framework will support the continuous updating of M-learning systems and services.**

*1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree*

please explain your answer

.....
.....

**18. Using the proposed framework will help design learning materials that support the diversity of learning styles.**

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

*please explain your answer*

.....
.....

**19. The proposed framework will aid faculty members utilize M-learning in their teaching by complementing the existing courses with value –added features.**

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

*please explain your answer*

.....
.....

**20. The proposed framework will support the building and maintaining of the M-learning system.**

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

*please explain your answer*

.....
.....

**21. Using the proposed framework will enable M-learning users to provide feedback on their teaching and learning experiences.**

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

*please explain your answer*

.....

.....

**22. The proposed framework will ensure an effective administrative system for the deployment of M-learning.**

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

*please explain your answer*

.....

.....

1. **In your opinion, what are the main obstacles that might face the university toward the deployment M-learning in its teaching and learning setting?**

2. **What other factors would you like to add in accordance to your institution and end-user needs?**

***Thank you very much for your assistance and co-operation***

# Appendix 5: Ethical Approval for First study

**School of Information Systems, Computing and Mathematics**
David Gilbert, Head of School, Professor of Computing
Jasna Kuljis, Head of Information Systems and Computing, Professor of Computing
Tony Rawlins, Head of Mathematical Science, Professor of Mathematics

The use of e-learning to improve numeracy on Schools

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Email:
Laurence.Brooks@brunel.ac.uk
Lampros.Stergioulas@brunel.ac.uk
Allan.Tucker@brunel.ac.uk

Date: 10th May 2011

**STATEMENT OF ETHICS APPROVAL**

**Proposer: Ahmad Yassen Abu-Al-Aish**

**Title: Determining the Mathematics Department (Brunel University)readiness for Mobile Learning**

The school's research ethics committee has considered the proposal recently submitted by you. Acting under delegated authority, the committee is satisfied that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that you will adhere to the terms agreed with participants and to inform the committee of any change of plans in relations to the information provided in the application form.

Yours sincerely,

**Dr. Laurence Brooks, Chair of the Research Ethics Committee**

Appendix 6: Ethical Approval for Second Study

**School of Information Systems, Computing and Mathematics**
David Gilbert, Head of School, Professor of Computing
Jasna Kuljis, Head of Information Systems and Computing, Professor of Computing
Tony Rawlins, Head of Mathematical Science, Professor of Mathematics

Brunel UNIVERSITY WEST LONDON

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Zidong.Wang@brunel.ac.uk

Date: 14 December 2011

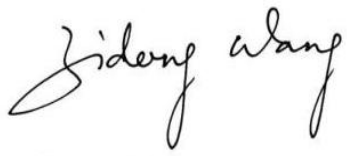
## STATEMENT OF ETHICS APPROVAL

**Proposer: Ahmad Yassen Abu-Al-Aish**

**Title: Factors influencing student acceptance of M-Learning: An Investigation in Higher Education**

The school's research ethics committee has considered the proposal recently submitted by you. Acting under delegated authority, the committee is satisfied that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that you will adhere to the terms agreed with participants and to inform the committee of any change of plans in relations to the information provided in the application form.

Yours sincerely,



**Professor Zidong Wang**
**Chair of the Research Ethics Committee**
**SISCM**

# Appendix 7: Ethical Approval for Third Study

**School of Information Systems, Computing and Mathematics**
David Gilbert, Head of School, Professor of Computing
Jasna Kuljis, Head of Information Systems and Computing, Professor of Computing
Tony Rawlins, Head of Mathematical Science, Professor of Mathematics

Brunel UNIVERSITY WEST LONDON

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Yongmin.Li@brunel.ac.uk
Annette.Payne@brunel.ac.uk
Lampros.Stergioulas@brunel.ac.uk
Zidong.Wang@brunel.ac.uk

Date: 29th October 2012

## STATEMENT OF ETHICS APPROVAL

**Proposer: Ahmad Yassen Abu-Al-Aish**
**Title: Toward a sustainable deployment of M-Learning: A framework in Higher Education**

The school's research ethics committee has considered the proposal recently submitted by you. Acting under delegated authority, the committee is satisfied that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that you will adhere to the terms agreed with participants and to inform the committee of any change of plans in relations to the information provided in the application form.

Yours sincerely,

**Professor Zidong Wang**
**Chair of the Research Ethics Committee**
**SISCM**