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# Solving the Puzzle of Mobile Learning Adoption

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# Solving the Puzzle of Mobile Learning Adoption

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## Abstract

The dissertation seeks to explore how to improve users' adoption of mobile learning in current education systems. Considering the difference between basic and tertiary education in China, the research consists of two separate but interrelated parts, which focus on the use of mobile learning in basic and tertiary education contexts, respectively.

In the dissertation, two adoption frameworks are developed based on previous studies. The frameworks are then evaluated using different technologies. Concerning mobile learning use in basic education settings, case study methodology is utilized. A leading provider of mobile learning services and products in China, Noah Ltd., is investigated. Multiple sources of evidence are collected to test the framework.

Regarding mobile learning adoption in tertiary education contexts, survey research methodology is utilized. Based on 209 useful responses, the framework is evaluated using structural equation modelling technology. Four proposed determinants of intention to use are evaluated, which are perceived ease of use, perceived near-term usefulness, perceived long-term usefulness and personal innovativeness.

The dissertation provides a number of new insights for both researchers and practitioners. In particular, the dissertation specifies a practical solution to deal with the disruptive effects of mobile learning in basic education, which keeps the use of mobile learning away from the schools across such as European countries. A list of new and innovative mobile learning technologies is systematically introduced as well. Further, the research identifies several key factors driving mobile learning adoption in tertiary education settings. In theory, the dissertation suggests that since the technology acceptance model is initiated in work-oriented innovations by testing employees, it is not necessarily the best model for studying educational innovations. The results also suggest that perceived long-term usefulness for educational systems should be as important as perceived usefulness for utilitarian systems, and perceived enjoyment for hedonic systems. A classification based on the nature of systems purpose (utilitarian, hedonic or educational) would contribute to a better understanding of the essence of IT innovation adoption.

**Keywords:** mobile learning, technology acceptance, disruptive effects, long-term usefulness, basic education

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## Chapter 1

### Introduction

*“Wherever one looks, the evidence of mobile penetration and adoption is irrefutable: cell phones, PDAs (personal digital assistants), MP3 players, portable game devices, handhelds, tablets, and laptops abound. No demographic is immune from this phenomenon. From toddlers to seniors, people are increasingly connected and are digitally communicating with each other in ways that would have been impossible to imagine only a few years ago.”*

*(Wagner, 2005, pp. 42)*

*“Consequently, it comes as no surprise that sooner or later people would begin to look for ways to integrate mobile computing into e-learning to make courses more accessible and portable.”*

*(Corbeil and Valdes-Corbeil, 2007, pp. 52)*

#### 1.1 Mobile learning: conceptual framework and context for use

Due to the continued expansion and increased reliability of broadband wireless network, mobile devices nowadays can be used to transmit text, voice, video and animated images at anyplace and anytime. These help to create a new mechanism for training and learning, which is termed as ‘mobile learning’ (or m-learning). The impacts of mobile learning are profound in light of a worldwide proliferation of mobile phones. According to a recent report of Euromonitor (2010), there were 4.0 billion mobile phone subscriptions in the world in 2008, an increase from 1.4 billion in 2003. Portio (2009) forecasted that the number of worldwide mobile subscriptions will surpass 6.3 billion by the end of 2014. In Western Europe, the figure has already reached 100% since 2007. These statistics indicate that no demographic is immune from the use of mobile phone and that potential users of mobile learning abound.

The past decade has seen mobile learning grow from a minor research interest to a thriving research field. It is now increasingly used in museums, schools and workplaces, enabling a wide range of new educational possibilities. For learners in general, mobile learning facilitates the utilization of previously unproductive time, enables learning behaviours regardless of time and place, and brings about tremendous possibilities for personalized, tailored and context-aware learning-support services. As Punie (2007) states that, if leveraged appropriately, mobile learning makes it possible to form a learning space which is socialized, personal,

digital, trusted, pleasant and emotional, creative and flexible, certified, open and reflexive. In universities, mobile learning helps educational institutions to enhance the accessibility, interoperability and reusability of educational resources, and also to improve flexibility and interactivity of learning behaviours at convenient times and places (Murphy, 2006). From the view of society, mobile learning not only extends learning opportunities to the traditionally hard-to-reach learner communities, e.g. dropout teenagers, unemployed learners and learners with learning disabilities, but it also provides a practical alternative to implement informal learning and lifelong learning. In many parts of the world, mobile learning is becoming a new booming industry sector and provides new business opportunities for merchants. For instance, according to a forecast released by Ambient Insight in 2008 (Adkins, 2008), in spite of the current economic crisis, the mobile learning market in the USA reached \$538 million in 2007 and it is estimated to continue to grow at a five-year compound annual growth rate (CAGR) of 21.7%. Mobile device manufacturers, such as Nokia and Apple, have stepped in the mobile learning market and are now playing an important role.

### **1.1.1 Conceptualizing mobile learning**

Despite widespread enthusiasm, mobile learning is still in its infancy and in an embryonic stage (Motiwalla, 2007). At this stage, researchers defined mobile learning from different perspectives, even if little agreement has been achieved.

For instance, Geddes (2004) defined mobile learning as the acquisition of any knowledge and skill through using mobile technology, anywhere, anytime that results in an alteration in behaviour. Geddes further specified that ‘alteration in behaviour’ indicates the result of learning from the perspective of behaviourism.

Ting (2005) conceptualized mobile learning as the application of mobile or wireless devices for learning when the learner is moving. The target of mobile learning is to enhance the value of wireless communication network, not to be a substitute for the classroom learning. Meanwhile, flexible, accessible and personalized learning activities are considered as the advantages provided by mobile learning (Ting, 2005).

Sharma and Kitchens (2004) referred to mobile-learning as a learning process which takes the advantages of mobile devices, ubiquitous communications technology and intelligent user interfaces. The adoption of mobile learning would facilitate further progress in “pedagogy, educational roles, curricular content, and classroom practices” (Sharma and Kitchens, 2004, pp. 203). In addition, Sharma and Kitchens (2004) noted that mobile learning intelligently

combines e-learning and instructor-led training to be a new kind of blended learning.

The majority of researchers and educators, actively or passively, describe mobile learning as the prolongation of e-learning. Wagner (2007), for example, regarded mobile learning as an extension of e-learning utilization at organizations. Jacob and Issac (2007) described mobile learning as a subset of e-learning. Motiwalla (2007, pp. 594) held the opinion that mobile learning is an essential extension of e-learning even though ‘this transition will not occur over night’. Quinn (2000) described mobile learning as the convergence of mobile computing and e-learning. In addition, both Wagner (2007) and Motiwalla (2007) considered that mobile technologies and mobile devices are stimuli to promote e-learning.

Among all the mobile learning definitions made, Laouris and Eteokleous (2005) provided one of the most extensive ones. After a comprehensive review and comparisons between e-learning and mobile learning in the article, they proposed an abstract formulation for the definition of mobile learning as follows:

$$MLearn = f(t, s, LE, c, IT, MM, m)$$

In the formula, the t, s, LE, C, IT, MM and m stand for time, space, learning-environment, content, information technology, mental abilities and method, respectively.

For the purpose of this dissertation, mobile learning is defined as the acquisition of any knowledge and skill through the use of handheld technology, anywhere, anytime, which is adapted from the work of Geddes (2004). A mobile learning device can be a handheld device but not necessarily a communication device. For instance, a mobile learning device can be a MP3, a MP4 or an E-book reader. Specifically, Corbeil and Valdes-Corbeil (2007) summarized eight different handheld devices for the purpose of mobile learning in terms of their particular merits and limitations, such as USB Drive. In particular, there is a series of new handheld devices designed especially for mobile learning purpose, which have no wireless telephony capability. In this sense, mobile learning devices therefore should not be limited to the contexts of mobile phones.

### **1.1.2 Context of use**

Context of use has been identified as an important variable to understand the use of mobile services. Use context can be defined as the concrete social setting in which a technology is going to be used (Wijngaert and Bouwman, 2009). The use of technology tends to be context-dependent (e.g. Wijngaert and Bouwman, 2009; Liu and Li, 2010). Similarly, to evaluate how mobile learning will be adopted, it is necessary to understand the possible contexts where mobile learning will be utilized.

By summarizing previous studies, Chen and Kotz (2000) divided mobile computing context into four categories:

- Computing context, such as network bandwidth, communication costs, and nearby resources such as workstations, printers.
- User context, e.g., user's profile, location, people nearby.
- Physical context, e.g., lighting, noise level, traffic conditions.
- Time context, e.g., time of the day, season of the year.

Regarding everyday learning activities, Vavoula (2005) classified context into six types, including temporal context, social context, situational context, educational context, activity context and historical context. In the study, Vavoula (2005) collected 161 learning scenarios reported from 15 adult participants in a period of two weeks. More specifically, 82 of the total 161 learning scenarios were found to take place at learners' office or home, while 34, 10, 8 and 3 scenarios took place in other locations in the workplace outside the office, at places of relaxation, outdoors and in a friend's house, respectively (Vavoula, 2005). 23 learning scenarios occurred in other locations, including places of worship, cafes, hobby stores, the doctor's surgery, in cars. Only 1% of the self-reported scenarios happened on public transport. This suggests a possible opportunity for people to exploit previously unproductive travelling time for learning purpose. To some degree, the study indicated that there are many learning scenarios in daily life where mobile learning can probably be involved and lend a helping hand. On the other hand, learning activity occurs frequently in daily life as long as people intend to adapt their activities to enable educational outcomes.

Some researchers emphasized the impact of interaction on forming mobile learning context. Sharples et al. (2005) proposed that context should not be viewed as a shell surrounding the learner at given time and place; context is a dynamic entity and is constructed through the interactions between learners and their environment. Similarly, Luckin et al. (2007) suggested that users can create learning contexts by themselves.

Further, some research indicated that mobile learning can be advantageous if a learner is situated in the 'right' episodes, particularly when a learner is moving or at a 'non-place'. The term 'non-place' refers to the places where people are mobile in logic, but physically immobile, such as airport terminals and waiting halls (Kynäslähti and Seppälä, 2003). Additionally, mobile learning can benefit learners situated in a stable episode, such as in class or in a situation where people want to avoid moving, e.g., a patient receiving a daily diagnosis and prescription at home from a doctor who is working at the hospital. At home, a sofa or a bed is the most frequently mentioned place by mobile device owners

(Hujala, et al., 2003), which can be a potentially ideal location for mobile learning. Additionally, mobile learning can be very useful regarding just-in-time learning or learning in urgent situations, such as first aid (Kynäsalahti, 2003).

## **1.2 What do we expect from mobile learning?**

Continuous technology advance rapidly increases the availability of low-cost mobile devices and mobile services, making mobile devices affordable to the masses (Cobcroft et al., 2006). As a result, more and more learners, who were previously unreachable from traditional education system, become accessible using their mobile phones. To a great extent, mobile learning is a method that seeks to extend education to all social economic levels and to various different contexts. Hence, it can be stated that potential users who can benefit from mobile learning abound.

### **1.2.1 Mobile learning for school and college students**

As forefront users of mobile technologies in modern societies, today's students have new characteristics different from their predecessors. Prensky (2001) stated that learners of different generations perceive and adopt information technology differently. 'Millennial students', those born in or after 1982, are grown up with SMS, mobile phones, chat rooms and emails as the main sources of communication (Oblinger, 2003; Oblinger, 2004; McMahan and Pospisil, 2005). In a review of over 400 studies related to mobile learning, Cobcroft et al. (2006, pp. 22) indicated that today's learners have changed greatly due to "a constant exposure to digital technologies, gadgets, games, and mobile devices". The millennial generation has developed an information technology mindset and a highly developed skill in multitasking (McMahan and Pospisil, 2005). They are described as having a focus on 'connectedness' and social interaction with a preference for group-based methods in study and social occasions (McMahan and Pospisil, 2005). It is suggested that students can learn best when their learning is socially constructed and contextual, self-controlled with clear outcomes and goals (McMahan and Pospisil, 2005; Oblinger, 2003). In summary, as Prensky (2001) points out, constantly surrounded by digital equipments, today's students "are no longer the people our educational system was designed to teach" (Prensky, 2001, pp. 1). Hence, many educators expected that mobile learning would accommodate today's students' life- and learning styles and engage students for a better education performance and outcomes (e.g. Cobcroft et al., 2006).

### **1.2.2 Mobile learning for mobile workforce**

Apparently, today's working environment and social competition become increasingly knowledge-based. This raises a need for employees to adopt more learning activities to renew and update their skills and knowledge, so as to stay competitive in workplace. The rise of learning requirements however went with problems, as today's workforce becomes increasingly nomadic around the world (Edwards, 2005). For example, according to the forecast of IDC (2008), 75% of American workforce and 80% of Japan workforce will become nomadic by 2011. Also it is estimated that the worldwide mobile worker population will increase from 758.6 million in 2006 to 1.0 billion in 2011, accounting for 30.4% of the total workforce (IDC, 2008). On the other hand, the time available for employees to access training in a traditionally sedentary manner is limited. In 2003, an employee on average had less than three days of training (Hayes et al., 2005). There is little evidence showing that time and resources available for formal training will be increased. Hence, the use of mobile learning can be beneficial considering its ubiquitous availability for nomadic workers.

### **1.2.3 Mobile learning for economically and educationally disadvantaged learners**

Some teenagers are subjectively unsatisfied with or economically unable to attend conventional classroom-based learning environments nowadays. Consequently they drop out without pursuing any further training or education. The dropouts are generally unreachable by conventional educational approaches and are more prone to become the future illiterates, resulting in particular social problems. For example, it is estimated that in the UK, nearly 10 million adults were found lacking confidence in using literacy skills (BBC, 2007), while in China, the number of people deemed illiterate jumped from 30 million in 2000 to 116 million in 2005, right after India (China Daily, 2007). Worldwide, there are about 785 million illiterate adults aged over 15 in 2009 (Indexmundi, 2009). Early dropout of teenagers from schools would cause serious social problems. It is reported that early dropouts are more likely to be in prison, unemployed, poor health, divorced and single parents, living in poverty and receiving government assistance (Pytel, 2006). Compared to the relatively high cost of a personal computer, a mobile phone contributes to an affordable conduit for young people to access education. As the mobile phone to a large degree provides the only effective channel for educator to access these disadvantage learners, mobile learning is therefore expected to make a contribution in this regard.



## **1.3 Benefits of mobile learning**

Tremendous advantages of mobile learning for different learner groups have been identified, which will be discussed in this section.

### **1.3.1 Benefits of mobile learning for general educators and learners**

A series of studies have been conducted on students' use of mobile learning technology. In a review of about 140 previous studies, Savill-Smith and Kent (2003, pp. 4) stated that palmtop computers can "assist students' motivation, help organizational skills, encourage a sense of responsibility, help both independent and collaborative learning, act as reference tools, and can be used to help track students' progress and for assessment". In a similar way, Corbeil and Valdes-Corbeil (2007, pp. 54) summarized the advantages of the use of mobile learning as follows:

- Great for people on the go.
- Anytime, anywhere access to content.
- Can enhance interaction between and among students and instructors.
- Great for just-in-time training or review of content.
- Can enhance student-centred learning.
- Can appeal to tech-savvy students because of the media-rich environment.
- Support differentiation of student learning needs and personalized learning.
- Reduce cultural and communication barriers between faculty and students by using communication channels that students like.
- Facilitate collaboration through synchronous and asynchronous communication.

Based on 12 international case studies, Kukulska-Hulme and Traxler (2005) summed up the advantages of using mobile learning for teaching and learning purposes. These advantages typically include:

#### Access

- Improving access to assessment, learning materials and learning resources.
- Increasing flexibility of learning for students.
- Compliance with special educational needs and disability legislation.

#### Changes in teaching and learning:

- Exploring the potential for collaborative learning, for increasing students' appreciation of their own learning process, and for consolidation of learning.

- Guiding students to see a subject differently than they would have done without the use of mobile devices.
- Identifying learners' needs for just-in-time knowledge.
- Exploring whether the time and task management facilities of mobile devices can help students to manage their studies.
- Reducing cultural and communication barriers between staff and students by using channels that students like.
- Wanting to know how wireless/mobile technology alters attitudes, patterns of study, and communication activity among students.

Alignment with institutional or business aims:

- Making wireless, mobile, interactive learning available to all students without incurring the expense of costly hardware.
- Delivering communications, information and training to large numbers of people regardless of their location.
- Blending mobile technologies into e-learning infrastructures to improve interactivity and connectivity for the learner.
- Harnessing the existing proliferation of mobile phone services and their many users. (Kukulska-Hulme and Traxler, 2005, pp. 3-4)

### **1.3.2 Benefits of mobile learning for mobile workforce**

For both mobile workforces and enterprises, the benefits of mobile learning are many. If implemented appropriately, mobile learning can help enterprises to reduce the traditional training infrastructure, assist employees' learning behaviours and promote their productivity and effectiveness whilst moving (e.g. Grohmann et al., 2005; Donnelly, 2009). Koschimbahr (2005) suggested that mobile learning can assist enterprises in saving cost, enhancing customer services and offering better selling opportunities. Also it is capable of improving job satisfaction and reducing job stress as well as employee turnover (Koschimbahr, 2005). It enables employees to utilize previously unproductive time in concert with people's hectic lifestyle (Geddes, 2004). Regarding ICT literacy, Punie (2007) stated that mobile learning helps to advance ICT skills, promote digital competence and fight ICT resistance. Ufi/learnirect and Kineo (2007) suggested that mobile learning enables to deal with a number of challenges faced by business community as follows:

- Mobile learning enables business entities to provide learning to mobile staff and to distribute learning quickly.

- Mobile learning enables the delivery of key data at the point of need—particularly relevant for workers who need access to updated product specifications, pricing details or other time-sensitive information.
- Mobile learning enables companies to utilize staff downtime, those short periods of time waiting or travelling.

### **1.3.3 Benefits of mobile learning for economically and educationally disadvantaged learners**

Compared to traditional educational approaches, mobile learning has a number of unique advantages in engaging economically and educationally disadvantaged learners. Considering the fact that many learners might never be able to afford a personal computer or enrol into formal education again, a mobile phone, which is becoming increasingly affordable for people, would contribute to an effective education delivery method. The advantages of implementing mobile learning for those learners are many. For instance, benefited from the communication function and the personal nature of mobile phone, mobile learning enables collaboration and informal interaction between peer students, which helps students to build social capital and motivates disengaged or at-risk students (Naismith et al., 2004; Sharma and Kitchens, 2004). On the other hand, it adds a new dimension for student–instructor interaction and induces a positive attitude among the students towards the instructor and learning (Vogel et al., 2007; Pei-Luen et al., 2006; Grohmann et al., 2005). In a similar way, Attewell (2005) stated that mobile learning is capable of benefiting disadvantage learners in the following aspects:

- Mobile learning helps learners to improve literacy and numeric skills and to recognize their existing abilities;
- Mobile learning can be used for promoting independent and collaborative learning experiences;
- Mobile learning helps learners to identify where they need assistance and support;
- Mobile learning helps to combat resistance to the use of ICT and can help to overcome the divide between mobile phone literacy and ICT literacy;
- Mobile learning helps to remove some of the formality from the learning experience and engages reluctant learners;
- Mobile learning helps to concentrate a learner’s attention for longer periods;
- Mobile learning helps to raise self-esteem;
- Mobile learning helps to raise self-confidence.

In light of its tremendous benefits, educators in general hold positive expectations on the future of mobile learning. For instance, Sharma and Kitchens (2004) argued that the advent and subsequent development of mobile learning indicate a profound evolution from distance learning (d-learning) to electronic learning (e-learning) and then on to mobile learning (m-learning). In addition, mobile learning is expected to establish a sort of “highly situated, personal, collaborative and long-term (learning); in other words, truly learner-centred learning” (Naismith et al., 2004, pp. 36).

#### **1.4 Motivation and aim for research; research problem and questions**

Currently, mobile learning industry is still in an embryonic stage. In particular, the uptake of mobile learning in general is much slower than expected. Pozzi (2007) stated that currently the use of mobile learning in school contexts is occasional and in a supplemental way. Patten et al. (2006) categorized current mobile learning applications into seven categories, namely administrative, referential, interactive, micro-world, data collection, location aware and collaborative. Finally, they concluded that much of the work presented across the categories has limited success “in the field” (Patten et al., 2006). Herrington and Herrington (2007) argued that current use of mobile learning is pedagogically regressive and is predominantly within a didactic, teacher-centred paradigm. In a study on mobile learning use in tertiary institutions, Duncan-Howell and Lee (2007, pp. 230) stated that “the adoption of M-Learning (mobile learning) in tertiary settings would appear to be underway, though it is still in its infancy.”

A number of studies indicated that there are many challenges impeding users’ acceptance of mobile learning technology. First, it is suggested that availability of mobile technology per se does not guarantee the use of technology. Recent report indicated that, in spite of a growing popularity of Third-generation (3G) mobile telephony, advanced mobile services have not yet found their ways into users’ everyday lives and users are generally hesitant to use these services (Carlsson et al., 2005; Carlsson et al., 2006a; Walden et al., 2007). There is no reason why mobile learning should be an exception.

Second, there are a number of possible technical restrictions that impede the use of mobile learning. Wang et al. (2009) indicated that the existence of a number of technological challenges makes it difficult to adapt traditional e-learning resources for mobile learning use. As specified by Maniar et al. (2008), these restrictions to a large degree are of ten aspects: (i) lack of data input capability; (ii) low storage; (iii) low bandwidth; (iv) limited processor speed; (v) short battery life; (vi) lack of standardization; (vii) limited interoperability; (viii) compatibility issues; (ix) low screen resolution; and (x) small screen size.

Third, unlike conventional classroom-based learning, the use of mobile learning presents a new option instead of a compulsory responsibility. Hence, the success of mobile learning heavily lies in learners' subjective willingness to adopt the technology. However, not all the learners are willing to use mobile learning. For instance, the studies of Attewell (2005) and Attewell and Savill-Smith (2003) found that an important part of the learners have no preference for future use of mobile learning at the end of their projects. Albeit equipped with advanced mobile devices, many students and education programmes are still not ready for mobile learning despite their familiarity with advanced mobile technologies (Corbeil and Valdes-Corbeil, 2007).

Fourth, recent years have seen a number of mobile learning phenomenons that are not well explained. Even if the conception of mobile learning has been proposed for more than ten years, the research on mobile learning is still lack of theoretical underpinnings. The industry has seen many mobile learning initiations failed with an investment of million dollars, but there are many mobile learning developers who make an annual profit of millions of dollars. We have seen mobile learning being frequently described as an education solution benefited from a wide prevalence of mobile phones, which are, however, forbidden to be used in schools across European countries. Meanwhile, we have seen a number of digital handhelds being specifically designed for mobile learning purposes, which are widely accepted by young students in schools in China. We have seen mobile learning being mostly described as a solution for learners of all ages; however, users of different age groups tend to use mobile learning in different ways. We have seen mobile learning being mostly described as a solution for mobile learners; however, some users tend to use it in stable environments, such as in classrooms and at home. Taking the above problems into consideration, it is necessary to investigate learners' behaviours in a more detailed way.

Considering above-mentioned challenges, a study to investigate learners' behaviour towards mobile learning acceptance is apparently needed. A research in this regard would offer fresh and practical insights on how learners use and accept the mobile learning technology. This is also the aim of the dissertation. The research is set to collect data in China, where mobile learning industry develops rapidly. It is worth noting that companies in China made a number of breakthroughs in implementing mobile learning technology in basic education.

Accordingly, the key research problem of the dissertation is to find out how to improve users' adoption of mobile learning. Considering contextual differences between basic and tertiary education environments, the dissertation aim to investigate the key research problem by answering two subset research questions, which are (Table 1.1):

- |   |
|---|
| <ol style="list-style-type: none"><li>1. How to promote students' acceptance of mobile learning in schools?<ol style="list-style-type: none"><li>a. <i>Why does mobile learning achieve an unprecedented success in basic education in China? How is mobile learning industry in China dealing with challenges faced?</i></li><li>b. <i>How to implement mobile learning in basic education so that it is acceptable by students, teachers and parents?</i></li></ol></li><li>2. How to promote students' acceptance of mobile learning in universities?<ol style="list-style-type: none"><li>a. <i>What are the factors driving mobile learning adoption in universities?</i></li><li>b. <i>To what degree do these factors influence the adoption of mobile learning in universities?</i></li></ol></li></ol> |
|---|

**Table 1.1 Research questions**

## **1.5 Overview of the dissertation and contributions from original papers**

To solve the above-formulated research questions, the dissertation is organized into eight chapters (see figure 1.1).

Chapter 1 explains the significance of the research, including what we expect from implementing mobile learning and the benefits of using the technology. Research objectives, motives and questions are presented in this chapter as well, followed by an outline of the structure of the dissertation.

Chapter 2 provides the state-of-art of current mobile learning development. Both theoretical and practical developments of mobile learning are depicted. Self-directed learning theory is discussed in the chapter, which helps to provide a theoretical underpinning of mobile learning research. The self-directed learning theory, also applied in Chapter 6, serves as an important theory to explain the disruptive effects of mobile learning in basic education. Additionally, mobile learning development in China is explicitly introduced, which offers background information of conducting the research.

Chapter 3 presents methodological basis of the dissertation and methodologies adopted for conducting the research.

Chapter 4 reviews key adoption theories in IS concerning the factors driving IT innovation adoption and success. Additionally, adoption research concerning both mobile technology and education technology is reviewed as well. This chapter offers theoretical basis for establishing research models.

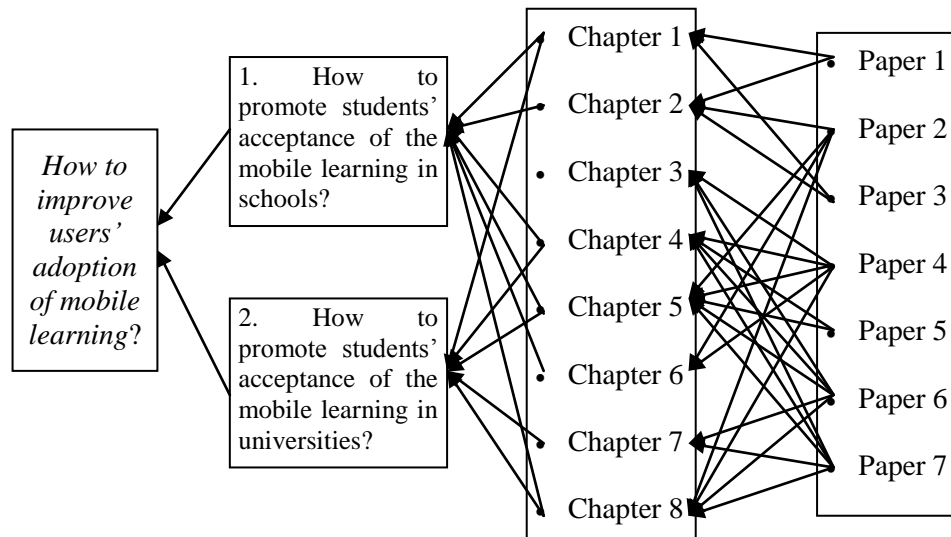
Chapter 5 establishes the research frameworks based on Chapter 4. Explicitly, two research frameworks are built concerning mobile learning in basic and

tertiary education environment, respectively. These two frameworks guide questionnaire design and data collection process.

Chapter 6 presents the research process and findings on mobile learning adoption in basic education. The related framework is assessed in the chapter.

Chapter 7 presents questionnaire design, data collection, instrument assessment and data analysis of research on mobile learning adoption in tertiary education. Key findings are illustrated and the related framework is assessed as well.

Chapter 8 summarizes research findings and answers to the research questions proposed at the beginning of the dissertation. Contributions of the research are discussed. The limitations of the dissertation are also presented and possible avenues for further research are discussed.



**Figure 1.1 Interrelationships between research questions and publications**

The dissertation is based on seven original publications, which are:

**Publication 1:** Liu, Y. and Li, H-X. (2008). Supporting Distance Users of Mobile Learning Technology. In proceedings of 2008 International Conference on Computer Science and Software Engineering, Wuhan, China.

The paper reports on the potentials of mobile learning in concert with people's expectation on the technology. Learning requirement and characteristics of different user groups are discussed. The paper concludes that mobile learning is of practical significance and that it is therefore meaningful to conduct the

research. The paper provides a starting point for the present research and contributes to chapter 1 and 2.

**Publication 2:** Liu, Y. and Li, H-X. (2009). What Drives M-learning Success?—Drawing Insights from Self-Directed Learning Theory. In proceeding of Pacific Asia Conference on Information Systems 2009 (PACIS 2009), Hyderabad, India.

The paper identifies the fact that current mobile learning research is lack of concrete theoretical underpinnings. Accordingly, the paper introduces self-directed learning theory into the field and uses it to explain the phenomena of current mobile learning development. A number of mobile learning initiatives are summarized and classified, which offers a brief picture of current mobile learning development. The paper explains the formation of disruptive effects of using mobile learning technology from the view of self-directed learning theory. The paper concludes that self-directed learning theory should be a sound theoretical underpinning for further mobile learning research. The paper contributes to chapter 2, 5, 6 and 8, and helps to answer the research question 1.

**Publication 3:** Liu, Y. and Li, H-X. (Accepted). Supporting Distance Users of Mobile Learning Technology, In Chao, L. (Ed.), Open Source Mobile Learning: Mobile Linux Applications. Publisher: IGI Global.

This book chapter is based on an integrated extension of both publication 1 and publication 2. The book chapter systematically introduces (i) key contexts of using mobile learning; (ii) theoretical and technological underpinnings of mobile learning implementation; (iii) advantages of applying mobile learning for different user groups. It contributes to chapter 1 and 2 in the dissertation.

**Publication 4:** Liu, Y. Liu, J. and Yu, S. (2008). A Case Study on Mobile Learning Implementation in Basic Education. In proceedings of 2008 International Conference on Computer Science and Software Engineering, Wuhan, China.

The paper is based on a case study on the success of mobile learning in basic education in China. Explicitly, the paper investigates a series of products of Noah Ltd., which are termed digital learning devices. Based on the technology acceptance model, a number of possible driving factors of mobile learning use are specified, which provide a direction for investigating the success of the company. In addition, technological breakthroughs achieved by the company are illustrated, together with its unique conceptions on mobile learning implementation. The paper helps to answer the research question 1 and relates to chapter 3, 4, 5, 6, 8 in the dissertation.



**Publication 5:** Liu, Y. Han, S-N. and Li, H-X. (2010). Understanding the factors driving m-learning adoption: A literature review. *Journal of Campus-Wide Information Systems*, Volume 27, Issue 4, pp. 210-226.

The paper aims to build a sound theoretical framework for investigating mobile learning adoption. Based on a review of prior adoption studies related to both mobile and educational technology, the framework is established which serves as the basis for future empirical study. The paper serves as a basis for developing adoption model in publication 6. It contributes to chapter 4 and 5 in the dissertation.

**Publication 6:** Liu, Y. Li, H-X. and Carlsson, C. (2009). Exploring the Factors Driving M-Learning Adoption. In proceeding of 15<sup>th</sup> Americas Conference on Information Systems (AMCIS 2009), San Francisco, California, USA.

Based on a survey questionnaire, the paper empirically assesses the driving factors of the intention to use mobile learning. In the paper, mobile learning applications and platforms in tertiary education contexts are discussed. Additionally, a number of hypotheses are developed and tested based on 209 useful responses. The paper concludes with a number of practical suggestions. The paper helps to answer the research question 2 and relates to chapter 3, 4, 5, 7 and 8 in the dissertation.

**Publication 7:** Liu, Y. Li, H-X. and Carlsson, C. (2010). Factors driving the adoption of m-learning: An empirical study. *Computers & Education*, Volume 55, Issue 3, pp.1211-1219. (Thomson ISI; 2009 Impact Factor = 2.059).

The paper is an extension of publication 6. A more in-depth discussion is made in the paper regarding the validation of using TAM in education contexts. Compared to publication 6, the paper specifically illustrates the research background and survey process. In addition, theoretical and practical contributions of the research are discussed in a more detailed manner as well. Like publication 6, the paper helps to answer the research question 2 and relates to chapter 3, 4, 5, 7 and 8 in the dissertation.



## **Chapter 2**

### **Literature review: state-of-art of mobile learning development**

In light of its tremendous potential, a wide spectrum of research has been conducted to promote the development of mobile learning. This chapter discusses the state-of-art of current mobile learning development from both theoretical and practical views. Current theoretical underpinnings for mobile learning are illustrated regarding their features. Considering the lack of sound theoretical underpinnings of mobile learning research, self-directed learning theory is introduced, which appears to be very useful to explain users' mobile learning activities. In practice, the development of mobile learning is discussed regarding different stakeholders. For instance, government organizations expect that mobile learning would help to deal with some difficult social problems, such as reducing the number of illiterates. Merchants seek to generate new revenue by selling mobile learning services and products. Educational institutions hope to improve teaching performance and engage their students by the use of mobile technology. Those efforts initiate new features of mobile learning development in different areas and countries. This chapter aims to offer a brief picture of mobile learning development in the world. In particular, a description of both mobile learning industry in China and Chinese education systems is made. As the dissertation is based on the development of mobile learning in China, this gives some basic information of research contexts, which is very important for an audience to understand the contribution and findings of the present dissertation.

#### **2.1 Theoretical development of mobile learning**

Unlike traditional education approaches, mobile learning is built on the use of mobile technologies. Hence, mobile learning has a number of unprecedentedly new features. In concert with the unique nature of mobile technologies, these new features can be illustrated as shown in Table 2.1 (source from: Sharples et al., 2005, pp. 3).

New Learning	New Technology
Personalized	Personal
Learner-centred	User-centred
Situated	Mobile
Collaborated	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

**Table 2.1 Convergence between learning and technology**

However, these new features also bring about new challenges for mobile learning establishing its theoretical underpinnings. Note that most theories of pedagogy fail to capture the unique nature of mobile learning, as they are mostly based on the assumption that learning takes place in a classroom environment, controlled by teachers. Compared with previous education methods, mobile learning appears to be a learner-centred approach (Naismith et al., 2004). It typically takes place in an unstructured environment and seeks to tailor service for personal needs.

### **2.1.1 Five mobile learning theoretical underpinnings proposed by Naismith et al.**

Currently theoretical underpinnings of mobile learning research are mostly based on the work of Naismith et al. (2004), who compared new mobile learning practices against existing learning theories, which are behaviourist, constructivist, situated, collaborated, informal and lifelong learning.

- **Behaviourist learning theory**

Behaviourist learning emphasizes learning experiences gained as a change in observable actions with proper stimulus and response. This approach is “predetermined, constrained, sequential and criterion-based” (Juhary, 2007, pp. 378). With the advance of mobile technologies, mobile learning makes it possible to form a ‘drill and feedback’ mechanism complied with the behaviourist learning theory. Specifically, mobile learning can give learners content specific questions, then gather their responses in a rapid manner and provide instant feedback by such as using wireless network or SMS, which fits with the behaviourist learning paradigm (Naismith et al., 2004).

- **Constructivist learning theory**

The constructivist theory emphasizes gaining learning experience in a way that learners actively build new ideas or concepts based on both their previous and current knowledge (Naismith et al., 2004). With a mobile phone, a learner can construct his/her own knowledge and share it freely with peers regardless of

time and place. Specifically, an easy way for mobile learning to enable an immersive constructivist learning experience is to offer edutainment (e.g. handheld games) (Corbeil and Valdes-Corbeil, 2007).

- **Situated learning theory**

Situated learning focuses on learning activities that occur in authentic contexts (Naismith et al., 2004), where the environment itself appears to be a part of education resources. For situated learning, the environments can be pre-organized, such as studying in a museum (Etxeberria et al., 2007), or naturally developed, such as watching birds in open air (Chen et al., 2003). Explicitly, situated learning experience can be realized via three manners, namely problem-based learning, case-based learning, and context-aware learning (Naismith et al., 2004).

- **Collaborated learning theory**

Collaborated learning experiences are initiated as a learning process with proper social interaction (Naismith et al., 2004). The increasing availability of wireless networks in personal devices not only makes it much easier to communicate and share data, files and messages with partners, but also makes learning collaboration easier to initiate and to respond to. Taking the recent popularity of open source software into account, learning collaboration to a large extent seems to be more self-initiated and socialized.

- **Informal and lifelong learning theories**

Informal and lifelong learning focuses on the learning activities that take place outside a dedicated learning environment, such as a predetermined curriculum (Naismith et al., 2004). Informal learning can be intentional with intensive and deliberate learning efforts, or it can be accidental, such as through TV, newspapers and conversations (Naismith et al., 2004). To the degree that mobile devices facilitate instant information acquisition in a seamless and unobtrusive way, mobile learning is in particular suited to promote informal and lifelong learning experience.

In essence, different learning theories seek to offer different mobile learning experiences and picture mobile learning from different aspects. It is the inherent nature of mobile learning that lends itself well to motivate learners intrinsically by offering versatile learning experiences. Hence these learning experiences should be integrated and combined instead of being separated.

Naismith et al. (2004)'s introduction of these theories into mobile learning contexts makes an apparent contribution to the field, which offers a number of practical insights about how mobile learning can be implemented into people's learning activities. However, these learning theories simply focus on explaining

how learning happens, while the learning activities suggested by those learning theories take place regardless of technological environment surrounded. Accordingly, these learning theories are not pertaining to mobile learning and fail to represent the unique nature of mobile learning as well.

Further, built upon a summarization of current mobile learning projects, Herrington and Herrington (2007) argued that current mobile learning applications are predominantly developed with a didactic, teacher-centred paradigm. In a contradictory manner, mobile learning is widely described as a learner-centred approach (e.g. Naismith et al., 2004; Moses, 2008).

The long dearth of proper theoretical underpinnings in mobile learning research has been identified by many researchers (e.g. Sharples et al., 2005; Muyinda, 2007). Regarding this challenge, Sharples et al. (2005) proposed a list of criteria against which a new mobile learning theory could be tested. These criteria also offer an important foundation for developing a new theoretical underpinning for mobile learning research, which are:

- Is it significantly different from current theories of classroom, workplace or lifelong learning?
- Does it account for the mobility of learners?
- Does it cover both formal and informal learning?
- Does it theorize learning as a constructive and social process?
- Does it analyse learning as a personal and situated activity mediated by technology? (Sharples et al., 2005, pp. 4)

### **2.1.2 Learner-centred andragogy: Self-directed learning theory**

In light of the lack of theoretical underpinnings, self-directed learning theory is introduced here. The purpose of this is to offer an alternative theoretical underpinning for mobile learning research, which also helps to explain learners' acceptance of mobile learning.

Self-directed learning (SDL) theory is a theory that has long been stressed and applied in problem-based, lifelong and distance learning settings (Fisher et al., 2001; Stewart, 2007). SDL can be defined in two general ways: (a) as a process of learning (Garrison, 1997; Grow, 1991), and as a personal attribute (Guglielmino et al., 1996; Oddi, 1987). In its broadest meaning, "self-directed learning describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975, pp. 18).

SDL research has evolved to be an empirical approach as early as 1980. Guglielmino (1977) proposed a notion of SDL readiness and developed a questionnaire to empirically assess learners' SDL attributes. This measurement concerns three variables, namely (i) self-management, (ii) desire for learning and (iii) self-control. In a similar way, self-management is included in readiness for online learning theory as an important dimension as well. "Indeed, the need for self-direction, or self-management of learning, runs clearly throughout the distance education and resource-based flexible learning studies (Smith, 2005, pp. 10)." The level of self-directed learning capability has been widely found to be a strong variable for predicting students' academic performance in a variety of education contexts (e.g. Hsu and Shiue, 2005; Stewart, 2007). The work of Warner et al. (1998) indicated that the capacity for self-directed learning is one important characteristic for the learners who successfully engage with online learning. Similarly, learners' self-management capability has been found to be a significant factor influencing their intention to adopt mobile learning as well (Wang et al., 2009).

However, SDL theory has not yet been introduced to mobile learning research. A reflection of both SDL theory and mobile learning indicates that they share similar research scenarios and basis, and that they are inter-related. A number of key statements describing key features of pedagogy, andragogy, self-directed learning theory and mobile learning are summarized here, which help to depict a picture of the relationships among them.

- The practice of pedagogy is teacher-centred while andragogy is learner-centred, with the role of the teacher primarily as a facilitator (Choy and Delahaye, 2002).
- "Andragogy describes the instructional approach based on SDL theory while pedagogy describes the traditional instructional approach based on teacher-directed learning theory" (Knowles, 1980; cited from Tasir et al., 2008, pp. 1023).
- SDL capability is closely related to distance and lifelong learning activities (Fischer and Scharff, 1998), in particular when learners are placed in a physical and social separation from both instructor and peer learners (Long, 1998).
- Mobile learning is expected to initiate a sort of "highly situated, personal, collaborative and long term; in other words, truly learner-centred learning" (Naismith et al., 2004, pp. 36).

SDL theory has been widely applied in distance and e-learning research. As mobile learning is illustrated as a new stage of distance learning and e-learning (e.g. Georgiev et al., 2004), or a paradigm shift from e-learning and distance

learning (Sharma and Kitchens, 2004), SDL theory should be applicable to mobile learning as well. Note that mobile learning is a personal issue typically initiated in an unstructured environment. In particular for mobile learners, mobile learning activities are mostly initiated in a mobile environment in which learners are separated from teachers and peer students. This fits well with the contexts of using SLD theory.

Furthermore, SDL theory suggests that the level of control that learners are willing to take over their own learning will rely on their attitude, abilities and personality characteristics (Fisher et al., 2001). A common target for SDL study is to aid individual learners to develop the requisite skills for engaging in self-directed learning such as planning, monitoring, and evaluating their own learning (Reio and Davis, 2005), which are also important capabilities to achieve positive mobile learning outcomes.

As a ubiquitous education approach, mobile learning activities can be initiated outside a pre-organized learning environment. Hence, learners are mostly physically separated from both teachers and peer students. It coincides with key research scenarios of SDL, in which learners play a central role in conducting learning activities without or with limited physical interaction with teachers and peer students. Considering its learner-centred nature, mobile learning to a degree appears to be a kind of self-directed learning method. There is a heightened need for mobile learning users to have a proper self-direction and self-management capability. To help students finish a mobile learning course, that for instance takes tens of hours, it is important to sustain their learning desire and help them to effectively self-control and manage the learning process. Hence, it stands to reason to apply self-directed learning theory to mobile learning contexts. In this light, a number of key findings of previous self-directed learning research are summarized here, which are purposely extended to explain users' mobile learning activities.

- Self-directed learning capability exists along a continuum and is present in all individuals to some degree (Fisher et al., 2001). Matching teaching delivery with learners' SDL capability enables the best opportunities for learning (Fisher et al., 2001; Fischer and Scharff, 1998; Grow, 1991). Self-management capability has a positive effect on behavioural intention to use mobile learning (Wang et al., 2009).

Above findings indicated that learners' personal traits influence their acceptance of mobile learning. Similar to SDL, mobile learning requires students to have a proper level of SDL capability in order to succeed.



- SDL capacity increases steadily during childhood, but rapidly during adolescence (Thomas et al., 2005). Therefore readiness for SDL appears to be increased with life experience and varies among individuals.

The great autonomy and responsibility heightened by mobile learning initiate a need for a corresponding level of SDL capability. By simply offering great autonomy and responsibility, mobile learning will not succeed in formal education scenarios when young students cannot properly self-direct themselves<sup>1</sup>.

- SDL is critical in distance education settings as learners are physically and socially separated from both the instructor and other learners (Long, 1998; Song and Hill, 2007). “For SDL to occur, students may need direction or facilitation to achieve their end goals” (Knowles et al., 1998; cited from Timmins, 2008, pp. 302).

The requirement for SDL capability can be somewhat decreased by offering appropriate and timely instructions. Mobile learning can be better implemented if the instructions are made available at the time of requirement.

- The level of self-direction required is associated with the learning scenarios being implemented, which may be changed in different contexts (Brockett and Hiemstra, 1991; Song and Hill, 2007). In a review of SDL literature, Fisher et al. (2001, pp. 517) noted that “there is a definite correlation between SDL readiness and student preference for structured teaching sessions”.

This indicated that the requirement for SDL capability can be reduced in a authentic and pre-designed environment. It helps to explain the phenomenon that mobile learning appears to be most successfully applied to tourism field, in which a situated and pre-arranged environment provides guidance for conducting the learning activities.

Finally, the list of criteria proposed by Sharples et al. (2005) as mentioned in the last section, are tested against self-directed learning theory based on the above discussions.

- Is SDL theory significantly different from current theories of classroom, workplace or lifelong learning?

Yes. Explicitly, SDL theory focuses on learner-centred learning activities. It is well applied to investigate the learning activities, in which learners are being

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<sup>1</sup> More related discussions are available in section 5.1.5 and section 6.2

physically separated from teachers and peer students. In this regard, SDL theory is significantly different from current theories of classroom and workplace learning, in which learners are supposed to interact with teachers or with other students. Lifelong learning supposes that deliberate, focused learning should occur throughout a person's lifetime (Coskun and Demirel, 2010). Lifelong learning activities can be initiated alone, or with other learners such as in workplace. Accordingly, SDL theory may help to investigate some lifelong learning activities if they are self-directed. However, it is undeniable that there are significant differences between SDL theory and theories of lifelong learning.

- Does SDL theory account for the mobility of learners?

Yes. Typically, when a learner is mobile, s/he is physically separated from teachers and peer students. As mentioned above, SDL theory excels in this regard. Hence, it can be stated that SDL accounts for the mobility of learners.

- Does SDL theory cover both formal and informal learning?

Yes. SDL theory can be applied to various learning contexts, including both formal and informal learning scenarios (e.g. Song and Hill, 2007). Further, the study of Song and Hill (2007) suggested that SDL capability required is different in formal and informal learning settings. Hence, it can be stated that SDL theory cover both formal and informal learning.

- Does SDL theory theorize learning as a constructive and social process?

Yes, to a large degree. A number of researchers described SDL as a constructive process (e.g. Simons, 2000), which is influenced by social contexts (Song and Hill, 2007). Simons (2000, pp. 3) illustrated SDL as “a social-interactive, contextual, constructive, self-regulated and reflective process” and stated that “for a theory of self-direction of learning this also means that self-directed learning should be conceived as an active constructive form of learning in which learners are becoming better and better in designing their own learning environments”.

- Does it analyze learning as a personal and situated activity mediated by technology?

Not necessary. SDL stresses that individuals take responsibility for their own learning activities while SDL capability can be described as a kind of personal

trait (Song and Hill, 2007). On the other hand, SDL is contextual (Simons, 2000). Further, Song and Hill (2007) stated that when situated in different environment, the requirement for SDL capability is different accordingly. SDL is not necessarily mediated by technology, but SDL theory is widely applied to research on e-learning and online learning (e.g. Song and Hill, 2007; Hung et al., 2010).

By testing SDL theory against the above criteria, SDL appears to be a sound theoretical underpinning for mobile learning research. As a result, SDL theory is applied to investigate students' use of mobile learning in the research, which is available in chapter 5 and 8.

## **2.2 Development of mobile learning applications**

### **2.2.1 Mobile learning development for adults or university students**

In recent years, mobile learning has received great attention from educational institutions, government and business communities. In Europe, mobile learning is projected to help marginalized citizens, such as dropouts and unemployed. As mobile phones are widely used by general citizens, mobile learning largely posits to be the only effective way to deliver education to the marginalized citizens. For instance, a pan-European project - m-learning - funded by the European Commission has been initiated since 2001 for educationally disadvantaged young adults to improve their literacy and numeracy skills. Additionally, a diversity of new mobile learning handhelds specially designed for mobile learning use are popularly used in many tourist attractions in European countries, such as the Louvre Museum and the Palace of Versailles.

In the USA, a recent report by Ambient Insight suggests that the tipping point for the mobile learning industry has been reached (Adkins, 2008). The report suggests that mobile learning market in US is growing in a fast speed. In this process, mobile device manufacturers, such as Apple, have a significant impact on the mobile learning market (Adkins, 2008). For instance, by July 2010, over 250,000 free lectures, videos, films, and other resources supporting mobile learning are available in iTunes U.

In China, mobile manufacturers are playing a leading role in offering mobile learning products and services as well. The ideas and concepts of mobile learning have started to become popular in China in 2005. At the end of 2005, a domestic mobile manufacturer, Bird Corp, launched a marketing campaign with a theme of 'learning in mobiles' for selling its new mobile phones with powerful English learning functions. After a successful initiation of the mobile learning

concept in 2005 and 2006, almost all mobile manufacturers, including Nokia, Lenovo, Amoi, OKWAP, LG and GIGANYTE, to some extent, started to embed mobile learning applications in their products.

More specifically, mobile learning initiations developed in recent years are various. As shown in Table 2.2, 24 kinds of mobile learning initiations are summarized. The classification is based on the following consideration of application functionalities:

- Informal learning: applications facilitate learning activities outside pre-designed educational establishments.
- Administration function: applications are used to administrate learning process and organize learning activities.
- Social network: applications enable peer communication as well as instructor-students interactions.
- Learning materials utilization: handheld devices are used to store and display learning materials, such as reading e-books and watching lecture videos.

Note that it is difficult for educational institutions to adapt their existing e-learning resource for mobile learning use due to the unique technical features of mobile phones. In addition, teaching staffs in general are lack of necessary skills of designing handheld learning materials. Hence, mobile learning applications offered by educational institutions are mostly for administration and social network purposes while commercial mobile learning applications are mostly for tourism use, such as museum. In general, business members are key providers of the learning materials for mobile phones.

Categories	Mobile learning services
Informal learning	Extracurricular study* (Liu et al., 2008a); Searching answers with for instance Google in wireless Internet;
Administration function	Sending reminders for examination or assignments (Rau et al., 2008); Informing about schedule or coordinating schedules (Yau and Toy, 2007); Calendars (Schreurs, 2006); Collecting feedback (Stead, 2005); Recording attendance or test taker (NMC and Educause, 2006); Recording lecture (Corbeil and Valdes-Corbeil, 2007); Recording information of patients (Kenny et al., 2009); Retrieving school-related information, such as timetables (Kim et al., 2006); Library services (Sharma and Kitchens, 2004); Digital dictionaries, translators (Sharma and Kitchens, 2004); Environmental detectives or recorders (Klopfer and Squire, 2008); Collecting and analyzing the data of learning processes (Liu et al., 2008a)
Social network	Interaction between instructor and students, or between peer students (Proctor and Burton, 2003); Learning collaboration, such as the virus game (Colella, 2000); Mobile 'blogging' (Yerushalmy and Ben-Zaken, 2004); Accessing online communities, discussion boards and chat rooms via mobile phones (Armstas et al., 2005);
Learning material utilization	Situated learning, such as learning in a museum (Chou et al. 2004), watching birds in open air (Chen et al., 2003) and mobile excursion games (Costabile et al., 2008); Displaying lecture videos and courseware (Corbeil and Valdes-Corbeil, 2007); Podcasting lectures (Maag, 2006); Playing quizzes (Stead, 2005); Mobile learning in language studying* (Liu et al., 2008b), and mathematics (Yerushalmy and Ben-Zaken, 2004) .

**Table 2.2 A summarization of current mobile learning initiatives** (\* are applications made for basic education)

## **2.2.2 Mobile learning in basic education**

Unlike its popularity in tertiary education, mobile learning development in basic education is lagging behind. For the most part, the use of mobile learning is outside formal classroom learning scenarios in schools. The reason for that may lie in the disruptive effect of mobile technologies. Many students misuse mobile technologies in schools, such as for cheating in exams. Due to this reason, some schools even drop their mobile learning projects, which may waste millions of dollars (e.g. Hu, 2007). Also, most schools do not treat informal networked interaction as legitimate learning; they forbid children to bring mobile phones and personal computers into the classroom (Sharples, 2006). Even if there are some mobile learning applications successfully implemented for school students, almost all of them are for administration or social network purpose. Few of them are capable of providing empirical evidences about their capability to effectively improve students' learning performance. Across literature, there are few applications that were found to be widely diffused.

In contrast, mobile learning for students in basic education in China has achieved a great success. However, the mobile learning devices used in schools in China are not mobile phones. They are a series of new devices especially designed for education purposes, which hold a number of domestic and international patents and patent applications. Companies, such as Noah Ltd. and Global View Co., Ltd., are leading mobile learning device and service providers. These companies launched a variety of advertisements in various media to market their products, which helps to flourish the market. According to the CCID Consulting (2009), 6.22 million educational electronic devices were sold in China in 2008 and the figure is expected to reach 7.06 million and 7.32 million in 2010 and 2011 respectively. Nonetheless, as merchants play a central role in this regard, little academic report was found in the field that introduces the success of mobile learning in China as well as the reasons of its success. Consequently, there is a growing interest to research on these companies and their products, in particular on their capability to deal with challenges that remain largely unsolved in the field.

## **2.3 Technology platforms for mobile learning**

In total, four broad categories of technology platforms for mobile learning are found, which are introduced as follows:

### **2.3.1 Mobile-manufacturer-initiated-platforms**

Technology platforms for mobile learning are diverse. Many mobile learning platforms are developed by mobile manufacturers, instead of by educational

institutions. For instance, Nokia as a leading mobile provider in China initiated a mobile English Language Teaching (ELT) platform ([www/wap.mobiledu.cn](http://www/wap.mobiledu.cn)). This platform is a built-in function, which is embedded in most of recent Nokia phones. In 2007, Nokia started to cooperate with BBC in language study field. As a result, a wide spectrum of English learning materials are available from the platform today, such as Real English, Take Away English, Quizzes and other BBC classic courses. In addition to language study, a wide range of other topics are covered, such as management, Yoga, cooking, golf, health preserving, etc. Many of the courses offered in the platform are sold with a price of 2 RMB (approximately 0.3 USD) per course. This gives Nokia a new manner of generating revenue.

Similarly, Apple Corps Ltd. enables its customers to access various learning materials via its products of iPod touch and iPhone. In 2007, it initiated a platform termed iTunes U, which is a powerful system for distributing learning materials, such as lectures, language lessons, films to labs, audio-books. The number of learning materials available in the platform is rapidly growing. As of July 09, 2010, over 250,000 educational audio and video files facilitating mobile learning are available in Apple iTunes U. Note that, in February 2009, the amount of the resource was about 100,000.

### **2.3.2 Software platforms irrespective of phone brands**

In addition to mobile-manufacturers-initiated-platforms, some platforms were established to offer mobile learning services on mobile phones irrespective of their brands. In China, Englishto ([www/wap.englishto.com](http://www/wap.englishto.com)) is a platform of this kind. The company was initiated in 2004. It cooperates with more than 20 mobile manufacturers, such as Nokia, Bird and Lenovo. The company focuses on mobile learning services for English learners. The platform is pre-installed in a diversity of domestic phones, which can be downloaded and installed in advanced mobile phones like software as well. Like the platforms offered by mobile manufacturers, special websites were developed, which are accessible via computers or mobile phones. Users can download learning materials via computers, but can only browse them on mobile phones with the platform installed.

### **2.3.3 Software platforms designed for new device**

Unlike mobile phones which are designed for business or entertainment purposes, there are a number of handhelds especially designed for mobile learning use. As traditional mobile phones are designed for business and entertainment purposes, usability problems frequently emerge when applied in education. Consequently, considering the unique requirements of learners, many merchants seek to develop their own handhelds to satisfy their customers.

Accordingly, a number of new mobile learning platforms were developed. Those new handhelds and platforms are widely employed in tourism industry to offer audio guide services, such as in the Louvre Museum and the Palace of Versailles. In basic education, Noah Ltd. heavily invested in developing a series of the most sophisticated mobile learning devices in the world. Development and research expenses of the company were RMB 55.3 million and RMB 52.7 million for the fiscal years ended June 30, 2008 and 2009, respectively. Its products are mostly based on their own proprietary NP-iTECH software platform, which hold a number of patents and patent applications. Additionally, the One Laptop Per Child Association, Inc. (OLPC), as a U.S. non-profit association, developed a series of low-cost, connected laptops, which are known as the \$100 Laptop, seeking to benefit children in the developing world with content and software designed for joyful, collaborative, self-empowered learning. Due to their business potentials, this kind of platforms and devices are increasingly popular in recent years, which represents the future of mobile learning industry.

#### **2.3.4 Web-based Platforms**

In addition to the above software-based platforms, many educational institutions develop web-based platforms to deliver mobile learning services. The services available on web-based platforms are mostly a migration of services from traditional Internet environment, such as blog, calendar, e-mail, library and administration services. SMS reminder is also used in some institutions to inform students, such as the change of course schedule. This kind of platform requires a limited amount of investment, which appears to be the mainstream of current mobile learning research and development in advanced education settings. Course slides and materials are usually accessible via these platforms. However, learning materials especially designed for mobile phone use are usually limited due to a lack of investment and necessary skills.

#### **2.4 Mobile learning – the impact of cultural differences**

Chinese education system is different from that of European countries. It is undeniable that different educational environments influence students' behaviours in different ways. In a different learning environment, students may initiate different standards regarding their study performance and may have different preferences of education technology. In this light, an overview of the impacts of Chinese education system on students' learning activities and requirements is necessary in order to place the research in context.

China is carrying out an education policy of 'nine-year compulsory schooling system', which means that each child must receive at least nine years of schooling. During the period, students are expected to finish both primary and



junior middle school programmes. Then after a typically three-year senior high school, students are ready to take the national university entrance exam. The exam plays an important role in the society, as the university education is highly related to a wide spectrum of benefits, such as better job opportunities, income and social prestige.

Compared to students living in other continents, Chinese students are under great learning pressure before passing the national university entrance exam. There are chiefly four kinds of pressures. First, a degree from prestigious universities will markedly increase their life chances in China. Only the students with the top exam score can enter those universities. Second, due to one-child policy in China, there are overwhelming pressures for students to perform well in school. Considering the current poor social security insurance system in China, for most students, the future of both their family and themselves entirely depends on a good university education. Third, Confucianism is a dominant philosophy in China, which values education more than other values. Hence, it is a tradition for parents to hold high expectations on their child regarding education, while failure in school is frequently related to individual and family shame (Davey, Lian and Higgins, 2007). Fourth, there are pressures from schools and teachers, as their reputations and associated economic benefits hinge on the number of their students who succeed in the exam (Davey, Lian and Higgins, 2007).

Today, it is not unusual for students living in cities to spend all of their time studying. The lives of two first-lines (school and home) represent the key feature of student's daily schedule. Getting a better exam score is an overwhelming target for students, teachers as well as parents. This initiates new features of Chinese education system. First, there are great emphases and expectations on education technologies, which are capable of improving learning performance. Second, parents in China are willing to invest in education products, if the products are proved to be useful. Third, students are eager to adopt new technology which can effectively improve their exam score. Fourth, unlike other IS innovations, students' adoption of new technology is not a personal decision. Instead, it is a collective decision under the supervision of both parents and teachers. As key stakeholders, parents and teachers will decide whether the technology can be used by students or not. Note that it completely depends on parents' willingness to purchase mobile learning devices in basic education, since young students cannot afford the products.

In tertiary education, the learning environment is quite different from that in basic education. In tertiary education contexts, the monetary cost for mobile learning is relatively limited since nearly every student has a mobile phone. Studying pressure is greatly reduced as well. Compared to other countries, it is much easier to gain an undergraduate degree in China, considering the over 92%

graduation rate in chief universities in China (The China Youth Daily, 2009). The pressures from parents and society are almost disappeared. There is much less need for students to improve their exam score compared with students in high schools. University students also have more time to think about their future and career. As a result, students focus their efforts more on the development of future career. Unlike in basic education, students now can make the decision of what to learn and whether or not to use a technology. A number of some key contextual differences regarding mobile learning adoption in basic and tertiary education are listed in Table 2.3.

	Basic education	Tertiary education
Age of students (years)	Typically between 6 and 18	Typically more than 18
Chief Learning Environments	School and home	Campus
Daily schedule	Tight	Loose
Study pressure	High	Low
Key stakeholders	Student, teacher and parents	Student
Technology adoption environment	Tight (supervised by both teachers and parents)	Loose (personal activities)
Monetary cost	High (cost for purchasing device and learning materials)	Low (cost for software and learning materials)

**Table 2.3 Contextual differences between basic and tertiary education**

Taking the environmental differences in basic and tertiary education into account, it is apparent that students' preferences on education technology and their adoption behaviours are different as well. Therefore, using one research methodology to study mobile learning use in basic and tertiary education appears to be inappropriate. Based on above reasons, to research on the adoption behaviours of students in basic and tertiary education, two research methods are adopted in the dissertation based on two different adoption models.

## **2.5 Chapter Summary**

This chapter presented state-of-art of mobile learning development. Theoretical underpinnings of mobile learning research were discussed and enriched, together with an illustration of mobile learning technology platforms. In particular, the chapter presented the contextual differences between basic and tertiary education. Considering these differences, it is suggested that adopting different research methods to study mobile learning adoption in basic and tertiary education environments respectively is necessary. In addition, considering the lack of sound theoretical underpinnings, SDL theory is introduced in order to better understand the use of mobile learning. Based on the discussion on SDL

theory and contextual differences of learning environments, some preliminary answers to the research questions are proposed here:

(i) To improve users' adoption of mobile learning, one should take the contextual differences of education systems into account. Students in basic education will have different requirements on mobile learning compared to those in tertiary education.

(ii) Parents and teachers may have a strong influence on students' adoption of mobile learning in basic education. In tertiary education, students may focus more on the capability of mobile learning to realize their future targets, such as finding a good job.

(iii) Students' self-directed learning capability may have an important influence on mobile learning adoption.



## **Chapter 3**

### **Research methodology**

This chapter aims to specify research philosophies and methodologies adopted in the dissertation. First, positivism and interpretivism, as two key philosophical assumptions of the research, are introduced in the chapter. Thereafter, the chapter overviews two research methodologies adopted for conducting the research, which are case study methodology and survey research methodology. Specifically, case study methodology is applied for studying mobile learning implementation in basic education while survey research methodology is for investigating mobile learning implementation in tertiary education contexts. The reasons for the selection of both research methodologies are discussed as well.

#### **3.1 IS research paradigms: Positivism and interpretivism**

Positivism and interpretivism are two dominant research paradigms in IS field. Positivism refers to a set of epistemological perspectives and philosophies of science. It is developed on the basis of the assumption that there are universal laws that govern social events, and therefore by uncovering these laws, researchers are able to describe, predict and control social phenomena (Wardlow, 1989). Positivism stems from the philosophical foundations established by Comte, who argued that social reality exists objectively and independently of people. Positivistic approach treats social events like a science-like phenomenon that is comprehensible through empirical investigation (Babbie, 1993). Positivistic researchers inherently recognize five assumptions as intrinsic features of the positivistic mode of inquiry (Wardlow, 1989; cited from Kim, 2003):

- The physical world and social events are analogous in that researchers can study social events like examining physical phenomena.
- Theory is universal. It can interpret human behaviour and phenomena independent of individuals and settings.
- Positivist adheres to subject-object dualism in studying social phenomena. Researchers and their research subjects are independent existence.

- Knowledge needs to be formalized using theories and variables which are operationally different from each other and defined accordingly.
- Hypotheses in forming principles of theories are accessed using quantificational observations and statistical analyses.

In contrast to positivism, interpretivism regards reality as socially constructed, instead of objectively determined (Husserl, 1965). Interpretivism proposes that researchers can better understand people's perceptions on their own activities by putting them in their social contexts (Hussey and Hussey, 1997). Accordingly, knowledge is defined as a collection of multiple sets of interpretations as part of the social and cultural context in which it occurs (Kim, 2003). As a result, qualitative methods are widely adopted by interpretivists in their pursuit of knowledge (Kaplan and Maxwell, 1994).

There is a long debate between positivism and interpretivism among researchers for many years, as some researchers may favour one of them and against another one. Both paradigms were found to have different merits and limitations (see Kim, 2003). Hence, some researchers argued that the true difference between these two paradigms may lie in their choice of research methods instead of any substantive difference at a meta-theoretical level (Weber, 2004). Kim (2003) stated that these research paradigms are not necessarily incompatible, and that both research contexts and subjects should be viewed as reasons in deciding which approach to be applied. Similarly, Benbasat et al. (1987, pp. 369) noted that "no strategy is more appropriate than all others for all research purposes". Based on above discussion, both research paradigms are adopted in light of their different merits. As the dissertation concerns mobile learning adoption in both basic and tertiary education environments, different research methodologies are favoured in accordance with their different research contexts.

Interpretivism underlies the research on mobile learning adoption in basic education contexts for answering the research question 1. This is due to that the unique social and cultural environment of China brings about a number of unique features to Chinese basic education system, which are supposed to influence students' adoption behaviours on mobile learning, as mentioned in section 2.4. On the other hand, positivism underlies the research on mobile learning adoption in tertiary education. Like in most of the other countries, students in tertiary education in China can decide solely whether to adopt a technology or not, while the influence from parents and teachers becomes limited. As social and cultural contexts are supposed to have little influence on the technology adoption (as discussed in section 2.4), positivism is applied as the philosophy behind the research on mobile learning adoption in tertiary education contexts for answering the research question 2.

### 3.2 Case study methodology

Case study methodology can be defined as a “scholarly inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used” (Yin, 1994, pp. 33). To ensure its methodological rigor, validity and reliability, researchers have proposed a number of key components that need to be adopted in order to conduct a case study. According to Dooley (2002), these key elements also show the sequence of key steps of conducting case study research, including:

- Determine and define the research questions
- Select the cases and determine data-gathering and analysis techniques
- Prepare to collect data
- Collect data in the field
- Evaluate and analyze the data
- Prepare the report

Prior studies have identified a number of unique features and advantages of case study methodology, which help researchers to specify the research area where the use of the method is most appropriate. Benbasat et al. (1987) specified eleven key characteristics of case studies, as shown in Table 3.1.

<ol style="list-style-type: none"><li>1. Phenomenon is examined in a natural setting.</li><li>2. Data are collected by multiple means.</li><li>3. One or few entities (person, group, or organization) are examined.</li><li>4. The complexity of the unit is studied intensively.</li><li>5. Case studies are more suitable for the exploration, classification and hypothesis development stages of the knowledge building process; the investigator should have a receptive attitude towards exploration.</li><li>6. No experimental controls or manipulation are involved.</li><li>7. The investigator may not specify the set of independent and dependent variables in advance.</li><li>8. The results derived depend heavily on the integrative powers of the investigator.</li><li>9. Changes in site selection and data collection methods could take place as the investigator develops new hypotheses.</li><li>10. Case research is useful in the study of "why" and "how" questions because these deal with operational links to be traced over time rather than with frequency or incidence.</li><li>11. The focus is on contemporary events.</li></ol>
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**Table 3.1 Key Characteristics of Case Studies**

Based on the study of Dooley (2002), a number of advantages of case study methodology are summarized as follows:

- Case study methodology excels in bringing new knowledge of a complex issue and can add strength to what is already known from prior studies.
- Case study research focuses on detailed contextual analysis of a limited amount of events or settings and their relationships.
- Case study research is capable of embracing multiple cases, using both quantitative and qualitative data with multiple research paradigms.
- Case study research is capable of adopting a wide spectrum of data collection approaches, such as participant observation, document analysis, surveys, questionnaires, interviews, Delphi processes and others.

Considering these features and advantages, Benbasat (1987) specified three reasons to apply case study methodology. These reasons lend case study research well to be used in studying certain research subjects, including:

- Researcher can study IS in a natural setting, learn about the state of the art, and generate theories from practice.
- The case method allows the research to answer “how” and “why” questions, that is, to understand the nature and complexity of the processes taking place.
- A case approach is an appropriate way to research an area in which few previous studies have been carried out.

Additionally, Rowley (2002) indicated that case study method is often applied as a useful tool at a preliminary and exploratory stage of a research project, serving as a basis for the initiation of the ‘more structured’ tools that are needed in experiments and surveys. It is also good for investigating contemporary events when the relevant behaviour cannot be controlled (Rowley, 2002). Benbasat et al. (1987, pp. 369) stated that case study method is in particular appropriate when “the research and theory are at their early, formative stages”, and “sticky, practice-based problems where the experiences of the actors are important and the context of action is critical”. Similarly, Pinsonneault and Kraemer (1993) indicated that case study is an appropriate method to study the relation between context and the phenomenon of the interest.

Based on above discussion, case study method is proposed to be one of the best approaches in studying mobile learning adoption in basic education in China. The key reasons for the proposition are listed as follows:

- The study seeks to answer ‘why’ and ‘how’ questions. Specifically, ‘why does mobile learning achieve an unprecedented success in basic education in



China' and 'how is mobile learning industry in China dealing with challenges faced?'

- Despite a vast body of mobile learning studies in tertiary education contexts, there is a very limited amount of research initiated in a basic education environment. The research of this aspect is in an initial stage, studies relevant to the topic are in a short supply.
- As previously specified, the most successful implementation of mobile learning in basic education is conducted by merchants. As their success seems to be based on constant experiments with new technology and products in market, there are few academic reports available from the companies. As practitioners, their solutions to deal with different challenges and to satisfy customers' requirements are important for researchers to grab new insights.
- China appears to be the only country in the world that achieves great success in mobile learning implementation in basic education. So there are limited entities available for the study. This complies with the advantages of case study of investigating 'one or few entities'.
- In prior adoption studies, adoption decisions are mostly made solely by users themselves. In basic education, the adoption decision is collectively made. Additionally, basic education in China has a number of distinctive characteristics making it different from the education systems in other countries. In this regard, contextual factors play an important role, which can be better investigated using case study method.

In the dissertation, case study method serves as a "window" to investigate mobile learning adoption in basic education in China and to answer the research question 1. The method can also be applied to investigate the mobile learning adoption in basic education in some other Asian countries, which share similar social and cultural background, such as Korea and Japan.

### **3.3 Survey research methodology**

According to Pinsonneault and Kraemer (1993), survey research methodology can be referred to as the research approach focusing on surveys that are carried out to advance scientific knowledge. Survey itself can be defined here as the means of collecting information about the characteristics, actions, or beliefs of a large group of people, referred to as a population (Tanur, 1982).

Pinsonneault and Kraemer (1993) stated that there are three distinct features of survey research, which are: (i) the purpose of survey is to develop quantitative depiction of some aspects of the study population; (ii) the main data collection approach is by asking people standardized, predefined questions; (iii) data is in

general collected from a proportion of the target population in a way that enables to generalize the findings to the whole population.

In past decades, survey research has become one of the most widely used quantitative, social science research methods. In most survey research, researchers establish a specific model including a number of clearly defined independent and dependent variables. The model represents a number of hypothesized relationships among the variables, which are assessed based on the observations of the target phenomenon in a wide variety of natural settings (Pinsonneault and Kraemer, 1993).

Survey research in general can be used for exploration, description or explanation purposes (Pinsonneault and Kraemer, 1993). Exploratory survey research takes place at the early stages of research projects, in which researchers seek to gain preliminary insights on a topic (Forza, 2002). In other words, an exploratory survey research is mostly used to build a basis for more in-depth survey. Through the exploratory survey, researchers are able to identify the concept to be investigated in relation to the phenomenon of interest while no specific model is needed.

Descriptive survey research takes place when researchers want to ascertain what is happening in a population, such as respondents' perspectives or experiences on a specified phenomenon. The purpose of the descriptive survey is to ascertain facts, instead of testing a theory (Pinsonneault and kraemer, 1993). As a consequence of the survey, researchers are capable of describing the distribution of the phenomenon in a population and their related characteristics.

Explanatory survey research is conducted with the specific purpose of testing theory and causal relations (Pinsonneault and Kraemer, 1993). The knowledge on the phenomenon is developed based on well-defined concepts, models and propositions (Forza, 2002). Pinsonneault and Kraemer (1993, pp. 83) argued that, the key research question in explanatory survey research is: "does the hypothesized causal relationship exist, and does it exist for the reasons posited?"

There are a variety of advantages of using survey research. For instance, Newsted et al. (1998, pp. 553) indicated that, those advantages include that survey research:

- is easy to administer and is simple to score and code,
- allows the researcher to determine the values and relations of variables and constructs,
- provides responses that can be generalized to other members of the population studied and often to other similar populations,

- can be reused easily and provide an objective way of comparing responses over different groups, times, and places,
- can be used to predict behaviour,
- permits theoretical propositions to be tested in an object fashion, and
- helps confirm and quantify the findings of qualitative research.

Considering the unique characteristics of survey research, it is argued that survey research methods are most appropriate when (Pinsonneault and Kraemer, 1993):

- The central questions of interest about the phenomena are ‘what is happening?’, and ‘how and why is it happening?’ Survey research is especially well-suited for answering questions about what, how much and how many, and to a greater extent than is commonly understood, questions about how and why.
- It is not possible or desirable to control the independent and dependent variables.
- The phenomena of interest must be examined in its natural settings.
- The phenomena of interest take place currently or recently.

Considering its advantages, the dissertation adopts the survey research method to study mobile learning adoption in tertiary education. Note that the dissertation seeks to find out the driving factors of mobile learning adoption in tertiary education and to what degree these factors influence students’ adoption behaviours. This is what the survey research methodology excels as above-mentioned.

### **3.4 Chapter summary**

This chapter outlined the methodological basis of the research. Positivism and interpretivism serve as the philosophical foundations of the underlying research on mobile learning adoption in different contexts. The merits of both case study method and survey research method were discussed. The two methods will be followed to guide the research on mobile learning adoption. In the next chapter, a number of key adoption theories and relevant research papers are presented, which help to instruct the establishment of research models in the present research.



## **Chapter 4**

### **Technology acceptance research**

Technology acceptance has been a hot topic in IS research for decades, as the success of a IS innovation is usually measured by the number of users who actually use the system. Therefore, it is important to know why users adopt the system and what factor is capable of promoting the use of the system. In the past decades, IS adoption research has been conducted based on different disciplines, while a number of adoption models and theories were established. The most dominant adoption theories in the field are the Innovation Diffusion Theory (IDT), the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Task Technology Fit Theory (TTFT). This chapter aims to provide a brief picture of these adoption theories and their applications, together with their different benefits and constraints. The chapter also provides theoretical bases for developing research models.

#### **4.1 Innovation diffusion theory**

Proposed by Rogers (1983), Innovation diffusion theory (IDT) posits that perceived characteristics of an innovation influence a user's adoption behaviour. In detail, the perceived characteristics are relative advantage, complexity, compatibility, trialability and observability. Rogers (1995) stated that these variables are typically capable of explaining 49-87% of variance of innovations adoption. Moore and Benbasat (1991) extended the theory with other innovation characteristics. The extended model includes relative advantage, ease of use, compatibility, image, visibility, result demonstrability and voluntariness of use. These perceived characteristics of an innovation can be defined as shown in Table 4.1.

Core constructs	Definitions
Relative Advantage	“The degree to which an innovation is perceived as being better than the idea it supersedes” (Rogers, 1995, pp. 212).
Ease of use	“The degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers, 1995, pp. 242).
Image	“The degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system” (Moore and Benbasat, 1991, pp. 195)
Visibility	The degree to which use of an innovation is visible to others (Moore and Benbasat, 1991).
Compatibility	“The degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters” (Moore and Benbasat, 1991, pp. 195)
Results Demonstrability	“The tangibility of the results of using the innovation, including their observability and communicability” (Moore and Benbasat, 1991, pp. 203)
Voluntariness of use	The degree to which the use of the innovation is perceived as being of free will (Moore and Benbasat, 1991).

**Table 4.1 Core constructs of IDT**

Nevertheless, the theory also received a number of criticisms. For instance, Bayer and Melone (1989) specified the limitations of the theory and stated that the theory fails to (1) offer precise theoretical and operational definitions of adoption; (2) distinguish between acquisition/authorization of an innovation in organizations and innovation adoption by individuals; (3) provide theoretical and empirical justification for the five adopter categories; (4) explain the reason of innovation discontinuance (i.e, ceasing adoption) in the theory; (5) theoretically interpret the influences of mandates on diffusion and adoption; (6) provide adequate research designs to justify the causal linkages implied; and (7) consider interactions between different social systems. However, the limitations of IDT remain largely unsolved today, which are also challenges of many other theories. On the other hand, some empirical evidences have been found in recent years to support the validity of IDT to some extent. For instance, personal innovativeness literature indicated that innovative individuals tend to be more daring, venturesome and risk takers, and they are more likely to accept a new IT innovation despite a high level of uncertainty and risk related to the technology adoption. This partly supports the classification of adopters in IDT.

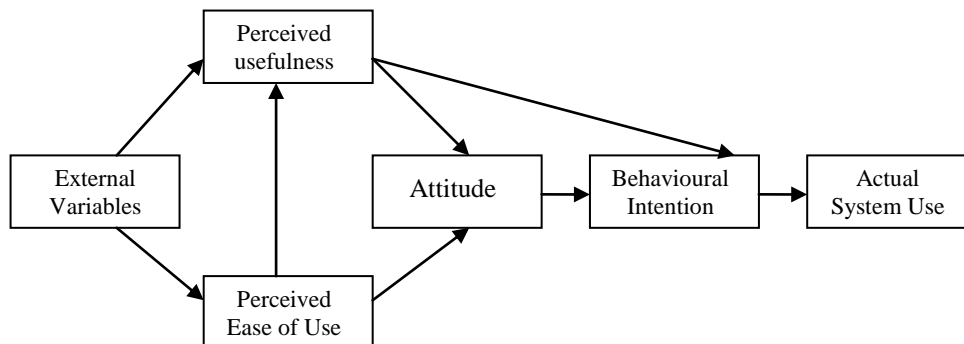
Considering the advantages of IDT, a number of adoption studies were conducted based on IDT or its extension. Studying multimedia message service adoption, Hsu et al. (2007) indicated that users’ perceptions on the service varied over different diffusion stages. Similarly, Liu and Li (2010) studied mobile

Internet diffusion and found that motivators of service adoption of different users groups are different. Zhang et al. (2008) found that relative advantage, image, compatibility, result demonstrability, voluntariness and visibility are indirect predictors of e-mail usage. Lin and Lee (2006) indicated that perceived relative advantage, compatibility, and complexity are important determinants of the intention to encourage knowledge sharing in organizations. IDT is also applied to study education technology adoption. Concerning Chinese students' adoption of e-learning, Duan et al. (2010) found that perceived compatibility and trialability have significant influences on e-learning adoption intention. Liao and Lu (2008) found that the predictors of e-learning websites adoption vary with different prior experience. For users with prior experience, compatibility and results demonstrability are significant adoption predictors, while for those without prior experience, relative advantage and compatibility are key motivators (Liao and Lu, 2008). These studies from different aspects provide support for the validity of IDT in IS contexts. However, in the review, it seems that IDT has not been extended to study the adoption of mobile learning technology.

In sum, IDT is one of the most comprehensive models compared to other adoption theories. It comprehensively considers different technological characteristics of an innovation. However, it lacks the consideration of the impacts of variables from intrinsic and social perspectives on IT adoption, such as perceived enjoyment and social influence. On the other hand, a lack of parsimoniousness makes it somewhat difficult to be extended. To some degree, this also influences the model's applicability for studying different IT innovations.

## **4.2 Technology acceptance model**

The technology acceptance model (TAM) was proposed by Davis (1989) as tailored to IS contexts. TAM is originally derived from the theory of reasoned action (TPA) (Ajzen and Fishbein, 1975; 1980). TRA posits that beliefs impact attitude, which affects intention. The intention in turn brings about behaviour. Based on this belief-attitude-behaviour relationship, TAM further postulates that perceived ease of use and perceived usefulness are two key beliefs leading to user acceptance of IT innovations. Additionally, perceived usefulness is a function of perceived ease of use. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, pp. 320). Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, pp. 320). It is proposed that external variables impact behaviour mediated by both perceived usefulness and perceived ease of use. Their core relationships are depicted in Figure 4.1 (Davis et al., 1989).



**Figure 4.1 The Technology Acceptance Model**

TAM is widely acknowledged as a robust and parsimonious model by researchers. The core constructs of TAM have been examined and extended in a diversity of IT innovations. Concerning electronic toll collection service, Chen et al. (2007) found that perceived ease of use and perceived usefulness are significant predictors of attitude. The attitude, together with subjective norm and perceived behavioural control, influences behavioural intention (Chen et al., 2007). Regarding hotel front office systems, Kim et al. (2008) indicated that perceived usefulness, perceived ease of use and perceived value positively relate to attitude, while attitude, together with perceived usefulness, positively influences actual usage of the system. Studying business management software adoption based on IT decision-makers, Hernandez et al. (2008) found that both perceived ease of use and perceived usefulness significantly impact the intention to use, which in turn influences the actual use of the software. Regarding the use of web-based information systems, Yi and Hwang (2003) indicated that perceived usefulness and perceived ease of use are significant determinants of behavioural intention while both behavioural intention and self-efficacy are significant predictors of actual usage. In other words, these studies suggest that TAM is robust and can be applied to study various IT innovations.

Compared to other models, TAM only considers perceived ease of use and perceived usefulness of technology use, which results in a particularly parsimonious model. This gives TAM a good capability to be extended, which is favoured by different researchers. As a result, TAM is widely applied in a vast body of studies since its first inception. However, TAM also received a number of criticisms, such as being rather too generic (Carlsson et al., 2006b; Bouwman et al., 2008). Also, as TAM is initiated from assessing productivity-related IT innovations by studying employees' behaviour in organizational environments, some problems may be generated when applied it in studying such as education- or entertainment-oriented IT innovations in personal and social contexts. However, considering its robustness and parsimoniousness, TAM is adopted as the theoretical basis for investigating mobile learning adoption in tertiary education contexts, which helps to answer the research question 2.

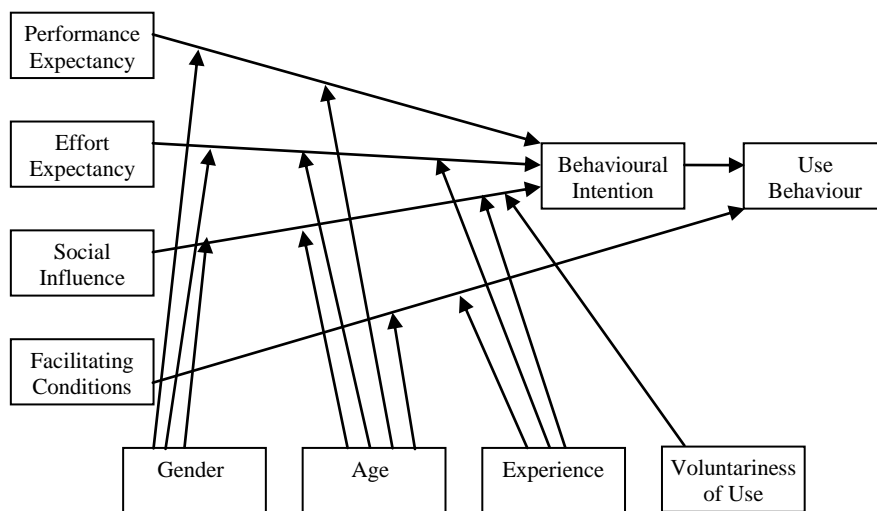


### 4.3 UTAUT

Formulated by Venkatesh et al. (2003), the Unified Theory of Acceptance and Use of Technology (UTAUT) is developed based on eight prior adoption models, including the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model (MM), the Theory of Planned Behaviour (TPB), the combined TAM and TPB (c-TAM-TPB), the Model of PC Utilization (MPCU), the Innovation Diffusion Theory (IDT) and the Social Cognitive Theory (SCT). UTAUT was empirically assessed and found to outperform the eight prior models. The model has a strong explanatory power, which accounts for 70% of variance in usage intention. Specifically, UTAUT postulates that there are four core determinants of IS usage intention and behaviour; these are (i) performance expectancy, (ii) effort expectancy, (iii) social influence and (iv) facilitating conditions. Additionally, gender, age, experience and voluntariness of use are included in the model mediating the impact of the four key constructs on usage intention and behaviour. Performance expectancy is conceptually similar to perceived usefulness in TAM. It is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance” (Venkatesh et al. 2003, pp. 447). Effort expectancy is defined as “the degree of ease associated with the use of the system” (Venkatesh et al. 2003, pp. 450), which is conceptually similar to perceived ease of use in TAM. Social influence is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al. 2003, pp. 451). Facilitating conditions are defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” (Venkatesh et al. 2003, pp. 453). The relationships among these variables are depicted in Figure 4.2 (Venkatesh et al., 2003).

UTAUT has received increasing popularity in recent years. Studying health information technology adoption in Thailand, Kijsanayotin et al. (2009) found that performance expectancy, effort expectancy, social influence and voluntariness are key motivators of IT acceptance. Gupta et al. (2008) conducted a research on the ICT adoption in a government organization in India. Their findings indicated that performance and effort expectancy, social influence and facilitating condition are all significant predictors of ICT usage (Gupta et al., 2009). Zhou et al. (2010) integrated UTAUT with task technology fit theory to interpret mobile banking adoption. Their research found that performance expectancy, task technology fit, social influence and facilitating conditions have significant impacts on user adoption (Zhou et al., 2010).

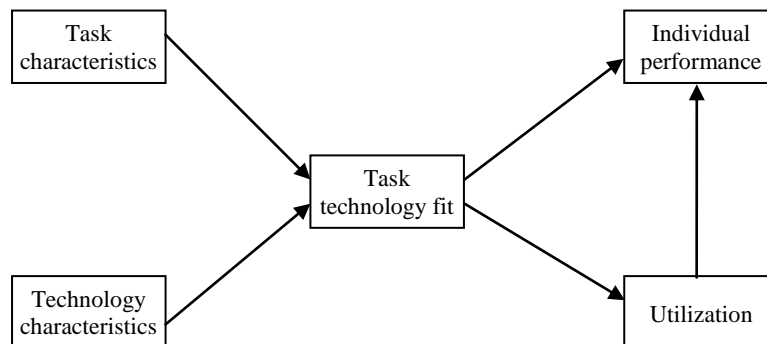
Compared with other adoption models, UTAUT has several advantages. Rather than simply considering a technological perspective of IT adoption, UTAUT also takes both social variables and facilitating conditions into account. This gives a considerable improvement on the explanatory power of the model, even if it slightly reduces the parsimony of the model. Also the model specifies a number of mediating variables, such as age and gender, which are very useful in understanding the characteristics of different user groups. Considering its strong explanatory power, it is adopted as a theoretical basis to investigate mobile learning adoption in basic education contexts and helps to answer the research question 1.



**Figure 4.2 The Unified Theory of Acceptance and Use of Technology**

#### **4.4 Task technology fit theory**

Developed by Goodhue and Thompson (1995), the task technology fit (TTF) theory posits that an innovation will be adopted if, and only if, the functions of the innovation can support the needs of users. In other words, innovation adoption occurs, if there is a good fit among task requirements, individual abilities, and the functionality of the IT innovation. Accordingly, TTF is defined as “the degree to which a technology assists an individual in performing his or her portfolio of tasks” (Goodhue and Thompson, 1995, pp. 217). The theory proposes that a higher level of individual performance can be expected, if TTF is improved, as shown in Figure 4.3 (Goodhue and Thompson, 1995).



**Figure 4.3 The Task Technology Fit Model**

TTF theory has been applied to study a wide spectrum of IT innovations. Concerning managers' performance in Malaysian port industry, Daud et al. (2008) found that TTF significantly influences technological usage, which further affects managers' performance. Regarding learning management systems, McGill and Klobas (2009) found that TTF positively influences perceived impact of the systems both directly and indirectly via level of utilization. Lin and Huang (2008) researched on antecedents of knowledge management system (KMS) usage and found that TTF, together with task interdependence, KMS self-efficacy and personal outcome expectations, are significant predictors of KMS usage. Concerning the use of an e-learning tool among teachers, Larsen et al. (2009) indicated that perceived TTF positively influences perceived usefulness and technology utilization. Concerning online auction website adoption, Chang (2008) found that TTF significantly affects perceived playfulness, perceived risk, perceived ease of use and perceived usefulness of the websites.

In sum, a prominent advantage of TTF theory lies in its capability to offer pragmatic answers to practitioners from an engineering perspective. A second advantage of TTF theory lies in its parsimoniousness, which gives researchers a good theoretical basis for extension. However, mobile learning may consist of various technology platforms used for various learning purposes in different ways. As a result, TTF theory is not applied to the present research on mobile learning.

#### **4.5 Adoption research on mobile technology and education technology**

Based on different adoption models, there are a few empirical studies published in recent years on mobile learning adoption. Concerning potential users' adoption of mobile learning in Taiwan, Wang et al. (2009) developed an adoption model of mobile learning, which was empirically assessed based on a

sample of 330 usable responses. Built upon UTAUT, the research of Wang et al. (2009) found that performance expectancy, effort expectancy, social influence, perceived playfulness and self-management of learning are all significant antecedents of the intention to use mobile learning. Additionally, the effects of effort expectancy and social influence on mobile learning intention are moderated by age differences, while the effects of social influence and self-management of learning on mobile learning intention are moderated by gender differences (Wang et al., 2009).

Huang et al. (2007, pp. 588) proposed a structure of perceived mobility value, and defined it as the “user awareness of the mobility value of M-learning (mobile learning)”. They developed an adoption model of mobile learning by integrating both perceived mobility value and perceived enjoyment into TAM (Huang et al., 2007). Based on 313 usable questionnaires collected from both undergraduate and graduate students in two Taiwan universities, they found that perceived mobility value, perceived usefulness, perceived ease of use and perceived enjoyment are direct or indirect antecedents of the intention to use mobile learning.

Based on 245 completed questionnaires collected from the students in Ramkhamhaeng University in Thailand, Ju et al. (2007) found that perceived self-efficacy positively influences perceived ease of use, which in turn significantly affects perceived usefulness. Additionally, both perceived usefulness and attitude are significant antecedents of intention to use mobile learning (Ju et al., 2007)

However, these three studies are focused on employees or university students in Taiwan or Thailand at relatively early stages of mobile learning diffusion, as all of them were published in 2007. There is hence a lack of investigation of mobile learning based on more recent data in mainland China. In addition, there is a lack of investigation on mobile learning adoption in basic education, which is quite different from that in tertiary education.

In light of this, the dissertation extended the scope of literature review on IT adoption to include related studies on both mobile and education technology adoption, as mobile learning is generally described as the intersection between mobile services and distance education, or as a natural extension of e-learning. This will help to understand mobile learning adoption from both mobile technology and education technology viewpoints, which helps to build a sound mobile learning adoption model. As shown in Table 4.2, only a part of the studies reviewed are listed, which were all published between 2008 and 2010.

<b>Authors</b>	<b>Theory basis</b>	<b>Study context</b>	<b>IT</b>	<b>Key findings</b>
Zhou et al. (2010)	TTF and UTAUT	Users in China (n=250)	Mobile banking	The model explains 57.5% of the intention to use. Performance expectancy was the most important direct predictor of behavioural intention.
Jung et al. (2009)	TAM	Users in South Korea (n=208)	Mobile TV	The model explains 50% of the intention to use. Perceived usefulness was the most important predictor of behavioural intention.
Mallat et al. (2009)	TAM	Helsinki citizens (n= 360)	Mobile ticketing	The model explains 55% of intention to use. Compatibility was the most important predictor of behavioural intention.
Kim (2008)	TAM	Working adults (n=286)	Smartphone	The model explains 62.7% of intention to use. Perceived usefulness was the most important predictor of behavioural intention.
López-Nicolás et al. (2008)	TAM	Households in Dutch (n=542)	Advanced mobile services	The findings show that the basic structures of TAM remain robust. Perceived usefulness was the most important direct predictor of behavioural intention.
Duan et al. (2010)	IDT	Chinese students (n = 215)	E-learning	Compatibility was the most important motivator while trialability has a negative impact on behavioural intention.
Lee (2008)	TAM	Students (n=1107)	Online learning	The model explains 18% of intention to use. Perceived usefulness was the most important predictor of behavioural intention.
Shih (2008)	TPB and the social cognitive theory (SCT)	Undergraduate students (n=319)	Web-based learning	The model explains 35% of intention to use. Perceived behavioural control was the most important predictor of behavioural intention.

**Table 4.2 Review of adoption research on mobile technology and education technology**

## **4.6 Chapter summary**

The chapter presented a number of key theories explaining the adoption and success of ICT innovations. The purpose is not to validate these theories, but to understand their different benefits and constraints. Also, the review shows that prior adoption studies on both mobile and education technology are mostly based on TAM, TPB or UTAUT. Conceptually related to performance expectancy and relative advantage, perceived usefulness was found to be the most significant predictor of behavioural intention in most of the studies. Considering unique features of different IT innovations in question, researchers extended the model by adding other related variables. This method is useful to increase the explanatory power of the model proposed, and to offer a more complete picture of innovation adoption. Generally, the adoption models proposed in these studies enable to explain a considerable amount of the intention to use IT innovations. As a result, considering its robustness and parsimoniousness, TAM is adopted as the theoretical basis of the present research on mobile learning adoption in tertiary education settings. On the other hand, considering the strong explanatory power of UTAUT, it is adopted as the theoretical basis of studying mobile learning acceptance in basic education. Like prior research, TAM and UTAUT are extended with other factors for establishing the conceptual research frameworks, which will be discussed in the next chapter.

## **Chapter 5**

### **Mobile learning adoption: conceptual frameworks**

Two conceptual frameworks are developed in this chapter in order to guide the study of mobile learning adoption in basic and tertiary education environments, respectively. Concerning the framework pertaining to basic education, the interest is to instruct the data collection process regarding how the mobile learning products in China deal with the challenges that remain largely unsolved in the field. On the other hand, an adoption model concerning tertiary education is developed with a number of hypotheses. It serves as a basis for developing survey questionnaires for data collection purposes, which is also the basis for further statistical analyses. Considering their different benefits, TAM and UTAUT serve as the theoretical bases for developing conceptually frameworks for mobile learning adoption in tertiary and basic education respectively. The conceptual frameworks will guide the investigation on mobile learning adoption in order to answer the research problem.

#### **5.1 A framework for investigating mobile learning in basic education**

Based on UTAUT, a conceptual framework is developed in the present section concerning six aspects of mobile learning success, which are performance expectancy, effort expectancy, perceived enjoyment, content quality, facilitating conditions and social influence. Parents' support and teachers' permission are proposed to have relationships with facilitating conditions and disruptive effects of mobile learning respectively. The reasons as to why the thesis investigates those six aspects are presented as follows:

##### **5.1.1 Performance expectancy**

Performance expectancy is originally defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance” (Venkatesh et al. 2003, pp. 447). It is conceptually similar to perceived usefulness, which is posited to be one of the most robust predictors of IT adoption.

Nonetheless, as previously mentioned, most mobile learning services seem to be simply migrations of services from desk computers to mobile phones. Some administration applications firstly developed by companies for their employees, are now immigrated to education contexts for benefiting students. As a result, the limited usefulness of mobile learning is confronting with the relatively high price of high-end mobile devices, which makes it easy for people to gain a feeling that mobile learning does not live up to its promises and expectations (Milrad and Spikol, 2007). Considering the tightly-scheduled life of Chinese students and their heightened learning pressure, a useful mobile learning service should more concern an improvement of learning performance. Hence, it is proposed that the usefulness of mobile learning to improve students' learning performance should be an important aspect for the success of mobile learning.

### **5.1.2 Effort expectancy**

Effort expectancy here refers to the degree to which students believe the use of mobile learning would be free of effort. Taking the continuous trade-off between portability and usability of mobile devices into account (Gebauer and Shaw, 2004), it results in a challenge for mobile learning to be implemented on a relatively small handheld as well. On the other hand, as Kukulska-Hulme (2007) stated, current mobile learning activities are based on the use of devices that are not designed for educational purpose, and consequently usability problems are frequently reported. These usability problems mainly relate to physical attributes (e.g. weight, memory, size and battery life), content and software applications (e.g. students seem to be more comfortable with built-in functions), network speed and reliability, and physical environment (e.g. use in rainy conditions, risk of loss and theft) (Kukulska-Hulme, 2007). Hence, it is proposed that solving these technological restrictions will reduce physical and mental efforts needed, which further promotes the use of the innovation. Accordingly, effort expectancy is posited to be an important dimension for the success of mobile learning.

### **5.1.3 Perceived enjoyment**

If perceived usefulness and perceived ease of use are two extrinsic motivations of technology use, perceived enjoyment appears to be a kind of intrinsic motivation. It can be defined as the extent to which an activity is perceived to be enjoyable in its own right, and this property is separated from any beneficial performance consequences that may be anticipated (Davis et al., 1992). Perceived enjoyment has been found to be an important factor motivating the use of a variety of IT innovations, such as Internet-based learning mediums (Lee et al., 2005), mobile Internet (Liu and Li, 2010). It is worth noting that education itself will not always bring a sense of gratification but also pressures. Hence, to



support a sustainable use of mobile learning, it is important to intrinsically motivate students. Accordingly, perceived enjoyment is included in the framework as an important aspect for mobile learning success.

#### **5.1.4 Content quality**

To a large degree, content quality is conceptually based on information quality in the IS success model proposed by Delone and McLean (1992). Content quality measures a number of different characteristics of content. Weniger (2010) defined perceived content quality as the desired characteristics, such as accuracy, meaningfulness, and timeliness, of the information delivered. Lee (2006) proposed that content quality is of two dimensions, including content richness and update regularity. Further, Lee (2006) found that perceived content quality is a predictor of perceived usefulness of an e-learning system. Al-Ammari and Hamad (2008) defined the content quality of an e-learning system as a measurement of the accuracy, authenticity, accessibility, the design and the appropriateness of the course content. Their study indicated that content quality is a significant factor influencing the system adoption (Al-Ammari and Hamad, 2008).

Considering the unique features of handheld devices, previous e-learning materials for desk computer use are not appropriate to be used in the handhelds with relatively small screen size. This initiates a new requirement to design new learning contents pertaining to mobile learning. On the other hand, teachers may be very comfortable using computers, but lack of skills of using mobile technologies (Herrington and Herrington, 2007; MacCallum and Jeffrey, 2009). Many mobile learning systems only provide students with the learning materials, which have already been presented in the classroom or in traditional e-learning systems, such as slides. This greatly reduced the novelty and usefulness of learning materials, resulting in low content quality. Therefore the number of students who access mobile learning contents is limited since they have already read the material before.

#### **5.1.5 Social influence: disruptive effects and teachers' permission**

In UTAUT, social influence is originally is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al. 2003, pp. 451). Regarding young students, parents and teachers are apparently important stakeholders who exert strong influence on the students' behaviours. It is important to have both teachers and parents' support in order to successfully implement mobile learning in basic education.

It is worth noting that, despite of various potentials, mobile technologies also bring about disruptive effects to well-organized learning environment. According to a recent poll concerning students' use of mobile phone between 13-18 years old, it was found that many students cheat using mobile technologies even if they do not consider it a cheating offense (Benenson Strategy Group, 2009), such as:

- Only 41% say that storing notes on a mobile phone to access during a test is cheating and a "serious offense." And almost 1 in 4 (23%) do not think it's cheating at all.
- Similarly, only 45% say texting friends about answers during tests is cheating and a serious offense, while 20% say it's not cheating at all.
- Over a third (36%) said that downloading a paper from the Internet to turn in was not a serious cheating offense, and almost 1 in 5 (19%) said it is not cheating at all.

Additionally, the poll indicated that teens with mobile phones send 440 texts a week on average in which 110 are sent while in the classroom (Benenson Strategy Group, 2009). Some mobile learning projects that cost millions of US dollars failed largely due to its disruptive effects. For instance, a number of schools in the USA dropped their one-to-one laptop programmes, somewhat because of student's cheating activities and their rare use of laptop for learning (Hu, 2007).

Concerning the disruptive effects of mobile technologies, it comes naturally that almost all the schools across Europe currently forbid the use of mobile phones in the classroom (Kukulska-Hulme et al., 2009; Sharples, 2006). Note that while mobile learning is always described as an approach giving great autonomy to students, there are few studies indicating how the autonomy can benefit students, instead of misleading them. Whilst many studies report that mobile learning is welcomed by both teachers and students, teachers still attempt to control the use of mobile technologies in order to avoid its misuse in class (e.g. Facer et al., 2005). Based upon the above discussion, it is important to study the solutions to deal with disruptive effects of mobile learning in order to have teachers' permission to actually implement mobile learning.

Similar to teachers, parents also have strong influences on their children, which are discussed in the next section, together with facilitating conditions.

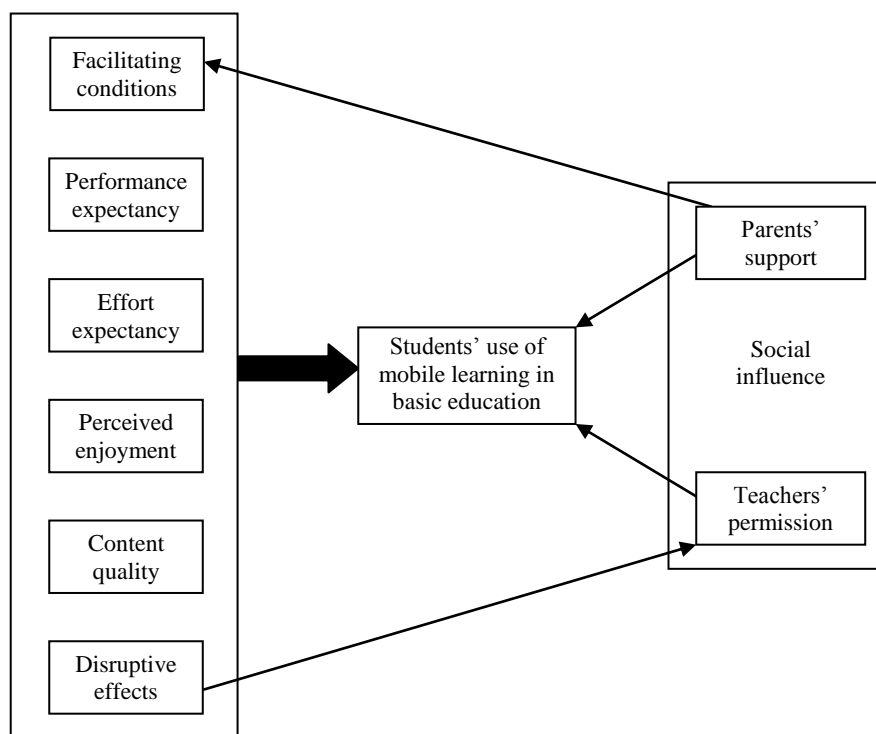
### **5.1.6 Facilitating conditions and parents' support**

In UTAUT, facilitating conditions are originally defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to

support use of the system” (Venkatesh et al. 2003, pp. 453). It typically relates to resources, knowledge and technical assistance necessary to use the ICT innovation. Apparently, behaviour cannot occur if objective conditions in the environment prevent it (Triandis, 1979). Similarly, a preliminary requirement for implementing mobile learning is students’ ownership of a proper device enabling mobile learning activities. Note that most students in basic education in China do not have a mobile phone or have a low-end phone with limited functionality. A challenge emerged is that how to provide enough mobile learning devices to students. Currently, the majority of mobile learning services are more like public goods rather than kinds of services that are capable to generate revenue to cover its cost. Most mobile learning projects are in a fragile situation; they tend to collapse and disappear when the funding is discontinued (Keegan, 2005; 2007). There is a lack of commercial models for using and developing mobile application for learning. Accordingly, facilitating conditions as a key construct is revised in the research, which refers to the availability of financial support to purchase mobile learning devices and services, in particular from parents.

Since schools in general cannot afford the purchase of mobile learning devices for all the students, it is important to have parents’ contribution to implement mobile learning. Also, it is very important to have parents’ permission for their children to interact with these devices in particular at home. In this light, it is essential to convince parents of the necessity of implementing mobile learning, so that they are willing to purchase the devices for their children. As a result, like teachers, parents also contribute to be an important aspect of social influence regarding implementing mobile learning technology in basic education settings.

Based on above-mentioned factors, a conceptual framework is developed illustrating the different relationships among the factors, as depicted in Figure 5.1.



**Figure 5.1 A framework for mobile learning implementation in basic education**

*Note: 1. The thick black arrow indicates the factors in left big box all have influences on students' use of mobile learning.*

*2. Parents' support and teachers' permission are included in the right big box as two key dimensions of social influence.*

## **5.2 A framework for investigating mobile learning adoption in tertiary education**

In this section, a conceptual framework for mobile learning adoption in tertiary education settings is developed based on TAM. This framework serves as a basis for survey questionnaire development, which in turn helps to collect data to empirically assess the framework. In the framework, five factors are included, which are (i) perceived ease of use, (ii) perceived near-term usefulness, (iii) perceived long-term usefulness, (iv) personal innovativeness and (v) behavioural intention. The theoretical background for designing the framework and related hypotheses is discussed in this section as follows.

### **5.2.1 Perceived near-term/long-term usefulness**

Perceived usefulness is a key construct of TAM. However, this construct receives some criticism, such as being rather broadly based (Moore and Benbasat, 1991). Relative advantage as a key component of the innovation diffusion theory is analogous to perceived usefulness. Similarly, it has been criticised as being poorly explicated and measured as well (Tornatzky and Klein, 1982). Built upon a review of both IS and psychology literature, Chau (1996) argued that perceived usefulness in fact consists of two distinct aspects, which are near-term usefulness and long-term usefulness. These two constructs were found to have significant influences on the intention to use IT (Chau, 1996). Thompson, et al. (1991) applied the conception of near-term/long-term usefulness to investigate the personal computer acceptance and developed two conceptually related constructs, which are job-fit and long-term consequences of use. Analogous to the perceived usefulness in TAM, the job-fit is defined as “the extent to which an individual believes that using a technology can enhance the performance of his or her job” (Thompson et al., 1991, pp. 129). The long-term consequences of use are defined as “outcomes that have a pay-off in the future” (Thompson et al., 1991, pp. 129). Both factors were found to have significant effects on personal computer utilization (Thompson et al., 1991). Regarding Internet acceptance at work, it was found that near-term usefulness significantly impacts long-term usefulness (Chang and Cheung, 2001). Additionally, perceived long-term usefulness has been proposed or validated to be an important factor motivating the adoption of a variety of IT innovations (e.g. Jiang et al., 2000; Lu, et al., 2003).

Note that perceived long-term usefulness or similar constructs have been widely used in studying students’ learning intention in education field. For instance, Cole et al. (2008, pp. 316) defined usefulness as “the student’s perception that the task will be useful to meet some future goal”. Concerning math, English, science and social studies, the research indicated that students’ learning effort and test results will suffer, if they cannot recognize the usefulness of the exam they are requested to complete (Cole et al., 2008). In a similar way, Eccles and Wigfield (1995) developed a construct of utility value, which is defined as the extent to which an individual believes the task relates to future goals. This structure is included in expectancy value theory of motivation as a key element of task value, which is widely applied to study students’ learning motivations (Eccles and Wigfield, 1995). Eccles and Wigfield (2002) noted that a student may initiate a learning activity since it facilitates the attainment of important future targets, even though he or she is not interested in the learning activity for its own sake. Hence, utility value appears to be a sort of extrinsic motivation, significantly impacting students’ learning behaviours (Chiu and Wang, 2008). For instance, Mori and Gobel (2006) found that to find a job, travel overseas and

live abroad in the future represented the utility value for Japanese students to learn English. Utility value is also found to be an important predictor of learners' intentions to attend graduate school as well as to continue mathematical studies (Battle and Wigfield, 2003; Brush, 1980).

Regarding educational IT innovations, utility value is found to have a significant impact on learners' intentions as well. For instance, it was found to be a factor explaining students' acceptance of web-based learning (Chiu et al., 2007; Chiu and Wang, 2008). Mendozze et al. (2008) conducted a longitudinal study on educational IS and found that students may discontinue IT usage if they cannot perceive long-term benefits or fail to resolve persistent issues. Instead of offering instant benefits, educational IT innovations, such as mobile learning, tend to reward learners in the future and in the long run. Students would be more likely to use mobile learning, if it can comply with their future goals. Built upon above discussion, the following hypothesis is made:

**H1:** Perceived long-term usefulness positively relates to behavioural intention to use mobile learning

As discussed above, perceived (near-term) usefulness is frequently found to be an important predictor of IT innovations adoption (e.g. Chau, 1996; Thompson et al., 1991). Accordingly, it is expected that students would be more willing to use mobile learning, if it can enhance their learning performance. Therefore, the following hypothesis is made:

**H2:** Perceived near-term usefulness positively relates to behavioural intention to use mobile learning.

Further, it is expected that, if students find that using mobile learning complies with their future target, they would be more likely to use mobile learning as an alternative to improve their near-term learning performance. The long-term usefulness of a mobile learning course would possibly motivate students to spend more efforts on mobile learning, which would improve their near-term learning performance. As a result, the following hypothesis is made:

**H3:** Perceived long-term usefulness positively relates to perceived near-term usefulness of mobile learning

### **5.2.2 Perceived ease of use**

In TAM, perceived ease of use is posited to be a determinant of perceived usefulness (Davis, 1989). In other words, if a user feels that an innovation is easy to use, the user will have a feeling that the innovation is useful. Perceived

ease of use is found to influence the perceived usefulness of Moodle (Sánchez and Hueros, 2010), wireless technology (Yen et al., 2010) and web-based training (Chatzoglou et al., 2009). Hence, the following hypothesis is proposed:

**H4:** Perceived ease of use positively relates to perceived near-term usefulness of mobile learning.

Perceived ease of use is related to usability issues of mobile learning. Prior studies have already identified a number of technological challenges of mobile learning adoption, as mentioned in section 5.1.2. In addition to this, perceived ease of use has long been identified to be a significant predictor of IT adoption in a long list of IS research (Li et al., 2008; Legris et al., 2003). For instance, perceived ease of use is found to be a motivator of the adoption of E-commerce (Liu and Wei, 2003), online learning (Lee, 2008) and email notification (Serenko, 2008). Based on literature related to perceived ease of use, the following hypothesis is therefore proposed:

**H5:** Perceived ease of use positively relates to behavioural intention to use mobile learning.

### **5.2.3 Personal innovativeness**

Personal innovativeness can be defined as an individual's willingness to try out any new information technology (Agarwal and Prasad, 1998). Prior research indicated that highly innovative individuals are more inclined to develop positive beliefs on new IT innovations compared to those who are less innovative (Lu et al., 2005). Personal innovativeness appears to be a sort of personal trait, which makes people more venturesome and daring to try out a new IT innovation in spite of a high level of uncertainty in new IT adoption. Recent years have seen a vast body of IS literature suggesting the importance of personal innovativeness in understanding new IT diffusion and usage. In particular, it was found to be a significant predictor for perceived ease of use (e.g. Lu et al., 2005; Yi et al., 2006). Therefore, it is hypothesized:

**H6:** Personal innovativeness positively relates to perceived ease of use of mobile learning.

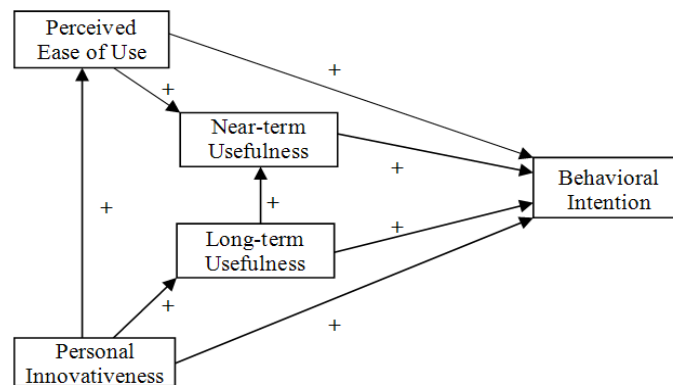
Based on personal innovativeness literature, it is suggested that an innovative user would more likely to develop positive feelings on new innovations. Accordingly, it is expected that an innovative individual would more likely to develop positive feeling on the perceived long-term usefulness of mobile learning alike. Therefore, it is hypothesized:

**H7:** Personal innovativeness positively relates to perceived long-term usefulness of mobile learning.

As mentioned above, innovative users are more venturesome in comparison to common users. Also, they generally tend to be the fore-runners of using new IT innovations. Prior studies suggested that personal innovativeness is a significant predictor of people's intention to use IT innovations (e.g. Taylor, 2007; Crespo and Rodriguez, 2008). Therefore, it is hypothesized:

**H8:** Personal innovativeness positively relates to behavioural intention to use mobile learning.

Based on the above hypotheses proposed, a conceptual framework for mobile learning adoption in tertiary education is developed, as shown in Figure 5.2.



**Figure 5.2 A framework for investigating mobile learning adoption in tertiary education**

As shown in the Figure 5.2, personal innovativeness is proposed to be a determinant of perceived ease of use, perceived long-term usefulness and behavioural intention. Perceived long-term usefulness is a predictor of both perceived near-term usefulness and behavioural intention. Perceived ease of use, together with perceived near-term usefulness, is a motivator of behavioural intention. Also perceived ease of use has a positive influence on perceived near-term usefulness as well.

### 5.3 Chapter summary

This chapter developed two conceptual frameworks, which help to identify possible factors influencing the adoption of mobile learning in basic and tertiary education respectively. The frameworks, together with the hypotheses proposed, contribute to preliminary answers to the research questions. However, the



validity of the frameworks and the related hypotheses need to be further evaluated. Consequently, in order to test the frameworks and the hypotheses, a case study and an empirical study are conducted as shown in the Chapter 6 and 7, respectively.



## **Chapter 6**

### **Assessing mobile learning adoption in basic education**

This chapter validates the framework concerning mobile learning adoption in basic education. A leading mobile learning service provider in China is introduced in the present chapter. Using case study methodology, data are collected from multiply sources. The data validation process is discussed. Based on the conceptual framework, this chapter investigates how the company deals with the challenges faced and enhances students' learning performance, which finally leads to a large-scale implementation of mobile learning in basic education in China. A series of innovative mobile learning devices are introduced, together with a number of innovative mobile learning technologies. The important role of both parents and teachers in students' adoption of mobile learning technology is discussed as well.

#### **6.1 Data collection and validation**

Currently, there are many mobile learning products available on the market from different companies. Among all the providers, Noah Education Holdings Ltd. (Noah) appears to be one of the most successful and profitable companies, which is listed on the NASDAQ stock market. Research on mobile learning devices from Noah has been included in China's 11<sup>th</sup> Five-Year Plan on educational technology projects. Consequently, compared to other companies, more information about the company and their products is made available due to both the business and research requirements. Previous studies suggested that, "in case study research, it is also possible to generalize from only one case (Gummesson, 2003; Stuart et al., 2002; Tellis, 1997) if it is useful for theory-building (Dyer and Wilkins, 1991) and testing (Bensabat et al., 1987)" (cited from Vissak, 2010, pp. 373). Considering the availability of resources and its uniqueness, Noah is selected as the only case to study the success of mobile learning in China and to test against the framework proposed in the Chapter 5.

The data is collected from multiple sources, in particular official business reports, the company's official websites and official product introductions. The reasons for adopting this data collection method instead of using traditional case study methods, such as interviews, are as follows: (i) the products are embedded with a number of new and patented technologies, and these technologies cannot be well-understood by the students in basic education, who are still under age. However, these technologies are very important and of interest for mobile learning researchers and practitioners; (ii) as a series of digital handhelds have been developed, together with a wide spectrum of services, some users may only use a part of them. For instance, some students may use the device only for studying English, while some for mathematics. Also there are differences in the learning requirements between students in primary and secondary schools. These may cause some deviations of their perceptions of the products, which make the study more complicated; (iii) adoption of mobile learning in basic education is decided collectively by students, teachers and parents. If an interview method is adopted, then all three stakeholders need to be interviewed. However, this would increase the work required and make the research more complicated with more subjectivity; (iv) since a number of challenges have been identified, it is more meaningful to study how the company deals with challenges, instead of simply interviewing customers.

To enhance the validity and reliability of case-based research, a list of guidelines proposed by Yin (1989) is evaluated in the context of the present study. Yin (1989) stated that a case study should be well constructed to ensure construct validity, internal validity, external validity, and reliability.

### **6.1.1 Construct validity**

Construct validity refers to the degree to which correct operational measures are established for the concepts being studied (Kidder and Judd, 1986). Yin (1994) proposed three solutions to improve the construct validity, which are (i) using multiple sources of evidence, (ii) establishing a chain of evidence, and (iii) having a draft case study report reviewed by key informants. In the present study, multiply sources of data are utilized. As mentioned above, the data utilized in the present study were derived from multiple sources, particularly official business reports, company's official websites and official product introductions. Since the research is based on data collected from official sources, it therefore tends to be more reliable and less subjective. Further, in order to establish a chain of evidence, an adoption framework is built upon existing theories and prior studies. Miss Jun Liu serves as a key informant to review the research paper published on the subject. Miss Jun Liu is the Deputy Team Leader of China's 11<sup>th</sup> Five-Year Plan on education technology projects—'a portable network learning system'. Undertaken by both Noah and Beijing

Normal University, the project focused on digital learning devices, which are also the research object of the present case study.

### **6.1.2 Internal validity**

Internal validity refers to the degree to which the study can establish a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships (Cook and Campbell, 1979; Yin, 1989; cited from: Stuart et al., 2002). The internal validity can be enhanced through conducting pattern matching, which requires using past experience, logic, or theory before specifying what the research expects to find (Grosshans and Chelimsky, 1990). In this light, the study developed an adoption framework based on related theories and studies, which is evaluated subsequently. Consequently, this helps to enhance the internal validity of the present study.

### **6.1.3 External validity**

External validity refers to the degree to which the results of a study can be generalized (Cook and Campbell, 1979; Yin, 1989). Note that the goal of case study research is analytical generalization, instead of statistical generalization in survey research (Yin, 1989). Stuart et al. (2002, pp. 430) noted that “with case research, generalization is from each case to a broader theory not from samples to populations”. External validity could be achieved from theoretical relationships and from them generalizations could be made (Yin, 1994; Amaratunga et al., 2002). The present study is based on an adoption framework and the framework is developed based on existing theories. This would improve the external validity of the results.

### **6.1.4 Reliability**

Reliability refers to whether the operations of a study can be repeated with the same results (Yin, 1989). Reliability can be enhanced by revealing every reference and every data source explicitly, so that other researchers are able to achieve the same results through repeating the analytical procedures (Stuart et al., 2002). Since nearly all the references and documents used in the present research are available from Internet, it is possible for other scholars to repeat the research. According to the suggestion from Stuart et al. (2002), the study seeks to well document the procedures and specify the references used explicitly as well.

## 6.2 Framework assessment

The design of Noah's products is based on the knowledge collected from continuous experiments with their products in the market and interaction with customers. Consequently, built upon a selective utilization of handheld technologies currently available and an independent development of new handheld educational technologies, a wide spectrum of new handhelds have been developed specifically for mobile learning purpose. Of these handhelds, a series of the most sophisticated and advanced handhelds are termed digital learning devices (DLDs) by Noah. Considering constant technology advance, only DLDs are discussed here. Mobile phones are not discussed in this chapter as they are not widely used for education purposes in basic education contexts in China. Similarities among the DLDs developed are summarized as follows, based on the framework proposed.

### Effort expectancy

There are a number of different models of DLDs, the prices of which largely range from 90 to 170 Euros. DLDs feature high resolution and high contrast picture quality with a big screen size, such as 3.5 inch of NP 1380 and 4.3 inch of NP2150. The screen is designed similar to a TV set or a laptop rather than the typical portrait layout of mobile phones. The input method is typically based on handwriting on a touch screen or a keyboard with more or less 64 keys, or both or them. DLDs can communicate with personal computers. It can also be connected to an external keyboard or a mouse. Additionally, rechargeable large-capacity lithium-ion battery, high-frequency chip, extended memory support, external loudspeakers, built-in pronunciation and dual-channel headphones, built-in digital voice recorder are widely embedded in the DLDs as well. The outlook of three models of recent DLDs is shown in Figure 6.1. To see how the learning materials are presented, a number of DLD interfaces are shown in Figure 6.2.



Figure 6.1 The outlooks of three DLDs

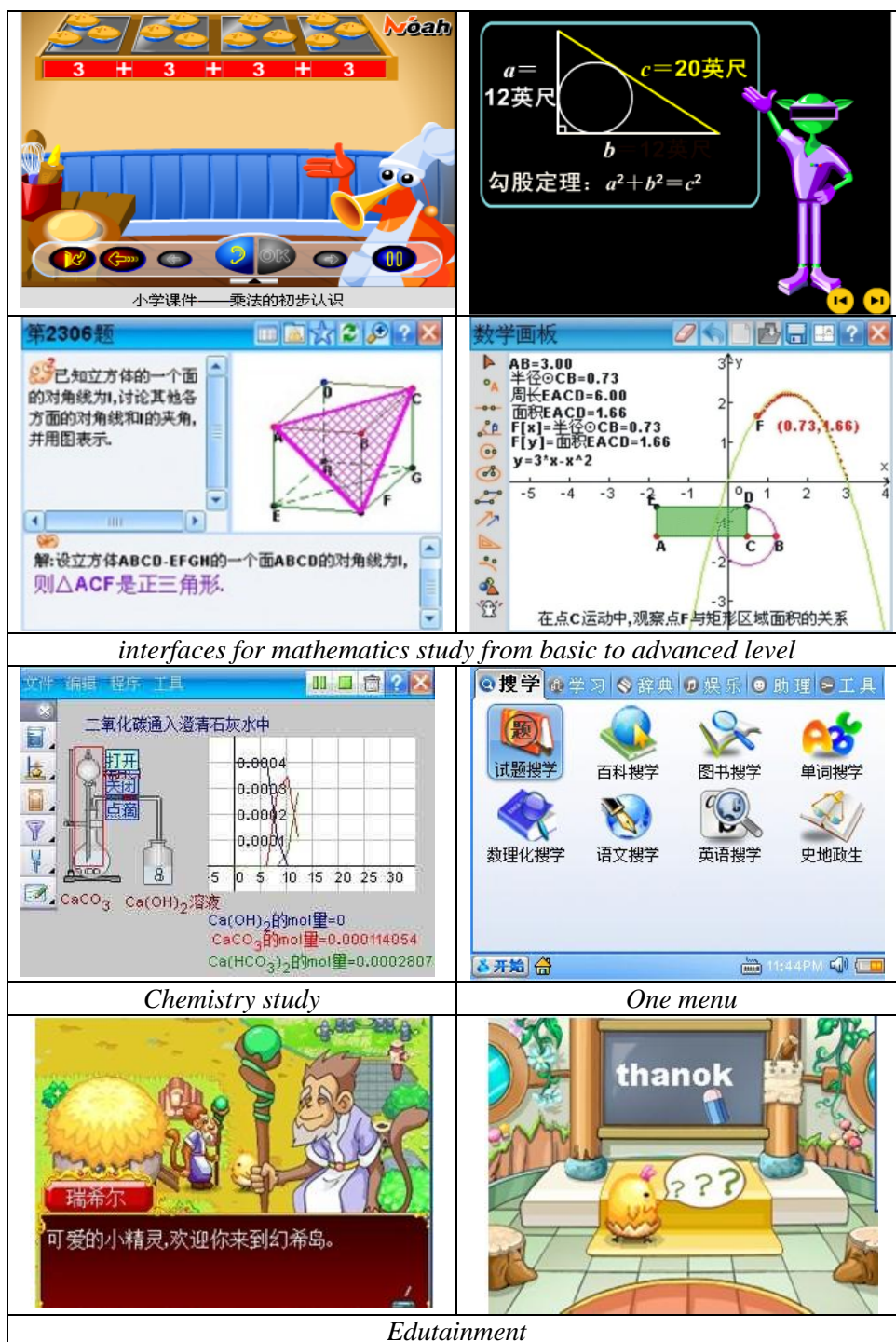
DLDs are designed to enable easy and comfortable operating and studying experience. Note that DLDs are embedded with a self-developed Linux and WinCE-based proprietary NP-iTECH software platform. Based on the platform, learning materials and interface are displayed in a full-screen format. Some interfaces are presented as shown in Figure 6.2. Further, concerning language study, Text-to-speech (TTS) technology is widely built in the system. A wide spectrum of file formats, such as txt, rmvb, MP3, MP4, MIDI, MPEG4, 3gp etc., can be presented in DLDs. To offer a more complete view of DLDs, a brief specification of a recent DLD (Model NP1380) is presented in Table 6.1. Its design is shown in Figure 6.3.

### **Performance expectancy**

A wide range of learning materials and functionalities are developed by Noah and available on DLDs, which makes the devices very useful for students. Noah develops and markets interactive, multimedia learning materials mainly to complement prescribed textbooks used in China's primary and secondary school curriculum covering standard subjects, such as English, Chinese, mathematics, biology, geography, physics, chemistry, history and political science. These titles are arranged by semester and by subject. As of June 30, 2009, Noah had developed a collection of approximately 47,500 courseware titles (MDR, 2009). The courseware titles combine texts, graphics, audios, visuals and animations, which are all presented in a multimedia and interactive manner. "The multimedia content provides an engaging and animated learning environment which we (Noah) believe encourages students' independent studies and enhances the students' learning experience" (MDR, 2009, pp. 25).

Further, over 340 series of English language learning courseware are made available, each based on a different series of textbooks (MDR, 2009). Noah has licensed and compiled over 250 dictionaries, including 26 dictionaries pertaining to the English language, eight dictionaries to Japanese language, ten dictionaries to other foreign languages and over 200 professional dictionaries on subjects like medicine, law and engineering (MDR, 2009). Many of these dictionaries are presented with colourful interactive animations, dialogues and explanatory graphics. In particular, Noah developed an animation dictionary with animated illustrations of 9000 commonly used words. The general research group's statistics show that DLDs can efficiently improve students' academic achievements (Sina, 2007).

A variety of personal information management functions are provided to help students effectively arrange their studies and daily lives. The functions include schedule, calendar, class schedule, memo, alarm, personal finances and many more.



*interfaces for mathematics study from basic to advanced level*

*Chemistry study*

*One menu*

*Edutainment*

Figure 6.2 Some interfaces of DLDs





**Figure 6.3 Physical design of NP1380**

<ul style="list-style-type: none"> <li>• Screen: 3.5-inch, 26 million colors TFT, 320×240 pixels</li> <li>• Size: 122mm x 74.5mm x 17mm</li> <li>• Color: Black/white/silver</li> <li>• Keyboard: 7 keys and handwriting input</li> <li>• Memory: 2 GB</li> <li>• CPU: 32-bit processor</li> <li>• Expansion Memory: Supports up to 16 GB micro SD</li> <li>• Battery type: Rechargeable Lithium (1.100mAh)</li> <li>• Download Interface: USB interface for downloading and charging</li> <li>• Audio: MP3, WMA, etc.</li> <li>• Video: AVI, RMVB, RM, 3GP, MP4, etc.</li> <li>• Image: JPG, BMP, GIF, TIFF, etc.</li> <li>• Built-in digital voice recorder</li> <li>• 28mm diameter stereo speakers, 3.5mm 2-channel high-fidelity headphone</li> </ul>
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**Table 6.1 Specifications of NP1380**

Note that Noah devotes itself to constantly developing new and useful education technologies and applications. As of June 2009, Noah held 22 domestic patents and had 19 pending patent applications. Three of these technologies are believed to be the most important, innovative and useful, and are introduced here. These technologies are termed as NP-iTECH, Learning Search Engine and Graphic Calculator Technology respectively.

NP-iTECH is the basic software platform for DLDs. It is short for ‘Handheld Network Multimedia Integrated Technology’. This technology held 12 related domestic patents, in addition to one international and one domestic pending patent application. Built upon network process technology, NP-iTECH helps to present multimedia-intensive content. In particular, it supports and integrates advanced audio and video formats and Flash animation technologies, such as MIDI, WAVE, MP3 and MPEG4. This technology enhances Noah’s content development capability by helping designers to effectively develop and assemble multimedia content elements (MDR, 2009).

NP-iTECH is built as an open architecture, and is therefore highly scalable. In addition to DLDs, it is not only compatible with the LINUX and WinCE operating systems, but also a variety of applications operating in the LINUX and WinCE operating environment. The technology is compatible with the cellular phone environment as well. As the basic software platform, NP-iTECH also systematically integrates a diversity of patents, including NMAIL, nFlashMX, DLSprite, nTrack, Nmessage, etc. These patents are of different usefulness for students, and are briefly introduced as follows:

- **NMAIL:** It is a multimedia mail sending and receiving application, which facilitates students to write or read nMail on DLDs. DLDs can send and receive the nMail automatically once connected to Internet.
- **nFlashMX:** It is a virtual design tool for developing cartoons, MTV, Electronic Album and courseware. It is said that a common user can easily learn to handle the software even within 20 minutes. The software is advertised by Noah as to ‘you can make a cartoon if you can use a mouse; you can make courseware if you can use a computer’. In this way, teachers who are not familiar with mobile technology are now capable of developing their own courseware for students in a light-hearted way.
- **DLSprite:** Combined with a ‘One-key download function’, DLSprite is designed to facilitate fast updating and downloading of learning materials to DLDs via Internet. Also students can use DLSprite to easily manage files stored in the DLDs, such as deleting, transferring and editing.
- **nTrack and Nmessage:** nTrack is a technology that automatically records the learning activities on DLDs, such as learning materials being used, learning process, history, accuracy of test, etc. The record is sent to the remote

database of Noah and studied through intelligent analysis system. The final analysis of records will be transmitted to parents or students by Noah. The results would help students to identify which part of the course still needs more efforts before an exam.

Learning Search Engine is a sort of vertical search technology, which enables students to search answers on DLDs by just inputting their questions. One of its interfaces is presented in Figure 6.4. The searchable practice question database is embedded on DLDs with approximately 300,000 practice questions. These questions initially concern the subjects of mathematics, physics and chemistry, but now are expanded to include topics, such as Chinese, English, history, political science, geography and biology. Each practice question contains 24 searchable fields and links to solutions and related questions and courseware titles. The search is built upon questions, books, encyclopaedia, English words and phrases. As for the encyclopaedia, Noah has developed more than 200,000 searchable test questions, covering subjects such as astronomy, geography, science and nature. In addition, Noah still hosts nearly 5,000 sample compositions and 24,000 digital books covering a wide spectrum of topics. Like NP-iTECH, the learning search engine is scalable and can be implemented on various platforms.



Figure 6.4 A interface of learning search engine.

Graphic Calculator Technology is China's first handheld graphic calculator technology, which launched on DLDs at the end of 2007. It integrates five basic functions, which are math sketch pad, algebra calculus, mathematical functions and programming, geometric dictionary and classic course. The technology helps to convert abstract mathematical concepts and theory into comprehensible

images in an intuitive and dynamic manner, which enables teachers to teach mathematics effectively.

Based on above discussion, it is apparent that a number of useful technologies and educational materials are embedded in DLDs, which make them a useful solution to improve students' learning performance. Hence, this suggests that an enhanced feeling of perceived usefulness (performance expectancy) can be generated through using DLDs, which has a positive influence on the adoption of mobile learning in basic education contexts.

### **Perceived enjoyment**

As previously mentioned, most of young Chinese students are under relatively high learning pressures. Hence, it is necessary to find possible solutions to alleviate the pressures so as to facilitate more persistent learning behaviours. Consequently, a variety of fashionable edutainment solutions are implemented on DLDs, such as MP3, E-book, My Blog, Electronic Album, E-drawing, role-playing games (RPG). Three well-developed digital magazines are offered monthly on nearly all walks of students' lives, such as friends making, extra-curricular learning, entertainment information and Flash development skills. Thousands of E-books, including both ancient and modern masterpieces, are available and downloadable on DLDs via Internet. In particular, four educational RPG games have been developed, which enable students to learn knowledge in a light-hearted environment. The availability of various edutainment methods accommodates different learning interests of students, which in turn intrinsically engages them for more persistent learning activities. This also suggests that adding perceived enjoyment into UTAUT can give a more complete picture of the factors driving mobile learning adoption in basic education environments.

### **Content quality**

A constant provision of high quality content is a key challenge for educational organizations. Teachers tend to give up developing mobile learning materials by themselves due to a lack of necessary resources, such as time, money and skills. On the other hand, students may lose interest in mobile learning, if the learning materials fail to be updated regularly and in-time.

In this light, Noah attempts to collect the knowledge of lots of well-known teachers and professors in China. In this way, Noah established a "Teacher's Alliance", which helps Noah to constantly produce high-quality education resources. The alliance consists of approximately 250 teachers and 17 education experts from over 100 top schools in 15 provinces throughout China. The learning materials adaptive to DLDs are developed by approximately 101 full-time designers and about 111 part-time designers (MDR, 2009). On the other

hand, Noah partners and licensees from leading domestic and international education publishers, including The Commercial Press, Foreign Language Teaching and Research Press, Beijing Language and Culture University Press, Shanghai Translation Publishing House, Shanghai Century Foreign Language Education Publishing House, Yilin Press, Shanghai Jiao Tong University Press, Shanghai Foreign Language Education Press, Jinan Xinghuo Memory Research Institute and Sanseido Co., Ltd. All of these efforts in turn initiate Noah a capability to provide high quality contents constantly.

### **Social influence: teachers' permission and disruptive effects**

Considering the disruptive effects of mobile technologies, previous studies frequently suggested that teachers tend to forbid the use of mobile phones in a classroom environment. In order to have teachers' permission for mobile learning, a key challenge that has to be solved is its disruptive effects on a well-organized learning environment. In this light, a theory has to be introduced here in order to better understand the causes of the disruptive effects, namely self-directed learning theory. Regarding UTAUT, this also helps to explain why negative social influences are exerted by some teachers on the use of mobile learning technology in basic education.

Self-directed learning theory is widely used in problem-based, lifelong and distance learning contexts (Fisher et al., 2001; Stewart, 2007). It is initiated from adult education, but its scope has been extended to include adolescents and young students (Taylor, 1995; Thomas et al., 2005). "In its broadest meaning, 'self-directed learning describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes'" (Knowles, 1975, pp. 18). Self-directed learning research seeks to help individual learners to develop the requisite skills for participating in self-directed learning, such as planning, monitoring and evaluating their own learning (Reio and Davis, 2005). Apparently, self-directed learning theory can also apply to mobile learning contexts since mobile learning is widely acknowledged as a learner-centred learning approach that gives students great autonomy on their own learning activities.

Prior study indicated that self-directed learning capability exists along a continuum and is present in all individuals to some degree, as stated in section 2.1.2 (Fisher et al., 2001). Self-directed learning capacity develops steadily during childhood and rapidly during adolescence (Thomas et al., 2005). Readiness for self-directed learning activities is increased with life experience. Meanwhile, brain research suggests that meta-cognitive, self-regulatory capability is inherently developmental. In this light, young students in basic

education system are not necessarily well self-directed, particularly when they are physically immature in brain capability. Consequently, it happens naturally that many students misuse mobile technologies in classroom. On the other hand, mobile learning approach heightens great autonomy and responsibility on students to manage their own learning, which calls for a corresponding self-directed learning capability. Simply heightening great autonomy on students may result in a disaster if they cannot properly self-manage themselves. Since previous adoption theories simply focus on how to promote the adoption of technologies, self-directed learning theory suggests that a promoted use of technology does not necessarily result in positive outcomes.

As a result, one possible solution to deal with disruptive effects of mobile learning is to reduce the autonomy put on the students to a proper level. Unlike mobile phones embedded with a variety of communication and entertainment services, DLDs appear to be a pure product for education purposes with only education-related contents. These devices give up the wireless communication capability but instead embed a great amount of built-in education resources. All of these characteristics reduce the learning autonomy required for conducting mobile learning and avoid the misuse of technology to a great extent. In this way, DLDs are capable of greatly alleviating the disruptive effects of mobile technologies, and therefore gain the teachers' permission to be used in schools. This suggests that the social influence from teacher influences students' adoption of mobile learning in basic education contexts. In particular, if teachers regard mobile learning as a disruptive technology, they will exert negative social influence on the implementation of mobile learning technology.

### **Facilitating conditions and parents' support**

Facilitating conditions of mobile learning in basic education here are proposed of several interrelated dimensions, including parents' support, technological support and availability of instructions.

Parents' support is one of the key facilitating conditions for using mobile learning. In particular, parents are actual decision makers to purchase mobile learning products in the market. Unlike most of current mobile learning projects, DLDs are not public goods. Instead, they are products through which the company can make profits. As a result, a series of advertisements have been launched to convince parents of the usefulness of DLDs in education, so that they are willing to purchase the devices for their children. Their support not only enables students to use mobile learning, but also facilitate the financial survival of the company. In the fiscal year ended June 30, 2009, Noah generated new revenue of US\$ 98.3 million. Since 2007, Noah has been listed in the NASDAQ stock market. These profits help Noah to constantly develop new learning

materials and invest in developing new technologies. This in turn forms a good cycle for providing high-quality mobile learning products and services.

Technological support is important for facilitating a sustainable use of DLDs. DLDs package a wide scope of learning materials once being purchased, while new learning content can be subsequently downloaded at over 10,000 points of sale, approximately 2,000 download centres, or via its website: [www.noahedu.com](http://www.noahedu.com). Taking into account the popularity of computers with Internet connection in China, the updating of DLDs appears to be an easy task today. In 2008, Noah launched a programme termed ‘Access Noah’, a strategic marketing initiative that directly partners Noah with public schools across China. The programme seeks to integrate Noah’s learning materials with in-classroom teaching. As of June 30, 2009, there are hundreds of schools across 28 provinces involved in the programme, covering millions of school children in China (MDR, 2009).

A lack of necessary facilitating conditions, such as immediate instructor feedback and personal contact, has been found to be barriers impeding the continuance of online courses (Fozdar and Kumar, 2007). Since July 2007, Noah starts to provide after-school tutoring programme online. Users can log-on to the website and post questions regarding their homework. Experienced teachers from the Teachers’ Alliance are available to answer the questions posted. Also other students can participate in the exchange and post their answers alike. Additionally, online community, chat rooms and bulletin boards are available to promote interaction among students, teachers as well as parents.

### **6.3 Discussion**

Noah’s solutions for mobile learning implementation in basic education offer a number of new and fresh insights, considering its unprecedented success in the market. In addition to mainland China, Noah also distributes its content and products to Hong Kong, South Korea, Malaysia and Turkey. By constantly experimenting with its products and ideas in the market, Noah has achieved a number of innovative solutions capable of dealing with the challenges that remain largely unsolved in the field.

Noah believes that its success of DLDs depends on its capability to “present traditional content in an engaging multimedia format and at a pace and order selected by each individual student, thereby creating a more tailored and more enjoyable teaching and learning experience” (EDGAR online, 2007). While most of current mobile learning projects are simply built on the use of mobile phones which are designed for business or entertainment purposes, Noah paves a new way of implementing mobile learning by completely developing handheld technologies solely for education use. Attractive learning materials presented in

an interactive and multimedia manner are important to concentrate students' attentions on learning for a longer time. Also platform, interface and contents especially designed for being used in a handheld environment help to alleviate the possible negative feelings related to the physical restrictions of portable devices. On the other hand, DLDs seek to accommodate the learning requirements and features of students. From outlook design to built-in technologies, from learning materials development to learning support, education use and students' requirements are constantly the key focuses and targets. This helps Noah to develop a series of mobile learning devices widely accepted by students, teachers and in particular parents.

In addition to students, DLDs are capable of satisfying the requirements of both teachers and parents, who are key stakeholders when it comes to the decision whether to use mobile learning. Advertisements and market campaigns initiated by both Noah and its competitors are available in various media, which convince people of the usefulness of DLDs in promoting students' learning performance. This helps to persuade parents to purchase the devices, which is a prerequisite first step in implementing mobile learning. Only with parents' permission, the use of DLDs can be allowed when students are at home. On the other hand, the design of DLDs well solved the problem of disruptive effects. As a result, teachers generally allow their students to use DLDs in classrooms and schools. Only with the permissions from both teachers and parents, a mobile learning project can be implemented successfully.

DLDs' successful solution to disruptive effects also indicates that great autonomy heightened by mobile learning for students does not necessarily lead to effective learning activities. It is not strange for young students to misuse mobile technologies in the classroom, since they are not physically mature enough to be self-managed and self-directed. This also helps to explain why disruptive effects are frequently reported in basic education contexts, but rarely happen during lectures in a tertiary education environment. DLDs reduce the requirements for conducting self-directed learning by giving up disruptive communication technologies, packaging a wide spectrum of well-organized learning materials and offering proper instructions on learning process. This offers researchers and practitioners a possible alternative to successfully alleviate disruptive effects.

To some degree, Noah's success shows that, for basic education in China, mobile communication technology appears to be not as important as it is for mobile employees. Communication technology may excel in delivering data and contacting people remotely in real-time. However, considering "the entering a school nearest to one's home policy" in China, students typically spend a short period of time commuting to schools, but stay in school and at home for most of the time. There is not a strong need for communication technologies. On one



hand, students can easily communicate with teachers and classmates face to face in the school. On the other hand, students can also easily contact with them at home using Internet or parents' mobile phones. Note that, as knowledge is not of high timeliness in nature, there is hence no urgent need to update courseware in a real-time manner using communication technology. According to Noah, a large amount of learning materials is pre-installed in DLDs with a big storage capability to satisfy possible inquiry. Also DLDs can be updated easily using high-speed Internet connection.

While many researchers seek to combine classroom learning, online learning and mobile learning to develop a more advanced level of education, namely blended learning, Noah's solution offers a possible alternative. Noah's mobile learning conception integrates all of the three educational approaches, in which mobile learning appears to be a bridge connecting classroom learning and online learning. More specifically, the learning content in DLDs complements the prescribed textbooks used in school, which actually supports classroom teaching. Meanwhile teachers may directly use the content in DLDs in the class, which are compiled by other famous and experienced teachers. If students are still confused about some knowledge, the availability of well-organized courseware in DLDs is available to help them. Further, DLDs provide its own optional exercises to student, which may help those with strong academic ambitions. On the other hand, online learning system helps DLDs to download and update learning materials at a fast speed, considering the high bandwidth of Internet. Further, online tutoring system based on relatively big monitors and easy-to-operate keyboards makes it easy for students to post questions regarding their homework and to interact with distant teachers at Noah. This helps to solve learning problems when direct help from students' own teachers is unavailable.

Further, Noah's business-oriented operation model is highly successful in particular when the majority of current mobile learning projects fail to generate revenue. This model helps Noah to constantly market and develop high-quality contents and new educational technology, which extends its influence to schools across China.

Currently, a series of studies on DLDs are being conducted in many schools across China, which is included in China's "11<sup>th</sup> Five-Year Plan" as a key research subject on education technology. Meanwhile, Noah and its competitors are constantly developing new learning materials and investing in new mobile learning technologies and services. In recent years, Noah has started to extend its customer base to include children from five to nine years old with a series of new handhelds, which are termed kid learning devices (KLDs). After several years of development, mobile learning has been widely recognized by Chinese students, teachers and parents in basic education contexts. It can be expected

that, along with technology advancement, DLDs as well as mobile learning will become more and more sophisticated and increasingly popular in China.

#### **6.4 Chapter summary**

The chapter systematically discussed how mobile learning industry in China deals with the challenges faced in the field. A number of new technologies were discussed. In addition, different roles of students, teachers and parents played in the adoption of mobile learning in basic education environments were specified. In particular, a possible alternative to deal with the disruptive effect of mobile learning technology in well-organized learning environments was presented. The chapter contributed to answering the research question 1 proposed in the chapter 1. In the next chapter, key factors motivating mobile learning adoption in tertiary educational environments are presented.

## **Chapter 7**

### **Assessing mobile learning adoption in tertiary education**

Based on the framework proposed in the chapter 5, this chapter presents the survey design, and statistical results of both data validation and framework assessment. Firstly, sample, instrument development and reliability, and survey procedures are presented. Then, after data validation, hypotheses are tested based on the validated data. Structural equation modelling technology is employed to assess the framework. Model fit indices are calculated to evaluate whether the model presents a good fit with the data. Both theoretical and practical insights are discussed. The chapter helps to answer the research question 2 through the testing of hypotheses.

#### **7.1 Survey instrument development**

The survey is conducted using a questionnaire. In order to develop a theoretically grounded questionnaire, the scales adopted were largely built upon the scope and structure of previous studies. The questionnaire consists of two parts. The first part of the questionnaire collects the demographic information of respondents, including gender, length of mobile phone usage, frequency of using advanced mobile services, and experience on mobile learning. The second part of the questionnaire collects the data regarding respondents' perceptions on mobile learning.

Respondents' perceptions are theorized to be a number of latent variables, which are not directly observable or measurable. Hence, a number of measurement items were assigned to each of these latent variables with numeric values. Specifically, respondents' statement on different items were rated on seven-point Likert-scales ranging from strongly disagree (1) to strongly agree (7). Totally, the questionnaire consists of five key constructs based on the framework proposed in section 5.2. The items for measuring perceived near-term usefulness (PNTU), perceived ease of use (PEOU) and behavioural intention (BI) were

adapted from the questionnaire developed by Davis (1989) and Chau (1996). The measurements for personal innovativeness (PI) were developed based upon the study of Agarwal and Prasad (1998). The items for measuring perceived long-term usefulness (PLTU) were adapted from that developed by Chau (1996) and Eccles et al. (1983). These items are presented as shown in Table 7.1. To satisfy the unique requirements of the present research, some modifications and rewording of the survey instruments were carried out. The questionnaire was first developed in Chinese and then the questionnaire was translated to English.

<b>Construct</b>	<b>Amount</b>	<b>Measurement indicators</b>
PNTU	3	<ol style="list-style-type: none"> <li>1. I think using m-learning can increase the efficiency of my studies and work.</li> <li>2. M-learning is useful for my studies.</li> <li>3. I think using m-learning can increase the effectiveness of my studies.</li> </ol>
PEOU	3	<ol style="list-style-type: none"> <li>1. I think learning to use m-learning is very simple.</li> <li>2. It would be easy for me to become skilful at using m-learning.</li> <li>3. I think using m-learning is easy.</li> </ol>
PLTU	4	<ol style="list-style-type: none"> <li>1. Using m-learning helps me to gain success in the future.</li> <li>2. Using m-learning benefits me in the long run.</li> <li>3. Using m-learning helps me to realize my future target.</li> <li>4. Using m-learning benefits me in the future.</li> </ol>
PI	3	<ol style="list-style-type: none"> <li>1. I like to experiment with new information technology.</li> <li>2. If I heard about a new information technology, I would look for ways to experiment with it.</li> <li>3. Among my peers, I am usually the first to try out new information technology.</li> </ol>
BI	2	<ol style="list-style-type: none"> <li>1. I intend to use m-learning in the future.</li> <li>2. I believe I will use m-learning in the future.</li> </ol>

**Table 7.1 Measurement indicators.**

## **7.2 Survey procedures and sample**

As the research focuses on the mobile learning adoption in tertiary education contexts, university students accordingly became the target population for conducting the survey. Consequently, the survey was conducted in one of the universities in China, namely Zhejiang Normal University. Totally, 230 undergraduate students were invited to participate and complete the questionnaire in computer rooms. After a brief illustration of research purposes,

major websites providing mobile learning products and services were then introduced, such as wap/www.englishto.com and wap/www.mobiledu.cn. Most of mobile learning materials provided in these websites concern English language study. Students were asked to visit the websites either via desk computers or their own mobile phones before actually filling in the questionnaire. Desktop computers were utilized to facilitate a fast navigation of mobile learning materials, which can be consequently downloaded and used on their personal mobile phone. This way of file transformation is popular among Chinese students, since it avoids the downloading cost of wireless connection. Hence, desktop computers were provided to the students to comply their habits of mobile phone usage, which made students more willing to trial mobile learning on their phones. It is worth noting that these mobile learning materials downloaded cannot be opened on a desk computer. They can only be opened in a mobile phone with corresponding software platform installed, as mentioned in section 2.3.1 and 2.3.2. The key reason for investigating only mobile-phone-based mobile learning usage is due to the fact that most of current mobile learning applications in tertiary education contexts are based on mobile phones.

Finally, a total of 220 responses were collected from 230 participants, resulting in a response rate of 95.7%. However, eleven responses were not included in the consequent data assessment as they were only partially completed. One response, which only missed a question regarding demographic information, was included in the analysis as well. Among the 209 respondents, 31.1% (N = 65) were male while 68.9% (N = 144) were female. All the respondents had a mobile phone and 93.3% of them (N = 195) have used their mobile phones for more than one year, in which 62.2% (N = 130) had an experience of using mobile phones for more than two years. Additionally, 1.9% (N = 4) of the respondents have used mobile phones for less than six months. 4.8% (N = 10) of the respondents have owned their personal mobile phones for more than six months, but less than one year. Hence, the 93.3% of the respondents (N = 195) are experienced users, who used mobile phones for at least one year.

Most respondents are experienced advanced mobile services users. Only 35.4% of the respondents (N = 74) have never used the services. The rest of the respondents (135) used advanced mobile services at least once per week. 9.6% of the respondents (N = 20) are frequent services users, who used the services for more than ten times per week.

Regarding respondents' experience on mobile learning, 43.5% of the respondents declared that they do not know what mobile learning is and never used it before. 42.1% of the respondents (N = 88) indicated that they know what mobile learning is, but never used it before. 13.9% of the respondents stated that they know what mobile learning is and used it before. One respondent did not answer this question. A limited amount of mobile learning users indicated that

mobile learning in tertiary education is in an initial stage. The demographic information of respondents is illustrated in Table 7.2.

Demographic		Frequency	Percent
Gender	Male	65	31.1
	Female	144	68.9
	Total	209	100
Length of time using a smartphone (years)	Less than 0.5	4	1.9
	0.5-1	10	4.8
	1-2	65	31.1
	More than 2	130	62.2
	Total	209	100
Frequency of using advanced mobile services (times per week)	Never	74	35.4
	1-5	71	34
	5-10	44	21
	More than 10	20	9.6
	Total	209	100
Experience	No answer	1	.5
	I do not know what mobile learning is and never used it before	91	43.5
	I know what mobile learning is, but never used it before	88	42.1
	I know what mobile learning is and used it before	29	13.9
	Total	209	100

**Table 7.2 Demographic information of participants**

Descriptive statistics of respondents' perceptions on mobile learning are collected and reported using software SPSS 17.0. As shown in Table 7.3, compared to other constructs, PEOU has the highest mean value, but the lowest standard deviation. This indicates that respondents hold a relatively uniformed and positive evaluation on the ease of use aspect of mobile learning. PNTU has the lowest mean value with a moderate standard deviation. BI gives a relative high mean value, but with the highest standard deviation. This indicates that respondents' perceptions on the use of mobile learning are of relatively high variability.

	Mean	Std. Deviation
PNTU	<b>4.6364</b>	<b>1.33998</b>
PNTU1	4.7895	1.52027
PNTU2	4.6172	1.59232
PNTU3	4.5024	1.42142
PEOU	<b>5.3254</b>	<b>1.24612</b>
PEOU1	5.2536	1.48641
PEOU2	5.3445	1.39917
PEOU3	5.3780	1.33578
PLTU	<b>4.6830</b>	<b>1.27204</b>
PLTU1	4.5263	1.41779
PLTU2	4.9378	1.38708
PLTU3	4.4976	1.40440
PLTU4	4.7703	1.52696
PI	<b>4.6475</b>	<b>1.31463</b>
PI1	5.1962	1.39876
PI2	4.8947	1.47688
PI3	3.8517	1.77374
BI	<b>4.8062</b>	<b>1.37614</b>
BI1	4.7560	1.48155
BI2	4.8565	1.44730

**Table 7.3 Descriptive statistics of users' perceptions on mobile learning**

As shown in Table 7.2, the survey accidentally included more females than males in the sample. Consequently, the sample seems to somewhat over-represent the female group. In this light, an independent sample T test based on SPSS 17.0 is conducted to investigate whether there are significant differences between males' and females' perceptions on mobile learning. The key results are presented in Table 7.4. The results indicate that there are no significant differences in all the constructs between two gender groups.

		t-test for Equality of Means			
		t	df	Sig. (2-tailed)	Mean Difference
PNTU	Equal variances assumed	.330	207	.741	.06631
	Equal variances not assumed	.304	102.760	.761	.06631
PEOU	Equal variances assumed	-.457	207	.648	-.08519
	Equal variances not assumed	-.428	106.469	.670	-.08519
PLTU	Equal variances assumed	-.369	207	.713	-.07025
	Equal variances not assumed	-.352	110.919	.726	-.07025
PI	Equal variances assumed	1.935	207	.054	.37760
	Equal variances not assumed	1.849	111.202	.067	.37760
BI	Equal variances assumed	.281	207	.779	.05796
	Equal variances not assumed	.277	119.558	.782	.05796

**Table 7.4 Results of independent samples T test**

### **7.3 Reliability and validity of research instrument**

Convergent validity is first assessed for the five measurement scales, which indicates the degree to which the measure of a scale that should be theoretically related is also interrelated in reality. It can be evaluated using three criteria suggested by Fornell and Larcker (1981):

- All indicator factor loadings should be significant and exceed 0.7;
- Construct reliabilities should be at least 0.8;
- Average variance extracted (AVE) by each construct should exceed the variance due to measurement error for that construct (e.g. AVE should exceed 0.50).

In this light, factor analysis using principal-components extraction with varimax rotation method is first conducted to extract five factors with the help of the



SPSS 17.0. As shown in Table 7.5, all the factor loadings are above the threshold of 0.7 while no cross-loadings are above 0.4. As a result, the results show that all the items well fit their respective factors, which provides a clean factor structure.

	Component				
	1	2	3	4	5
PU1	.306	<b>.730</b>	.031	.144	.290
PU2	.235	<b>.825</b>	.141	.030	.224
PU3	.301	<b>.855</b>	.070	.134	.045
PEOU1	.163	-.010	<b>.819</b>	.075	.213
PEOU2	.122	.106	<b>.873</b>	.215	.026
PEOU3	.090	.140	<b>.856</b>	.234	.043
PLTU1	<b>.788</b>	.374	.044	.212	.079
PLTU2	<b>.792</b>	.219	.208	.103	.196
PLTU3	<b>.815</b>	.314	.082	.141	.201
PLTU4	<b>.818</b>	.158	.194	.073	.258
PI1	.273	.012	.315	<b>.709</b>	.243
PI2	.218	.119	.208	<b>.819</b>	.257
PI3	.003	.134	.114	<b>.827</b>	-.033
BI1	.282	.367	.187	.129	<b>.778</b>
BI2	.361	.213	.126	.252	<b>.780</b>

**Table 7.5 Results of principal-components extraction with varimax rotation**

After that, reliability analysis was conducted using Cronbach's alpha which is a measure of internal consistency or reliability. SPSS 17.0 is utilized to calculate the value as well. As shown in Table 7.6, all alpha values are acceptable, which range from 0.798 to 0.909. The results indicate that our constructs have acceptable validity and reliability.

Constructs	Cronbach's alpha
PNTU	.863
PEOU	.861
PLTU	.909
PI	.798
BI	.867

**Table 7.6 The values of cronbach's alpha**

To further confirm our assessment on factor loadings, AMOS 18.0 is utilized to generate standardized factor loadings, which serve as a basis for evaluating composite reliability (CR) and AVE of respective constructs. As shown in Table 7.7, all the standardized factor loadings are above the cut-off value of 0.7, except for the item PI3. The value for PI3 is 0.58, which is still in an acceptable range.

Items	Standardized Factor Loading
PNTU1	.802
PNTU2	.832
PNTU3	.840
PEOU1	.727
PEOU2	.892
PEOU3	.858
PLTU1	.856
PLTU2	.805
PLTU3	.902
PLTU4	.820
PI1	.836
PI2	.925
PI3	.580
BI1	.878
BI2	.871

**Table 7.7 The values of standardized factor loadings**

Further, the values of CR and AVE are calculated, as shown in Table 7.8. The results show that the values of CR and AVE of all the constructs satisfy their respective thresholds of 0.8 and 0.5. Consequently, all three conditions for convergent validity are closely met.

Constructs	CR	AVE
PNTU	0.865	0.680
PEOU	0.867	0.687
PLTU	0.910	0.717
PI	0.832	0.630
BI	0.867	0.765

**Table 7.8 The values of CR and AVE**

Discriminant validity refers to the extent to which concepts that should not be related theoretically are, in fact, not interrelated in reality. It indicates that “a latent variable is able to account for more variance in the observed variables associated with it than a) measurement error or similar external, unmeasured influences; or b) other constructs within the conceptual framework” (Farrell, 2010, pp. 324). Discriminant validity is satisfied if the square roots of the AVE extracted for each construct are greater than the correlations between this construct and any other construct in the model (Fornell and Larcker, 1981). As shown in Table 7.9, the square roots of AVE of all constructs are much higher than the correlation estimated with the other constructs, which indicates that each construct is more closely related to its own measures than to those of others. This, therefore, suggests that discriminant validity is supported in the present study.

Variables	PNTU	PEOU	PLTU	PI	BI
PNTU	<b>0.825</b>				
PEOU	0.254	<b>0.829</b>			
PLTU	0.627	0.351	<b>0.847</b>		
PI	0.324	0.463	0.405	<b>0.794</b>	
BI	0.585	0.368	0.635	0.455	<b>0.875</b>

**Table 7.9 Correlation Matrix and Discriminant Assessment**

(The bold items on the diagonal represent the square roots of the AVE while off-diagonal elements are the correlation estimates. Correlation is significant at the 0.01 level (two-tailed).)

Structural equation modelling (SEM) is used to assess the research model. SEM is a comprehensive statistical approach for testing and estimating causal relationships using a combination of statistical data and qualitative causal assumptions, which allows researchers to test complex theoretical models. Based on the SEM, a number of model fit indices are calculated to measure how well the model fits the data.

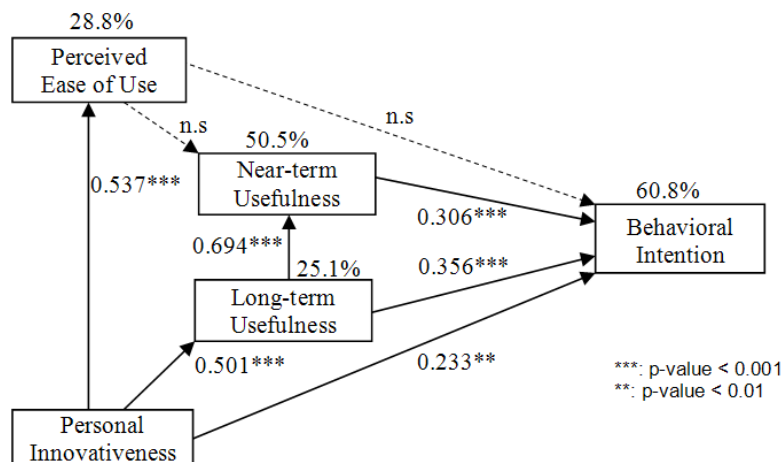
The chi-square value for this model is significant ( $\chi^2$  of 165.605 with 82 degrees of freedom,  $p < 0.001$ ). Six additional model fit indices are estimated, which are the goodness-of-fit index (GFI), the adjusted GFI (AGFI), the normed fit index (NFI), the comparative fit index (CFI), Tucker-Lewis index (TLI) and the root mean square error of approximation (RMSEA). For the research model,  $\chi^2/df$  is 2.02, GFI is 0.905, AGFI is 0.86, NFI is 0.922, CFI is 0.959, TLI is 0.948 and RMSEA is 0.07. Hence, an adequate model fit is guaranteed, as shown in Table 7.10.

Model Fit Indices	$\chi^2/df$	GFI	AGFI	NFI	CFI	TLI	RMSEA
Recommended value	< 3	> 0.9	> 0.8	> 0.9	> 0.9	> 0.9	< 0.08
Obtained	2.020	0.905	0.860	0.922	0.959	0.948	0.07

**Table 7.10 Model Fit Indices**

#### **7.4 Structural model evaluation and hypothesis testing**

Figure 7.1 gives a graphical presentation of the results of the model testing, including both path coefficients and variances explained. The findings offer significant supports for all the hypotheses, except for H4 (PEOU→PNTU,  $\beta = 0.054$ ,  $p > 0.5$ ) and H5 (PEOU→BI,  $\beta = 0.063$ ,  $p > 0.5$ ). Specifically, perceived long-term usefulness is found to be the most influential predictor of mobile learning acceptance ( $\beta = 0.356$ ,  $p < 0.001$ ). Also perceived long-term usefulness is found to significantly impact the perceived near-term usefulness ( $\beta = 0.694$ ,  $p < 0.001$ ). Perceived near-term usefulness is found to be the second important factor leading to mobile learning adoption ( $\beta = 0.306$ ,  $p < 0.001$ ). Additionally, personal innovativeness is found to significantly affect behavioural intention ( $\beta = 0.233$ ,  $p < 0.01$ ), perceived long-term usefulness ( $\beta = 0.501$ ,  $p < 0.001$ ) as well as perceived ease of use ( $\beta = 0.537$ ,  $p < 0.001$ ). The model proposed is found to explain 60.8% of adoption intention. More specifically, perceived long-term usefulness enables to interpret 50.5% of perceived near-term usefulness, while personal innovativeness accounts for 28.8% and 25.1% of perceived ease of use and perceived long-term usefulness respectively. A summary of the results of the hypotheses testing is available, as shown in Table 7.11.



**Figure 7.1 The results of model evaluation**

Hypothesis	Path	Path coefficient (critical ratio)	Supported or not
H1	PLTU → BI	0.356(3.74)***	Yes
H2	PNTU → BI	0.306(3.375)***	Yes
H3	PLTU → PNTU	0.694(9.571)***	Yes
H4	PEOU → PNTU	0.054(0.848)	No
H5	PEOU → BI	0.063(0.906)	No
H6	PI → PEOU	0.537(5.98)***	Yes
H7	PI → PLTU	0.501(5.849)***	Yes
H8	PI → BI	0.233(2.839)**	Yes

**Table 7.11 A summary of the results of hypotheses (\*\* p < 0.01; \*\*\* p < 0.001)**

In addition to direct effects, AMOS 18.0 helps to generate the values of both indirect and total effects of all the variables, which offers a more complete picture of model assessment. As shown in Table 7.12, personal innovativeness also indirectly but strongly influences both perceived near-term usefulness ( $\beta = 0.377$ ,  $p < 0.01$ ) and behavioural intention ( $\beta = 0.328$ ,  $p < 0.01$ ). Compared to personal innovativeness, perceived long-term usefulness has a relatively weak indirect effect on behavioural intention ( $\beta = 0.212$ ,  $p < 0.05$ ). Perceived ease of use has an insignificant indirect effect on behavioural intention ( $\beta = 0.017$ ,  $p > 0.05$ ).

	PI	PLTU	PEOU	PNTU	BI
PLTU	0.000	0.000	0.000	0.000	0.000
PEOU	0.000	0.000	0.000	0.000	0.000
PNTU	0.377(0.001)	0.000	0.000	0.000	0.000
BI	0.328(0.001)	0.212(0.016)	0.017(0.413)	0.000	0.000

**Table 7.12 Indirect effects (P-values are present in brackets)**

As shown in Table 7.13, even if perceived near-term usefulness has a stronger direct influence on behavioural intention than personal innovativeness, its total influence ( $\beta = 0.306$ ,  $p < 0.05$ ) is weaker than that of personal innovativeness ( $\beta = 0.561$ ,  $p < 0.01$ ). In particular, perceived long-term usefulness has the strongest total impact on both perceived near-term usefulness ( $\beta = 0.694$ ,  $p < 0.01$ ) and behavioural intention ( $\beta = 0.569$ ,  $p < 0.01$ ). Hence, it can be stated that, regarding total effects, perceived long-term usefulness is the strongest predictor of the intention to use mobile learning, personal innovativeness is the second most important one while perceived near-term usefulness is the third one. Perceived ease of use has no significant direct, indirect or total effect on the behavioural intention.

	PI	PLTU	PEOU	PNTU	BI
PLTU	0.501(0.002)	0.000	0.000	0.000	0.000
PEOU	0.537(0.002)	0.000	0.000	0.000	0.000
PNTU	0.377(0.001)	0.694(0.002)	0.054(0.468)	0.000	0.000
BI	0.561(0.001)	0.569(0.002)	0.080(0.350)	0.306(0.021)	0.000

**Table 7.13 Total effects (P-values are present in brackets)**

## 7.5 Evaluation of the acceptance model

### 7.5.1 Key findings and managerial implications

The results specify three significant predictors of mobile learning adoption, which are (i) perceived near-term usefulness, (ii) perceived long-term usefulness and (iii) personal innovativeness. Note that whilst perceived near-term usefulness is a significant motivator of usage intention, it (50.5%) can be largely explained by the perceived long-term usefulness. In other words, learners' feeling of near-term usefulness is mostly the result of a positive perception of long-term usefulness. For practitioners, this finding offers some new insights, which can be illustrated as follows: even if prior studies stated that mobile learning is very useful for promoting learning productivity by using formerly unproductive time, such as commute and travelling time (e.g. Geddes, 2004; Corbeil and Valdes-Corbeil, 2007), a provision of mobile learning content with

long-term usefulness will be the key reason to convince students to make use of this unproductive time for learning purposes.

Of all the predictors, perceived long-term usefulness is found to be the strongest motivator driving the intention to use mobile learning. Hence, an enhanced feeling of long-term usefulness contributes to the key for the success of mobile learning, as it will not only promote the perceived near-term usefulness but also support the intention to use. This helps to explain a phenomenon in China in which mobile learning for language-studying purpose tends to be the most popular. Note that a good language capability is critical for university students in their pursuit of advancement in studies and in their future work. Specifically, there are language requirements that have to be satisfied, if one wants to successfully apply for Master and Ph. D positions in China, or apply for a good work position or studying abroad. For designers, this indicates that, to promote mobile learning adoption, it is necessary to give students learning material that is useful for their future lives, in other words, with long-term benefits. It is suggested that there are three possible manners to realize this, which are:

- The topic of mobile learning courses offered to students should be well selected, that should comply with students' long-term objectives, such as career development, job promotion, or being able to benefit learners in their future daily lives, such as cooking or health preserving.
- A mobile learning course provider should carefully inform students about the long-term benefits of taking the course, particularly at the initial stage.
- A mobile learning course should offer practical ways for students to practice the knowledge learnt in real-life contexts or in related work situations, convincing students that the knowledge will be useful some time in the future.

Consistent with previous research on personal innovativeness (e.g. Taylor, 2007; Crespo and Rodriguez, 2008), an innovative individual would more likely develop positive beliefs on new IT innovations, such as perceived long-term usefulness in the present study. Further, innovative users would be more willing to adopt mobile learning. This finding indicates that personal traits have a significant effect on people's intended use of mobile learning. On the other hand, it suggests that it would be an effective strategy to push mobile learning to innovative users at the early stage of the introduction of mobile learning methods and technology.

Inconsistent with previous studies (e.g. Li et al., 2008; Legris et al., 2003), a perception of ease of use has no significant influence on the intention to use mobile learning. It is worth noting that, among all the latent variables estimated, the mean value of perceived ease of use (PEOU= 5.32) is much higher than other variables with a large standard deviation, as shown in Table 7.3. It suggests, to

some extent, a broad feeling among users that mobile learning is easy to use. In contrast to currently popular beliefs in mobile learning research, technological restrictions seem not to induce significantly negative influence, which inhibits mobile learning acceptance. This should largely be due to the efforts from both mobile manufacturers and learning materials providers. In the Chinese market, a number of devices and software platforms are specially designed for mobile learning use, such as by Nokia and Noah; consequently, the negative impact of technological limitations, such as a small screen size and cumbersome input routines, can, to a large extent, be alleviated. Additionally, there are widespread efforts to design learning material in a way which is suitable for handheld usage. As a result, the feeling of ease of use is broadly perceived among students, and results in an insignificant predictor of mobile learning adoption in the present study. On the other hand, the results somewhat suggest that an inclusion of mobile device manufacturers in the provision of mobile learning products is a practical and flexible strategy to build a prosperous mobile learning market, which will help to deal with possible technological restrictions in association with perceived ease of use.

### **7.5.2 Theoretical implications**

The empirical study also shed some new insights regarding IS adoption theory. Based on an integration of the findings from IS and education literature, the chapter systematically describes and evaluates the conception of perceived long-term usefulness. Also, significant influences from personal innovativeness to perceived long-term usefulness and to perceived near-term usefulness were found for the first time, at least in mobile learning contexts.

In a review of TAM research, Lee et al. (2003) stated that although TAM has aided the understanding of IS acceptance, there is a need for a deeper understanding of factors contributing to ease of use and usefulness. In this regard, the research helps to specify two predictors of both perceived ease of use and perceived (near-term) usefulness, respectively. Explicitly, the research found that the degree of perceived ease of use can be decided by personal traits, such as personal innovativeness while perceived long-term usefulness is a significant determinant of perceived (near-term) usefulness. On the other hand, this finding also empirically supports Chau's argument (1996) that perceived usefulness in fact consists of two distinct aspects, which are near-term usefulness and long-term usefulness.

Traditional TAM constructs, including perceived ease of use and perceived (near-term) usefulness, were not found as robust as they were in previous TAM studies. Explicitly, perceived ease of use is found to insignificantly relate to both perceived (near-term) usefulness and behaviour intention. In particular, perceived (near-term) usefulness is not the most dominant determinant compared



with perceived long-term usefulness and personal innovativeness regarding total effects. Regarding mobile learning, perceived usefulness loses its dominant explanatory power in favour of perceived long-term usefulness. In concert with research on hedonic systems (Van der Heijden, 2004), the findings indicate that the nature of system use is an important boundary condition to the validity of the TAM. As TAM is initiated from studying work-oriented innovations, it may result in some problems when applied to study hedonic and educational information innovations, in which the use of innovations tend to be more personalized and far away from work-related environments. Accordingly more attention should be given to the important role of system purpose: when the purpose of a system is educational rather than work-oriented, the predictive power of the determinants will be different. It also suggests that perceived long-term usefulness for educational systems should be as important as perceived usefulness for utilitarian systems, and perceived enjoyment for hedonic systems. A classification based on the nature of systems purpose (utilitarian, hedonic or educational) would contribute to a better understanding of the essence of IT innovation adoption.

Finally, taking previous studies on both education and IS into account, perceived long-term usefulness should be an important predictor in evaluating users' acceptance of educational systems. The validity of this factor has been verified in both traditional classroom-based learning and technology-mediated learning, such as web-based learning (e.g. Chiu and Wang, 2008) and mobile learning in the present research. Hence, it is proposed that, in future research on educational IS, scholars should pay attention to the impact of perceived long-term usefulness. An integration of perceived long-term usefulness may contribute to a good alternative to establish a sound adoption model for educational IS.

## **7.6 Chapter summary**

The chapter sought to answer the research question 2. The adoption framework regarding mobile learning adoption in tertiary education contexts was empirically evaluated. Key factors driving mobile learning adoption were found and their predictive powers are specified as well. Based on the results, practical and theoretical insights were presented.

In the next chapter, answers to the research questions proposed in chapter 1 are provided while the findings of the present research are summarized and discussed. Limitations of the research and avenues for future research are discussed as well.



## Chapter 8

### Conclusions and limitations

This chapter concludes the dissertation by answering the research questions proposed at the beginning of the research. Research findings are summarized in this chapter as well. As the research is based on two separate but inter-related studies on mobile learning adoption in basic and tertiary education environments respectively, a summarization of the research findings is therefore necessary. Theoretical implications on both mobile learning research and IT adoption research are outlined. For practitioners, practical suggestions are made and summarized alike. Finally, the limitations of the research are evaluated, together with suggestions for future research. The purpose of this chapter is to evaluate the research and to suggest the possible avenues for future studies.

#### 8.1 Answers to research questions

The key research question of the dissertation is *to investigate how to improve users' adoption of mobile learning*. To answer this key research question, the dissertation focuses on two important users groups, which are students in basic education and in tertiary education respectively. Accordingly, two subset research questions are investigated in order to answer the key research question.

##### **Question 1: How to promote students' acceptance of mobile learning in schools?**

- a. Why does mobile learning achieve an unprecedented success in basic education in China? How is mobile learning industry in China dealing with challenges faced?*
- b. How to implement mobile learning in basic education so that it is acceptable by students, teachers and parents*

It is a fact that most students in basic education have no mobile phone or only have a low-end phone, in particular in China. This restricts the possibility of implementing mobile learning simply based on the use of mobile phones. Also

since mobile phones are mostly designed for communication or entertainment use, they are not necessarily the best device for mobile learning use for young students. The companies in China initiate an innovative mobile learning solution by intensively utilizing and developing handheld technology to accommodate education, instead of making education to accommodate technologies. From the device design to built-in ICTs selection and development, from learning content provision to learning support, education is always the focus and target, resulting in a series of new devices easily accepted by students. Also this solution is able to largely alleviate the negative influence of technological restrictions on the use of mobile learning.

The adoption of mobile learning differs from other IT innovations. Practitioners should pay attention to the willingness of both teachers and parents. Without the permission of them, mobile learning cannot be successfully implemented. Explicitly, parents are important stakeholders who will pay for the use of mobile learning, including the cost of both device and related services. Hence it is important to convince parents of the usefulness of mobile learning. Accordingly, in implementing mobile learning in basic education, it is necessary to actively involve parents in the project as a first step.

It is also very important to have the support from teachers to implement mobile learning. If teachers do not like the use of mobile learning, it is quit possible for them to forbid the use of the devices in schools, just like what teachers are doing now in the schools across European countries.

In order to have teachers' permission, a key issue that has to be solved is the disruptive effects of using mobile technology in a well-organized learning environment. However, through applying self-directed learning theory to the contexts, it indicates that the misuse of technology happens naturally, since young students in basic education are still physically immature in particular regarding their brain capability, which makes them not well self-directed and self-managed. In this regard, the companies in China design their product to be a purely educational innovation with only education-related technology and content embedded. This reduces the requirement for students' self-direction and self-management capability, resulting in a device with little disruptive effects in the class. In this way, mobile learning devices can be accepted by teachers, which are then allowed to be used in the classroom. For practitioners, this provides a good alternative to deal with the disruptive effects of mobile technology.

In addition, since most of current mobile learning projects in schools are lack of solutions to generate revenue, merchants of China offer a possible business model in this regard. Also the business model has been approved to be an

applicable and profitable one, considering good revenues the companies generated.

From the perspective of adoption research, it is found that mobile learning acceptance is different from most of the previous IT innovations. Traditionally, the acceptance decision of an IT innovation is solely made by users themselves or possibly by the organization that wants to implement the innovation. In the case of mobile learning in basic education, the adoption decision is made by teachers, parents and finally students, even if students are the actual users. Hence, mobile learning providers have to satisfy first the needs of both teachers and parents in order to make students to use the services.

## **Question 2. How to promote students' acceptance of mobile learning in universities?**

- a. What are the factors driving mobile learning adoption in universities?*
- b. To what degree do these factors influence the adoption of mobile learning in universities?*

In the research, three significant predictors of mobile learning were found, which are (i) perceived near-term usefulness, (ii) perceived long-term usefulness and (iii) personal innovativeness. In this sense, it can be stated that a user would more possibly adopt mobile learning, if:

- S/he is an innovative person, who likes experimenting with new mobile innovations.
- S/he believes that mobile learning would enhance her/his learning performance.
- The learning materials provided by mobile learning comply with her/his future target.

Accordingly, to facilitate a successful implementation of mobile learning in a tertiary education environment, universities should first develop a series of mobile learning resources complying with students' future needs and then push the services to the innovative students. It would be better if the mobile learning service is capable of improving users' learning performance. As an insignificant predictor, perceived ease of use on the other hand indicates that technological restrictions do not lead to serious adoption problems.

The structure of TAM is not found to be as robust as it was in traditional IT innovations. Perceived long-term usefulness is found to be a stronger predictor in comparison to perceived near-term usefulness. Perceived ease of use is not as significant as in previous TAM studies. It is concluded that since TAM is initiated in studying work-related IT innovations, it may be problematic when

applied to study education-related IT innovations. Also perceived long-term usefulness should be a stronger predictor of the acceptance of educational IT innovations compared to perceived near-term usefulness.

The study also indicates that the adoption environment is quite different between schools and universities. In universities, students are free to choose what technology to use. Also they put more emphasis on their future career development when making the decision to use a technology.

## **8.2 Contributions to research and practice**

To summarise, the dissertation makes a number of contributions for researchers and practitioners. First, contributions from the research papers published are summarized as follows:

Research paper 1:

- Identifies the possible social contexts in which mobile learning technology can be used;
- Systematically introduces the theoretical underpinnings of mobile learning research;
- Specifies the potentials of mobile learning for different user groups.

Research paper 2:

- For the first time systematically introduces self-directed learning theory in the field of mobile learning and uses it to explain complicated mobile learning phenomena. This also helps to deal with the dearth of concrete theoretical underpinnings of mobile learning research;
- Summarizes a number of different mobile learning services from the view of functionality;
- Explains the reasons leading to the disruptive effects of mobile learning in schools while possible solutions are proposed;
- Based on self-directed learning theory, a number of suggestions are made in order to successfully implement mobile learning technology.

Research paper 3:

- Introduces the benefits of using mobile learning technology;
- Systematically introduces technological underpinnings of implementing mobile learning.

Research paper 4:

- For the first time systematically introduces the development of mobile learning industry in China to the English world;

- Systematically introduces the unique mobile learning conception initiated by a leading mobile learning provider in China;
- Finds a possible solution to initiate a sound blended learning, which integrates mobile learning with both classroom-based learning and e-learning in a reasonable manner;
- Introduces a number of innovative mobile learning technologies, such as NP-iTECH;
- Specifies the interrelated relationships of technology adoption among Noah, students, parents and schools;
- Finds a possible solution to deal with the usability problem, which is that practitioners should accommodate technology to students' education need, rather than let students adapt to accommodate the technologies embedded in the phones;
- Finds a possible alternative for practitioners to constantly produce high-quality mobile learning material, which is to collect intelligence of teachers and to partner leading education publishers;
- Finds a profitable business model for implementing mobile learning;
- Introduces an alternative to successfully implement mobile learning in schools in a way that satisfies students, schools and parents.

Research paper 5:

- Reviews adoption research on mobile services, technology-mediating learning and mobile learning;
- Develops a conceptual adoption framework identifying the possible factors driving mobile learning adoption.

Research paper 6 and 7:

- Briefly introduce mobile learning applications and platforms;
- Develop and assess a adoption model in mobile learning contexts based on TAM;
- Empirically evaluate the impacts of perceived ease of use, perceived near-term/long-term usefulness and personal innovativeness on users' intention to use mobile learning;
- Suggest that TAM is not necessarily the best model to study educational IT innovations, since it is initiated from studying work-related innovations in organizational environments;
- Suggest that an inclusion of mobile device manufacturers in the provision of mobile learning products is a practical and flexible strategy to flourish the market, and this will help to tackle possible technological restrictions in association with perceived ease of use;
- Find a potentially useful marketing strategy for service providers, which is to market the products to innovative users at current stage.

The dissertation is based on a summarization of above-mentioned publications. In addition, some new contributions are made in the dissertation as well:

- Briefly introduces the characteristics of Chinese educational environments in the chapter 2. In the chapter, environmental differences between schools and universities are specified as well as their potential influences on mobile learning adoption;
- Identifies a practical solution to implement mobile technologies in schools without disrupting the well-organized learning environments in the chapter 6;
- Identifies a new pattern of adoption behaviours, in which adoption decision has to be made collectively by students, teachers and parents, while actual users is found to be the weakest decision maker in the chapter 6;
- Systematically introduces two research philosophies, which are positivism and interpretivism in the chapter 3. In addition, case study methodology and survey research methodology are introduced in the chapter as well;
- Briefly reviews a number of key adoption theories and identifies their different benefits and constraints in the chapter 4;

### **8.3 Limitations of the study and an outline of future research**

As with all research, there are some limitations in the present research that should be considered as well. The research as a whole is based on investigating Chinese students in schools and universities. Hence, it may be problematic to generalize the results to users in different age groups or with other cultural backgrounds. Accordingly, future research would be able to provide new insights if based on users in other countries and different age groups. Regarding the case study on mobile learning in basic education, the present research provided first-hand materials to investigate the factors leading to the acceptance of the technology. However, more studies that enable to provide concrete empirical evidence would further enhance the validity of the case study. It is also a new and possible avenue for future research.

Regarding the study on mobile learning adoption in tertiary education, the study only considered the intention to use, while actual usage is not included. Hence, it might be helpful if future research could be conducted to investigate the actual use of mobile learning services. Second, as the study only focused on education-oriented mobile learning products, the results therefore should not be generalized to the mobile learning applications for communication or administration purposes. Accordingly, new insights could be generated by investigating the factors promoting the adoption of mobile learning services for administration or communication purposes.



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## **Part 2**

### **Original research publications**

1. Liu, Y. and Li, H-X. (2008). Supporting Distance Users of Mobile Learning Technology. In proceedings of 2008 International Conference on Information Technology in Education, Wuhan, China.
2. Liu, Y. and Li, H-X. (2009). What Drives M-learning Success?—Drawing Insights from Self-Directed Learning Theory. In proceeding of Pacific Asia Conference on Information Systems 2009 (PACIS 2009), Hyderabad, India.
3. Liu, Y. and Li, H-X. (Accepted). Supporting Distance Users of Mobile Learning Technology, In Chao, L. (Ed.), Open Source Mobile Learning: Mobile Linux Applications. Publisher: IGI Global.
4. Liu, Y. Liu, J. and Yu, S. (2008). A Case Study on Mobile Learning Implementation in Basic Education. In proceedings of 2008 International Conference on Information Technology in Education, Wuhan, China.
5. Liu, Y. Han, S-N. and Li, H-X. (2010). Understanding the factors driving m-learning adoption: A literature review. *Journal of Campus-Wide Information Systems*, Volume 27, Issue 4, pp. 210-226.
6. Liu, Y. Li, H-X. and Carlsson, C. (2009). Exploring the Factors Driving M-Learning Adoption. In proceeding of 15<sup>th</sup> Americas Conference on Information Systems (AMCIS 2009), San Francisco, California, USA.
7. Liu, Y. Li, H-X. and Carlsson, C. (2010). Factors driving the adoption of m-learning: An empirical study. *Computers & Education*, Volume 55, Issue 3, pp.1211-1219. (Thomson ISI; 2009 Impact Factor = 2.059).



## **Research paper 1**

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# Supporting Distance Users of Mobile Learning Technology

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**Abstract**—With a rapid deployment of mobile devices, mobile learning gives rise to new possibilities for extending learning opportunities to all social-economic levels. Nevertheless, current research on mobile learning has mostly been aimed at enhancing learning of school or college students. In this light, the paper seeks to throw light on the potential of mobile learning for distance learner communities, including problem teenagers, social employees and ageing people. Rather than being employed as a complementation to the current conventional learning and teaching scenarios, mobile learning tends to make more sense when it serves as an effective conduit for a particular learner community to access training and education. Also, mobile learning is of increasing importance when used to support the learning activities of hard-to-reach groups to underpin social transformation and to deal with the challenges posed by demographic shifts.

**Keywords**—mobile learning; aging learner; illiterate; informal learning; lifelong learning; population aging

## I. INTRODUCTION

Increasingly, information and communication technologies, or ICTs, have started to permeate nearly every aspect of our lives. It not only dramatically alters the way we communicate, work and run businesses, but also gradually changes the way people deliver and receive training. Advance in broadband wireless network technology enables mobile devices to transmit text, voice, video and animated images at anyplace and anytime. This in turn establishes a concrete technical basis for translating mobile learning from theory into actual practice.

The potential and impact of mobile learning are support through the worldwide proliferation of mobile phone. A report from Portio Research predicts that the global mobile penetration rate will surpass 50 percent in 2008, and a further 1.5 billion new mobile phone users are expected to bring the overall penetration rate to 75 percent by 2011, in which 65 percent of new consumers will come from the Asia Pacific Region [1]. In some parts of the world, such as Western Europe, the figure has already hit 100% since 2007 [2]. The wide penetration of mobile devices proposes that the number of potential users of mobile learning services has far exceeded the amount of students within the current education systems.

As mobile devices are becoming more and more sophisticated and affordable, they are increasingly deployed among ordinary consumers. As a result, it comes as no surprise that sooner or later people would begin to look for new ways to

activate learners, in particular those with academic ambitions but reluctant to or can't enroll in the formal education systems. A Europe-wide mobile learning project—m-learning, for instance, has been launched for the purpose of educationally disadvantaged young adults, such as teen dropouts and unemployed. In addition to common students, it is clear that a number of new learner communities could benefit and be involved, and become an indispensable part of the future mobile learning landscape.

As most of the current research is carried out in the school or college settings, partly due to the easier availability of research resources, this paper aims to provide new insight on mobile learning potentials when applied to the distance learner communities. After studying the theoretical support of mobile learning for engaging learners in their daily lives, we discuss the benefits mobile learning offers in association with the unique learning requirements of different learner communities.

## II. ENABLING MOBILE LEARNING IN SOCIAL CONTEXTS

Learning can take place as long as people hope to start and adapt their activities to enable educational behavior and outcomes. Vavoula in a study of everyday adult learning episodes discovered that, 51% of a total of 161 learning episodes took place at learners' home or workplace, while 21%, 6%, 5% and 2% of episodes happened respectively in a workplace outside the office, at places of leisure, outdoors and in a friend's house [3]. Other locations took 14%, including places of worship, the doctor's surgery, cafes, hobby stores, in cars. In addition to this, 48% of mobile episodes were found to be associated with work. Note that only 1% of the self-reported episodes occurred on public transport, indicating that there may be a chance to provide learning opportunities for people to utilize unproductive travelling time. The study indicated that there are lots of learning episodes in daily lives where mobile learning can probably be involved and lend a helping hand. Also, since learning practices are mobile in terms of location and time, technologies that support learning should also be mobile [4].

Among all the learning episodes, mobile learning will be favored if a learner is situated in the 'right' scenario. Mobile learning can be advantageous, particularly when a learner is on the move or at a 'non-place'. The term 'non-place' refers to the places such as airport terminals, waiting halls and hotels [5], where people are physically immobile but mobile in logic. Also, mobile learning facilitates learning activities where a

learner is in a stable scenario, such as learning in class, or in a situation where a learner wants to avoid moving, e.g., a patient following a daily prescription and diagnosis at home when the doctor is working in the hospital. At home, a bed or a sofa is the most often mentioned place by mobile device owners [6], which shows a potentially ideal location for mobile learning. What is more, mobile learning is effective for just-in-time learning or the learning in urgent situations, such as first aid [7].

In addition to the opportunities initiated by exterior factors, mobile learning lends itself well to motivate learners intrinsically by offering versatile learning experiences. Naismith et al. [8] summarized these new practices and compared them against existing learning theories, which are behaviorist, constructivist, situated, collaborated, informal and lifelong learning.

#### A. Behaviorist learning theory

Behaviorist learning emphasizes learning experiences gained as a change in observable actions with proper stimulus and response. With the advance of mobile technologies, mobile learning makes it possible to form a 'drill and feedback' mechanism complied with behaviorist learning theory. Specifically, mobile learning can give learners content specific questions, then gather their responses in a rapid manner and provide instant feedback eventually.

#### B. Constructivist learning theory

Constructivist theory emphasizes gaining learning experience through a program which learners actively build new ideas or concepts based on both their previous and current knowledge. With a mobile phone, a learner can construct his/her own knowledge and share it freely with peers regardless of time and place. Specifically, an easy way for mobile learning to enable a constructivist learning experience is to offer edutainment (e.g. handheld games).

#### C. Situated learning theory

Situated learning emphasizes learning activities that take place within authentic contexts where environment itself appears to be a part of education resources. For situated learning, the environments can be per-organized, such as studying in a museum [9], or naturally developed, such as watching birds open air [10]. Specifically, situated learning experience can be realized via three manners, namely problem-based learning, case-based learning, and context-aware learning.

#### D. Collaborated learning theory

Collaborated learning experiences are promoted as a learning process with proper social interaction. The increasing availability of wireless networks in personal devices not only makes it much easier to communicate and share data, files and messages with partners, but also makes learning collaboration easier to initiate and to respond to. Taking into consideration the recent popularity of the Really Simple Syndication (RSS) as well as open source software, learning collaboration on a large scale appears to be more socialized and self-initiated.

#### E. Informal and lifelong learning theories

Informal and lifelong learning emphasizes the learning activities that take place outside a dedicated learning environment, such as a predetermined curriculum. Informal learning can be intentional with intensive and deliberate learning efforts, or it can be accidental, such as through conversations, TV and newspapers [11]. To the extent that mobile devices facilitate instant information acquisition in a seamless and unobtrusive way, mobile learning is especially suitable for offering informal and lifelong learning experience.

In essence, these learning experiences tend to be integrated and combined instead of being separated. If leveraged appropriately, mobile learning makes it possible to form a learning space which is socialized, personal and digital, trusted, pleasant and emotional, creative and flexible, certified, open and reflexive, which will facilitate learning and knowledge management [12].

### III. ENABLING MOBILE LEARNING FOR NEW LEARNERS

It is evident that a rapid proliferation of mobile devices expands the reach of education to all social-economic levels. As a result, mobile learning appears to be especially important for learner communities unreachable for conventional education approaches. As they are of great demographic importance, these new learners apparently can not be neglected.

#### A. Engaging problem teenagers and illiterate

In most parts of the world, it is undeniable that many teenagers are unsatisfied with classroom-based educational environments and they drop out without pursuing any further training or education. Teen dropouts are in general hard-to-reach by traditional educational approaches and are more likely to be the future illiterates, resulting in many serious social problems. For instance, in UK, nearly 10 millions adults lack confidence in using literacy skills [13], while in China, the people deemed illiterate jumps by 30 million to 116 million from 2000 to 2005, right after India [14]. Today, there are still about 785 million illiterate adults aged over 15 worldwide [15]. Early dropout of teenagers from schools would lead to serious problems for the society. According to a report of Pytel [16], early dropouts are more prone to be unemployed, in prison, living in poverty, receiving government assistance, poor health, divorced and single parents.

With this, mobile learning appears to be an ideal solution with a potential to accommodate the characteristics of today's young generations. Current young people, in particular the 'Millennial generation' that was born in or after 1982, shows a clear preference for technology applications [17,18]. With an information technology mindset and a highly developed skill for multitasking, the millennial generation is described as being focused on 'connectedness' and social interaction with a preference for group-based methods in study and social occasions [18].

To engage millennial learners, in particular teen dropouts, mobile learning has great advantages as it accommodates the unique nature of these new learners in comparison to traditional



education approaches. Also, in light of the fact that many learners might never be able to afford a personal computer or enroll into formal education again, a mobile phone, which is increasingly popular among young people, becomes a desirable conduit for delivering education. According to Attewell [19], there are several advantages to initiate mobile learning for problem teenagers as well as illiterates:

- Mobile learning helps learners to improve literacy and numeric skills and to recognize their existing abilities;
- Mobile learning can be used for promoting independent and collaborative learning experiences;
- Mobile learning helps learners to identify where they need assistance and support;
- Mobile learning helps to combat resistance to the use of ICT and can help overcome the divide between mobile phone literacy and ICT literacy;
- Mobile learning helps to remove some of the formality from the learning experience and engages reluctant learners;
- Mobile learning helps to concentrate a learner's attention for longer periods;
- Mobile learning helps to raise self-esteem;
- Mobile learning helps to raise self-confidence.

#### B. Supporting the informal and lifelong learning of employees

As human societies are becoming more and more hectic and knowledge-based, employees have to adopt more learning activities to renew and update their knowledge and skills to remain competitive in the workplace, and to accommodate to an increasingly technological environment. The growing learning requirements went with problems, as today's workforce is increasingly mobile around the world [20]. Approximately 40–50% of the American workforce, for instance, is mobile, according to the Runzheimer International study on workforce mobility [21]. In 2009, the global mobile workforce is expected to reach 850 Million [22]. Consequently, the time available for employees to stay in a stationary place to learn is becoming limited. In 2003, the average time available for training was less than three days [23]. Also, there is little evidence to show that time and resources available for formal training will be increased.

In this regard, mobile learning appears to be a desirable way to provide transmitting training and education to an increasingly mobile workforce. Great benefits can be achieved though the use of mobile learning. As Koschimbahr state, mobile learning can assist enterprises in saving cost, enhancing customer services and offering better selling opportunities [24]. On the other hand, mobile learning reflects a potential to improve job satisfaction and to reduce job stress as well as employee turnover [24]. Also, it enables employees to utilize previously unproductive time as part of people's increasingly hectic lifestyle [25]. With regard to ICT literacy, as Punie pointed out, mobile learning promotes ICT skills, digital competence and other new skills, and helps to fight ICT

resistance [12]. Ufi/learnDirect and Kineo indicate that mobile learning can help address some challenges faced by businesses as follows [26]:

- Mobile learning enables business entities to provide learning to mobile staff and to distribute learning quickly.
- Mobile learning enables the delivery of key data at the point of need— particularly relevant for workers who need access to updated product specifications, pricing details or other time-sensitive information.
- Mobile learning enables companies to utilize staff downtime, those short periods of time waiting or travelling.

#### C. Facilitating the retraining of aging people

Population aging is a pervasive phenomenon. In the Asia-Pacific area for instance, people aged 50 and above are expected to take up approximately 31% of the total population by 2025 [27], while in Japan, population ageing seems to be more significant and one in three will be elderly in 2025 [28]. In addition to this, it is predicted almost one third of the working age population will aged 50 or over by 2050 in developed countries [29]. In this light, population aging impresses people with an ongoing trend—aging people will inevitably become an incremental part of the future workforce. Due to lack of enough qualified employees, ageing people nowadays have already been encouraged to join the workforce in some parts of world. In Europe, a marked rise has been found in the employment rate of people aged 55-64 from 36.6% in 2000 to 43.6% in 2006 [30].

The requirement for the retraining of aging learners is intensified, but research targeted at aging learners is in short supply, also within the context of mobile learning. Unlike young and prime adults, aging learners have unique learning requirements and traits. For instance, ageing individual needs a learning approach that facilitates the review of learning materials, as they incur a biologically-based decline in fluid intelligence, which impairs rapid processing of new information [31]. In addition, older learners may have a lack of confidence and thereby resist trying something new. In this concern, mobile learning gains advantages as it tends to address these problems through bringing training into local areas and offering courses in less formal settings [32]. Also, there is little extra economical and physical effort required for aging people to learn via mobile devices in comparison to the computer-based or classroom-based learning approaches.

## IV. CONCLUSION

The potentials of mobile learning are profound and far-reaching. With a worldwide diffusion and increasingly educational use of mobile devices, mobile learning extends learning opportunities to all social-economic levels and the people who can benefit from mobile learning is increasing. For learners as well as society as a whole, mobile learning is particularly cost-effective in terms of its capability to be centrally processed and updated with a fast and economical allocation of educational resource in a 24X7 manner for all

mobile phone owners regardless of location. As such, in addition to common students, more attention is needed to play to learners who are previously hard-to-reached or incompatible with traditional educational approaches so as to realize the full potential of mobile learning. As little effort in literature has been made regarding mobile learning implications for distance learner communities, this paper attempts to make a contribution in this regard and provide theoretical support and topics leading to an in-depth understanding of mobile learning potentials.

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## **Research paper 2**

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# WHAT DRIVES M-LEARNING SUCCESS? –DRAWING INSIGHTS FROM SELF- DIRECTED LEARNING THEORY

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# WHAT DRIVES M-LEARNING SUCCESS? –DRAWING INSIGHTS FROM SELF-DIRECTED LEARNING THEORY

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## Abstract

*Contrary to its rapid diffusion, m-learning is short of concrete theoretical underpinnings. This study serves as a first important step to apply self-directed learning theory to the m-learning field. Based on a review of both m-learning and self-directed learning theory literature, present study applies findings of prior self-directed learning research to portray current m-learning activities. Evidence is also found, suggesting that self-directed learning theory should be an important theoretical underpinning of m-learning. Based on a reflection on current m-learning initiatives, the paper suggests that, to design a sound m-learning system, a sufficient consideration of learners' self-directed learning attributes is critical and essential.*

Keywords: Mobile learning, Self-directed learning, Education, Implementation, Adoption.

# 1. INTRODUCTION

The advance of mobile technology along with the accelerating prevalence of handhelds initiates a new education approach, which is termed as 'mobile learning' or 'm-learning'. Currently m-learning is ushering us into a new era of training and learning. Stated Sharma and Kitchens (2004): the advent and subsequent development of m-learning indicates a profound evolution in education from distance learning (d-learning) to electronic learning (e-learning) and to m-learning. Based on a review of over 400 recent publications, Cobcroft, Towers, Smith and Bruns (2006) stated that m-learning extends the scope of users to include those who are aged, gifted and remote, but also those with cognitive, social, physical or mental difficulties. A long list of m-learning potentials has been specified with a growing number of promising applications (Attewell, 2005; Duncan-Howell & Lee, 2007). As Naismith et al. pointed out, m-learning would enable a kind of 'highly situated, personal, collaborative and long term; in other words, truly learner-centred learning' (Naismith, Peter, Giasemi and Sharples, 2004, pp: 36).

Nonetheless, m-learning research has long been in need of theoretical underpinnings (Muyinda, 2007). Even if m-learning applications abound, they are implemented separately without a unified education strategy. Further, most m-learning research is built upon a teacher-centred pedagogical approach whilst m-learning activities are learner-centred in essence. As a result, the current understanding on m-learning offers limited insights for practitioners to comprehend m-learning phenomenon. This lack of sound theoretical underpinnings will impede us to further explore the potentials of m-learning.

This paper serves as a first important step to apply learner-centred andragogy (self-directed learning theory) to describe m-learning activities. After a close reflection on both m-learning and self-directed learning (SDL) literature, the paper proposes that SDL theory contributes to a better understanding on current m-learning applications. SDL theory therefore should be an alternative theoretical underpinning for future m-learning research and implementation. Insights can be drawn for practitioners not only to implement a sound m-learning system but also to engage distance learners for a sustainable success. After literature review part in section 2, the paper attempts to interpret current status of m-learning initiatives from an SDL viewpoint in section 3. In section 4, conclusions are made followed by a brief report of limitations in the fifth section.

## 2. LITERATURE REVIEW

### 2.1 SELF-DIRECTED LEARNING THEORY STUDIES

SDL theory is one of the most important education theories, which has long been stressed and applied in problem-based, lifelong and distance learning settings (Fisher, King, & Tague, 2001; Stewart, 2007a). It is derived from adult education, but has already extended to the scope of adolescents and young students (Taylor, 1995; Thomas, Reio, & Davis, 2005). There are two general manners in defining SDL: (a) as a process of learning (Garrison, 1997; Grow, 1991), and (b) as a personal attribute (Guglielmino, Guglielmino, & Zhao, 1996; Oddi, 1987). In its broadest meaning, 'self-directed learning describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes' (Knowles, 1975). A common aim for SDL research is to assist individuals in developing the requisite skills for engaging in self-directed learning such as planning, monitoring, and evaluating their own learning (Reio & Davis, 2005). The theory suggests that the level of control learners are willing to take over their own learning will depend on their abilities, attitude, and personality characteristics (Fisher, King, & Tague, 2001). Also the theory believes that SDL capability varies among individuals and that not all the learners are self-directed.

Previous literature indicates that the SDL capability is closely associated with distance and lifelong learning activities (Fischer & Scharff, 1998), in particular when learners are placed in a physical and social separation from both instructor and other learners (Long, 1998). As early as 1980, SDL research has evolved to be an empirical approach. Guglielmino (1977) proposed the notion of SLD readiness and designed a questionnaire to empirically measure learner's SDL attributes. The measurement concerns three factors, namely (i) self-management, (ii) desire for learning and (iii) self-control. Indeed, the need for self-direction, or self-management of learning, runs clearly across distance

education and resource-based flexible learning literature (Evans, 2000; Smith et al., 2003). Study of Shapley (2000) concerning online distance education revealed that learners need to have a high level of self-direction in order to succeed in online learning settings. The students who have low readiness for SDL will exhibit high levels of anxiety when exposed to an SDL project. In addition, the level of self-directed learning is widely found as a strong factor for predicting learners' academic success in various education contexts (Hsu & Shiue, 2005; Stewart, 2007b). In an online learning environment, Warner, Christie, & Choy (1998) proposed the notion of readiness for online learning (ROL) to measure personal attributes in affecting learning performance, which is conceptually similar to SDL readiness. Self-management capability as an important dimension included in both SDL readiness and ROL theories, has been found to significantly impact m-learning intention (Wang et al., 2009).

SDL capability exists along a continuum and in all individuals to some degree (Fisher et al., 2001). Research found that matching teaching delivery with learners' SDL capability enables the best learning opportunities (Fischer & Scharff, 1998; Grow, 1991; O'Kell, 1988). Across both m-learning and SDL literature, these two research directions constantly share similar research scenarios, basis, objectives and tasks. However, SDL theory has not yet been extended to the m-learning context. While there are a handful of studies making a reference to SDL capability in m-learning settings, we found no studies that enable SDL as a concrete m-learning theoretical underpinning.

## 2.2 CHALLENGES OF M-LEARNING RESEARCH

There are many critical assessments of m-learning research and applications. Currently m-learning runs danger of becoming a buzz word as empty as 'e-learning', as Ullrich et al. (2008) noted that, 'some years ago, every learning software that used the Internet in some way was coined as 'e-learning software', regardless of whether it was innovative or helpful for learning'. Patten, Sanchez, & Tangney (2006) classified m-learning services into seven broad categories and stated that much of the work presented across the categories has limited success 'in the field'. Whilst m-learning applications are many, they tend to be occasionally used in an education context and have not yet had any great impact on education (Pozzi, 2007).

Based on a summarization of current m-learning projects, argued Herrington et al. (2007) current m-learning applications are predominantly within a didactic, teacher-centred paradigm. A contradictory view however is that m-learning is a learner-centred approach as acknowledged by almost all the scholars. These pedagogical approaches well explain how learners can learn better in a stable and mostly pre-defined learning context, but offer limited understanding on the learning activities in a constantly changing social context with limited or even no intervention from teachers. Consequently, these theories fail to establish a unified education strategy in aligned with the unique nature of m-learning. Even if there are already tens of m-learning initiatives available, strategy as to how to integrate them into a sound system is lacking. First, although m-learning is acknowledged as an education approach offering great autonomy and freedom, little considerations is made regarding in what way these freedoms can benefit learners. Second, the so-called, 'at the right time', 'at the right place', 'on the right device', 'for the right person with the right content' access of m-learning (Bhaskar & Govindarajulu, 2008; Wagner, 2005), remains a slogan instead of a reality.

There is also a lack of understanding on the long-term impact of m-learning activities. Indeed, prior studies indicated that mobile technologies are being widely adopted and inherently engage young generations nowadays (Cobcroft, Towers, Smith, & Bruns, 2006). However, more recent findings report that simply availability of technology doesn't guarantee the adoption of m-learning services (Carlsson, Hyvonen, Repo, & Walden, 2005; Corbeil & Valdes-Corbeil, 2007; Wang, Wu, & Wang, 2009). Students are still not ready for m-learning even with advanced handhelds (Corbeil & Valdes-Corbeil, 2007). On the other hand, many students are not willing to use handhelds for accessing training and education (Attewell & Savill-Smith, 2003; Attewell, 2005). Good explanations for these phenomena are lacking.

## 3. SELF-DIRECTED LEARNING IN M-LEARNING ENVIRONMENT

As m-learning is still in an initial stage, we propose to introduce the previous findings of SDL research to m-learning contexts and to not adopt an empirical approach. Similar to SDL (Smedley, 2007), m-



learning is an approach to learn that heavily depends on students to take the responsibility for, and possess the ability to be self-directed in their own learning. As McFarlane et al. (2007) pointed out, the increased learner autonomy and personalization posit a heightened requirement for appropriate self-direction learning capability, such as a capability of locating and evaluating resources, critical thinking and reflecting on their own learning. In this light, it stands to reason to apply SDL in studying m-learning for a more complete understanding.

- SDL capacity increases steadily during childhood and rapidly during adolescence (Knowles 1984; Thomas, Reio et al. 2005). Readiness for SDL is increased with life experience.

Misuse of mobile devices by school students has been frequently reported. Most schools and colleges do not treat informal networked interaction as legitimate learning; they forbid children to bring phones into the classroom (Sharples, 2006). Brain research indicates that meta-cognitive, self-regulatory capability is developmental in nature. Hence young students are not necessarily self-directed in particular when they are physically immature in brain capability. It would lead to a disaster to offer great autonomy while students can not properly manage it. A project in the USA including thousands of students across a number of schools shows us a clear case. After issuing laptops to school students one-to-one, students however are found to exchange answers on tests, play games and hack into local businesses, and some students are found to rarely or never use their laptops for learning. Thus some schools now start to drop laptops in the project (New York Times, 2007). Whilst some researchers openly criticize that teachers' effort to avoid the misuse of mobile phones in classrooms is derived from the conservative education system, SDL research indicates that young students' misuse of mobile phones for learning tends to be an inherent nature since students are not mature enough to be self-directed. Instead a successful implementation of m-learning is widely initiated in China's primary schools. A series of new handheld devices—digital electronic education devices, are designed and allowed to be used in classrooms in China by limiting the autonomy offered (Liu, Liu, & Yu, 2008). These devices give up the wireless connection capability but instead embed a great amount of built-in education resources (Liu et al., 2008). These devices have gained a wide-spread acceptance by both schools and the market as 6 million of them are predicted to be sold in 2008 (Assme news, 2006).

**Propositions:** The greater autonomy and responsibility heightened by the m-learning approach calls for a corresponding self-direct learning capability. By simply offering great autonomy and responsibility, m-learning won't succeed in formal education scenarios while young students can not properly self-direct themselves. It instead would result in a disruption of well-organized learning contexts. Based on the success of digital electronic education devices in China, a practical solution should be a reduction of the autonomy that students have to manage.

- SDL is critical in distance education settings as learners are physically and socially separated from both the instructor and other learners (Long, 1998; Song & Hill, 2007). 'For SDL to occur, students may need direction or facilitation to achieve their end goals' (Knowles, Holton, & Swanson, 1998; cited by Timmins, 2008, pp: 302).

A lack of physical communication between instructor and learner would increase the requirement for the level of self-directed learning. This sort of need is in line with the m-learning paradox proposed by Tella (2003). Building on a study of Sahlberg (1996), Tella (2003, pp: 16) contended a paradox in m-learning, which is 'the more the studying and learning environment is decentralized, the more important will be the guidance and support given to the learner by the teacher or a peer because the environment itself no longer supports the use of familiar and safe learning processes'. The unstructured learning environment is associated with a high level of anxiety for the learners with a low level of SDL (Wiley, 1983). Anxiety in turn will impede a student's continuous intention to utilize, for instance, web-based learning (Chiu & Wang, 2008). In the unstructured environment, a lack of both personal contact and in-time feedback may easily happen, which further cause learner dropout (Fozdar & Kumar, 2007). This situation can be somewhat improved in m-learning contexts due to the personal nature of handhelds. Based on mobile technologies, personal communication becomes ubiquitous and is easy to be initiated in a number of formats, such as phone call, SMS, mobile blog, mobile communities and online discussion boards. In the study by Rau, Gao and Wu (2008), SMS communication between students and instructors is found to give students' positive attitudes toward

the instructor and learning, which can't be found through the methods of e-mail and online forums. In addition students' communicating through SMS with the instructor can alleviate the studying pressure and significantly increase the students' extrinsic motivation when combined with Internet communication media (Rau et al., 2008).

**Propositions:** The level of self-direction required can be decreased by offering appropriate and timely instruction. Due to the ubiquitous and personal nature of handhelds, m-learning has an advantage in terms of its personal and ubiquitous nature to connect peers or experts over a distance.

- The level of self-direction needed is associated with the learning scenarios being implemented, and may change in different contexts (Brockett and Hiemstra 1991; Song and Hill 2007). After a review of SDL literature, Fisher et al. (2001) stated that "there is a definite correlation between SDL readiness and student preference for structured teaching sessions".

In contrast to the limited success in a formal education setting, authentic m-learning tends to be the most successful application. Previous research indicated that authentic m-learning bring about most desirable learning outcomes and it is currently widely implemented for tourist attractions, such as museums. In authentic m-learning, a situated environment can provide guidance for learning activities with the support of locating technologies. As suggested by previous SDL research, the level of self-direction required relates to personal attributes, the design of the learning process and learning contexts (Song & Hill, 2007). This suggests that the change of environmental factors could help to reduce the requirement of self-direction capability and thereby leads to a more successful implementation of learning activities. In many tourist attractions, tourists' learning process is organized by GPS, audio guidance, digital maps and preset learning objectives based on the predesigned environment. Consequently, the requirement for self-direction capability can be greatly reduced where the situated environment provides a learner with the hints about where, when and how to conduct learning activities.

**Propositions:** As the level of self-direction required can be changed and reduced in relation to an authentic environment, m-learning excels in authentic studies by offering a predesigned learning process and guidance.

Based on the above discussion, our propositions can be summarized as follows:

1. Education is not inherently a gratification process; anxiety initiated either by education or by lacking of social interaction will impede learners in the pursuit of m-learning. Hence there is a need to sustain students learning desire.
2. Success in m-learning initiates a requirement for SDL capability, but not all the learners have a proper SDL capability for m-learning; hence technology and services should help learners to organize their learning process and to evaluate their learning outcomes.
3. The misuse of mobile phones in a classroom happens naturally since young students inherently have a limited capability of self-management and self-direction;
4. Great autonomy and freedom placed on learners do not guarantee effective m-learning as well as positive academic outcomes;
5. An unstructured learning environment tends to be the typical environment for m-learning; this type of environment may cause anxiety for learning and lead to arbitrary learning;
6. For those with a low SDL capability, solutions to reduce the requirement for SDL capability are essential otherwise students may not use m-learning or discontinue the use after starting to use it;
7. From an SDL viewpoint, there are four alternative solutions to implement a successful m-learning system:
  - To provide learning environments with proper guidance particularly for situated m-learning.
  - To reduce the autonomy and freedom offered to an appropriate level that most learners feel comfortable with.
  - To help learners manage their learning process using for instance SMS reminders and distance instruction.
  - To motivate students and alleviate learning pressure using more personalized communication and a social network.

Apparently, any m-learning application has a potential to benefit a learner. However a single application alone can't bring about a complete success of m-learning. In this light, we make an attempt to summarize innovative m-learning applications reviewed and seek to build them into a framework for successful m-learning implementation. A classification of these services is made from the perspective of functionality, which includes 24 kinds of m-learning initiatives.

Categories	M-learning services
Informal learning	Extracurricular study (Liu et al., 2008); Searching answers with for instance Google in wireless Internet;
Administration function	Sending reminders for examination or assignments (Rau et al., 2008); Informing about schedule or coordinating schedules (Yau & Toy, 2007); Calendars (Schreurs, 2006); Collecting feedback (Stead, 2005); Recording attendance or test taker (NMC & Educause, 2006); Recording lecture (Corbeil & Valdes-Corbeil, 2007); Recording information of patients (Kenny, Park, C. Neste-Kenny, J. M. C., Burton, & Meiers, In press); Retrieving school-related information, such as timetables (Kim, Mims, & Holmes, 2006); Library services (Sharma & Kitchens, 2004); Digital dictionaries, translators (Sharma & Kitchens, 2004); Environmental detectives or recorders (Klopfer & Squire, 2008); Collecting and analyzing the data of learning processes (Liu et al., 2008)
Social network	Interaction between instructor and students, or between peer students (Proctor & Burton, 2003); Learning collaboration, such as the virus game (Colella, 2000); Mobile 'blogging' (Yerushalmy & Ben-Zaken, 2004); Accessing online communities, discussion boards and chat rooms via mobile phones (Armstas, Holt, & Rice, 2005);
Learning material utilization	Situated learning, such as learning in a museum (Chou et al. 2004), watching birds in open air (Chen, Kao, & Sheu, 2003) and mobile excursion games (Costabile et al., 2008); Displaying lecture videos and courseware (Corbeil & Valdes-Corbeil, 2007); Podcasting lectures (Maag, 2006); Playing quizzes (Stead, 2005); M-learning in language studying (Liu, Yu, & Ran, 2008), and mathematics (Yerushalmy & Ben-Zaken, 2004) .

*Table 1 A summarization of current m-learning initiatives*

The classification is made based on the following consideration of application functionalities:

- Informal learning: applications support the learning activities outside predesigned educational establishments.
- Administration function: applications are used to administrate the learning process and organize learning activities.
- Social network: applications facilitate peer communication as well as instructor-students interactions.
- Learning materials utilization: handheld devices are used to store and display learning materials, such as reading e-books and watching lecture videos.

From an SDL perspective, we propose a framework for m-learning implementation as shown in Figure 1. Apparently, many innovative m-learning initiatives are not directly related to education and thus are not pedagogy significance, such as services in administration category. However, these m-learning services contribute to an improvement of SDL attributes, which includes sustaining learning management, learning desire and effective self-control. For instance, learners can use administration services to manage their learning activities, such as using SMS reminders. Also, it is suggested that social network is useful for reducing anxiety and thus helps to sustain learning desire. Informal learning is associated with personal interest and therefore contributes to maintaining the learning desire. Finally, to design a sound m-learning system, functions offered should contribute to either an improvement of learners' SDL capability or to a reduction of requirement for conducting SDL learning. Only in this way can a successful m-learning system which is suitable for most learners be worked out and implemented.

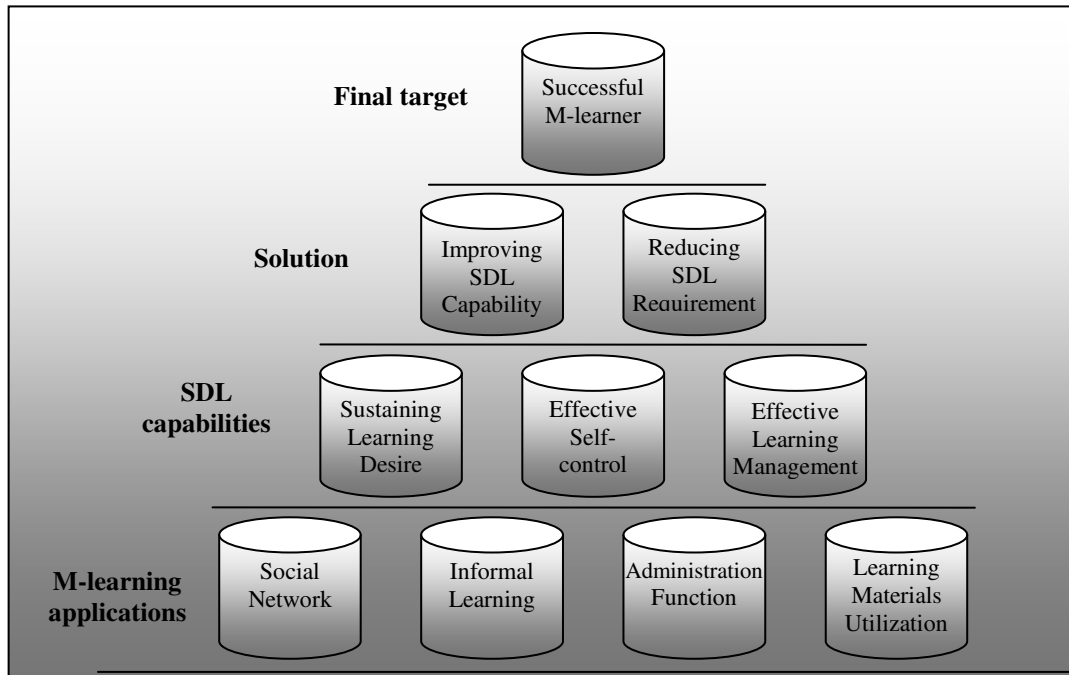


Figure 1. An M-learning Pyramid

#### 4. CONCLUSIONS AND IMPLICATIONS

M-learning is a personal issue typically initiated in an unstructured environment. As a result, m-learning can only be better explained using learner-centred education approaches, such as self-directed learning theory. In typical m-learning contexts, most learners are situated outside a pre-organized learning environment and physically separated from both teachers and peer students. Hence a capability to be self-directed and self-managed is important for being a successful m-learning user.

On the other hand current m-learning applications are mostly initiated separately without concrete theoretical support. This paper is a first step to introduce SDL theory into the context of m-learning and offers an alternative theoretical underpinning. As the fields of SDL and m-learning are largely overlapped, an adaption of SDL in the m-learning context will deepen our understanding of both research directions. Based on SDL theory along with the unique nature of m-learning, a conceptual pyramid for m-learning implementation is proposed. To support this framework, a summarization of current m-learning initiatives is made in concert with their functional uniqueness whilst the summarization is far from exhausted.

Note that m-learning is expected to be an approach that enables training at the right time, on the right place, for the right person. It is problematic that learners themselves are aware of when, where and what way is right for m-learning, as it initiates a heightened requirement for proper self-direction and self-management capability. An m-learning environment initiates less structured learning activities and more freedom along with more SDL tasks. However, previous research indicated that some learners are not well self-managed and self-directed in independent learning scenarios. In particular, the less self-managed learners are less likely to accept m-learning (Wang, 2008). Based on the SDL approach, the solutions for effective use of m-learning are either to promote learners' SDL capability, or to reduce SDL requirement by helping learners to organize learning processes.

Based on an elaboration of the unique nature of both m-learning and SDL, it is self-evident that a learner's personal attributes will affect the learning outcome, and that simply the availability of technologies do not guarantee the use of m-learning. Also unrestrained freedom doesn't guarantee effective learning as well as subjective adoption. To design a sound m-learning system, a full consideration of learners' SDL capabilities is important and essential. Meanwhile, SDL should be a concrete theoretical underpinning in m-learning research and more research in this regard is required.

## 5. LIMITATIONS

This paper is an attempt to introduce SDL into the m-learning field based on a reflection on current m-learning applications. A logical next step would be an empirical study of SDL in m-learning contexts that would provide more concrete supports.

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### **Research paper 3**

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# Supporting Distance Users of Mobile Learning Technology<sup>1</sup>

## ABSTRACT

With a rapid deployment of mobile devices, mobile learning emerges as a promising approach giving rise to a wide spectrum of new education possibilities. It serves as an effective conduit to deliver education to civilians of all social-economic levels, in particular the learners previously unreachable from traditional education systems, such as problem teenagers, social employees and ageing people. Hence, unlike traditional education approaches, it is considered to be a good alternative to deal with the challenges posed by demographic shifts and social transformation. The purpose of this chapter is to: (i) identifying the theoretical and technological underpinnings for delivering mobile learning to the distance learner; (ii) discussing the possible learner communities that can be benefited from mobile learning technology, with regard to their unique learning requirements and features.

## 1. INTRODUCTION

Increasingly, information and communication technologies, or ICTs, have started to permeate nearly every aspect of our lives. It not only dramatically alters the way we communicate, work and run businesses, but also gradually changes the way people access training and education. In particular, advance in broadband wireless network technology today enables mobile devices to transmit text, voice, video and animated images independent of time and location. This establishes a concrete technical basis for translating mobile learning from theory into actual practice.

The potential and impact of mobile learning are further enhanced in consideration of a worldwide proliferation of the mobile phone. A report from Portio Research (2007) predicts that the global mobile penetration rate will surpass 50 percent in 2008, and further 1.5 billion new mobile phone users are expected to bring the overall penetration rate to 75 percent by 2011, in which 65 percent of new consumers will come from the Asia Pacific Region. The statistic is further confirmed by a recent report released by Euromonitor (2010), which indicates 4.0 billion mobile phone subscriptions in the world in 2008. In some parts of the world, such as Western Europe, the figure has already hit 100% since 2007. The worldwide penetration of mobile devices indicates that the number of potential users of mobile learning services has far exceeded the amount of students within the current education systems.

As mobile devices are becoming more and more sophisticated and affordable, they are increasingly equipped by ordinary consumers. As a result, it comes as no surprise that sooner or later people would begin to look for new ways to activate learners, in particular those with academic ambitions but reluctant to or can't enroll in the formal education systems. A Europe-wide mobile learning project—m-learning, for instance, has been launched for the purpose of

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educationally disadvantaged young adults, such as teen dropouts and unemployed. In addition to common students, it is clear that a number of new learner communities could benefit and be involved, and become an indispensable part of the future mobile learning landscape. For audience, this chapter seeks to draw a brief picture of mobile learning in terms of its theoretical and technological underpinnings, and identify its potentials regarding a diversity of users.

## **2. ENABLING MOBILE LEARNING IN SOCIAL CONTEXTS**

Knowledge has an inherent nature to mobilize in concert with people's increasingly mobile lifestyle. Research indicates that learning activities happen frequently in daily lives. It can take place as long as people hope to start and adapt their activities to enable educational behavior and outcomes. Vavoula (2005) conducted a study on everyday adult learning episodes in which 161 learning episodes were reported from 15 participants in a research period of two weeks. Of the total 161 learning episodes, 51% of them took place at learners' home or workplace, while 21%, 6%, 5% and 2% of episodes happened respectively in a workplace outside the office, at places of leisure, outdoors and in a friend's house (Vavoula, 2005). Other locations took 14%, including places of worship, the doctor's surgery rooms, cafes, hobby stores, and in cars. In addition to this, 48% of mobile episodes were found to be associated with work. Note that only 1% of the self-reported episodes occurred on public transport, indicating that there may be a chance to explore learning opportunities for people to utilize unproductive travelling time. These findings indicated that there are many learning episodes in daily lives where mobile learning can probably be involved and lend a helping hand.

Further, among all the learning episodes, mobile learning will be favored if a learner is situated in the 'right' scenario. Mobile learning can be advantageous, particularly when a learner is on the move or at a 'non-place'. The term 'non-place' refers to places such as airport terminals, waiting halls and hotels (Kynäslähti & Seppälä, 2003), where people are physically immobile but mobile in logic. Also, mobile learning facilitates learning activities where a learner is in a stable scenario, such as learning in class, or in a situation where a learner wants to avoid moving, e.g., a patient following a daily prescription and diagnosis at home when the doctor is working in the hospital. At home, a bed or a sofa is the most often mentioned place by mobile device owners (Hujala, Kynäslähti & Seppälä, 2003), which shows a potentially ideal location for mobile learning. What is more, mobile learning is effective for just-in-time learning or the learning in urgent situations, such as first aid (Kynäslähti, 2003).

In addition, a number of studies reveal that mobile technologies have many unique advantages to support teaching and learning activities. Savill-Smith & Kent (2003), during a review of the published literature on the use of palmtop computers for learning, stated that palmtop computers can "assist students' motivation, help organizational skills, encourage a sense of responsibility, help both independent and collaborative learning, act as reference tools, and can be used to help track students' progress and for assessment" (p. 4). Similarly, Corbeil & Valdes-Corbeil (2007, pp. 54) summarized the benefits of using mobile learning as follows:

- Great for people on the go.
- Anytime, anywhere access to content.
- Can enhance interaction between and among students and instructors.
- Great for just-in-time training or review of content.
- Can enhance student-centered learning.
- Can appeal to tech-savvy students because of the media-rich environment.
- Support differentiation of student learning needs and personalized learning.

- Reduce cultural and communication barriers between faculty and students by using communication channels that students like.
- Facilitate collaboration through synchronous and asynchronous communication.

Based on an analysis of 12 international case studies, Kukulska-Hulme & Traxler (2005) summarized the reasons to use mobile learning in teaching and learning activities, including:

Access

- Improving access to assessment, learning materials and learning resources
- Increasing flexibility of learning for students
- Compliance with special educational needs and disability legislation

Changes in teaching and learning:

- Exploring the potential for collaborative learning, for increasing students' appreciation of their own learning process, and for consolidation of learning
- Guiding students to see a subject differently than they would have done without the use of mobile devices
- Identifying learners' needs for just-in-time knowledge
- Exploring whether the time and task management facilities of mobile devices can help students to manage their studies
- Reducing cultural and communication barriers between staff and students by using channels that students like
- Wanting to know how wireless/mobile technology alters attitudes, patterns of study, and communication activities among students

Alignment with institutional or business aims:

- Making wireless, mobile, interactive learning available to all students without incurring the expense of costly hardware
- Delivering communications, information and training to large numbers of people regardless of their location
- Blending mobile technologies into e-learning infrastructures to improve interactivity and connectivity for the learner
- Harnessing the existing proliferation of mobile phone services and their many users. (Traxler & Kukulska-Hulme, 2005, pp. 3-4)

The benefits of mobile learning abound. Generally, it can not only engage learners from different backgrounds, enable more effective learning activities, but also support a shift of current education system and teaching style for a better performance. Note that, as mobile learning is still in its initial stage, its benefits have not yet been fully addressed.

## **2.1 Technological underpinning for realizing mobile learning**

Since learning practices are mobile in terms of location and time, technologies that support learning should be mobile as well (O'Malley et al., 2003). On the other hand, the unique nature of handheld and mobile technologies make them excel in supporting learning activities in terms of mobile nature of human activities and knowledge (Thomas, 2005; Cobcroft et al., 2006). In fact, any handheld device, in addition to mobile phones, can be to some extent used for education purposes, in other words, supporting mobile learning. Hence the conception of mobile learning technologies and devices are not limited to the use of mobile phones. Many handhelds, such as

iPod, MP3 player, Personal digital assistant and E-book reader, have unique pros and cons for mobile learning implementation (Corbeil & Valdes-Corbeil, 2007). Based on the research findings of Corbeil & Valdes-Corbeil (2007), we listed a number of the most common handheld devices and discussed their features for mobile learning use, which can be summarized as follows:

- iPod

The iPod enables students to download podcasts of educational materials, such as audio and video lectures. It can be used to present e-books. Also it can be used as a calendar and a mass-storage device. In addition, students can use the iPod to exchange files, and collaborate on the work even in a distant place. Note that iPod can utilize iTunes to download a wide spectrum of learning materials. By February 2009, over 100,000 educational audio and video files supporting mobile learning had already been available in iTunes U. However, there are some disadvantages of the iPod, such as high price, one-way communication and small screen sizes.

- MP3 Player

The MP3 player is compact and light. Students can use MP3 players to listen to podcasts and audio lectures, and books. Also some devices with the voice recording function can be used to record information, such as a lecture. However, the MP3 player can be replaced by another device with the audio playing function. Also it is time-consuming to transfer files. No interactivity communication is offered.

- Personal Digital Assistant (PDA)

Compared to other devices, PDAs have a relatively large screen size and convenient input methods, such as screen keyboard, a stylus or external peripherals. The PDA enables students with many new possibilities to access education, including (i) playing audio, video and flash files; (ii) presenting and editing text and word documents; (iii) accessing e-mail and web resources; (iv) instant interactive communication and learning; (v) serving as a mass storage device; (vi) video recording functions, which can be used to record lectures; (vii) GPS function, which can be used to support research on geography and environment. However, the PDA is relatively bulky and expensive. Note that previous functions of the PDA are increasingly embedded in common cellular phones along with technology advances. Hence, differences between PDAs and cellular phones are getting blurred.

- USB Drive

A USB drive is light and small, which can be used to store and transfer files. Students can use it to save, share and submit their works. However, the function offered by a USB drive is quite limited while other devices may also serve as a mass storage device.

- E-book Reader

E-book readers have large screens which makes reading comfortable. It can be used to download, store and play text-based learning materials. Magnification, highlighting, bookmark and full-text search functions make it easy to be used. However its functions are limited and only serve for the book reading purpose with limited computing power.

- Laptop/Tablet PC

A laptop/tablet PC is the most complete and functional devices among all the devices introduced. It has nearly all the functions that a PDA has, but also offers a big screen and keyboard facilitating easier operation experiences. Students can easily start their work using laptops at any place and time they want. However, they are also relatively expensive and cumbersome to be carried when traveling. Also it is nearly impossible to use it when walking.

- New Devices (especially designed for mobile learning purposes)

Recent years have seen a number of new devices especially designed for mobile learning purposes. These devices are used for varied purposes and therefore embed different handheld technologies. For instance, in tourist attractions, such as in Louvre Museum and the palace of Versailles, a number of new handhelds were employed and rented to tourists to offer audio



guidance. In this case, mobile learning not only enhances tourists' knowledge on the masterpieces presented in museum, but also generates a new source of revenue for the tourist industry. The One Laptop Per Child Association, Inc. (OLPC), as a non-profit organization, developed a new low-cost laptop, which is known as the \$100 Laptop, in order to offer children in the developing world with content and software designed for collaborative, joyful, self-empowered learning. In China, a series of handheld digital learning devices are especially developed for mobile learning purposes. According to the CCID Consulting (2009), 6.2 million educational electronic devices were sold in China in 2008 and the figure is expected to reach 7.3 million in 2011.

Note that, in general, there are many technological challenges that mobile learning faces, such as lack of data input capability, low storage, low bandwidth, limited processor speed, short battery life, lack of standardization, limited interoperability, compatibility issues, low screen resolution and small screen size (Maniar et al., 2008). Additionally usability problems are frequently reported in current mobile learning research, since most mobile learning activities are based on the use of the devices that are not designed for educational use (Kukulka-Hulme, 2007). Hence the devices with special consideration on mobile learning usability issues offer a new approach to facilitate learners' adoption of mobile learning services. It can be predicted that future mobile learning industry tends to rely more on these handhelds that have education in mind.

Utilizing different handheld technologies and devices, a wide spectrum of mobile learning applications has been developed in recent years. As shown in Table 1, authors summarized 24 kinds of mobile learning initiatives and classified them into four broad categories from the perspective of functionality, which include:

- Informal learning: applications facilitate the learning activities outside predesigned educational establishments.
- Administration function: applications are used to administrate the learning process and organize learning activities.
- Social network: applications facilitate peer communication as well as instructor-students interactions.
- Learning materials utilization: handheld devices are used to store and display learning materials, such as presenting e-books and lecture videos.

Categories	Mobile learning services
Informal learning	Extracurricular study; Searching answers in for instance Google in wireless Internet;
Administration function	Sending reminder for examination or assignment; Informing schedule or coordinating schedules; Calendars; Collecting feedback; Recording attendance or test taker; Recording lecture; Recording information of patients; Retrieving school-related information, such as timetable; Library services; Digital dictionaries, translators; Environmental detectives or recorders; Collecting and analyzing the data of learning process;
Social network	Interaction between instructor and students, or between peer students; Learning Collaboration, such as virus game; Mobile 'blogging'; Accessing online communities, discussion boards and chat rooms via mobile

	phones;
Learning material utilization	Situated learning, such as learning in a museum, watching birds in open air and mobile excursion games; Displaying lecture videos and courseware; Podcasting lectures; Playing quizzes; Mobile learning in language studying, and mathematics.

*Table 1 A summarization of current mobile learning initiatives (Liu & Li, 2009)*

In general, mobile learning applications currently available in tertiary education are mostly for administration and social network purposes, while chief commercial mobile learning applications are for tourism use, such as mobile learning in museum. Note that mobile learning industry adopts different way of development in different countries. For instance, mobile learning applications in China are mostly initiated by business communities for students in basic education, while in Europe, mobile learning are generally developed by government and educational organizations for students in tertiary education or adults.

## **2.2 Theoretical underpinning for realizing mobile learning**

Different from traditional education approaches, mobile learning is built on the use of mobile technologies, which brings it a number of unprecedentedly new features. In concert with the unique nature of mobile technologies, these new features can be illustrated as shown in Table 2.

<u>New Learning</u>	<u>New Technology</u>
Personalized	Personal
Learner-centered	User-centered
Situated	Mobile
Collaborated	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

*Table 2. Convergence between learning and technology (Sharples, Taylor & Vavoula, 2005, p. 3)*

The new features of mobile learning brought by the mobile technologies also bring it new challenges to establish its theoretical underpinnings. Note that most theories of pedagogy fail to capture the unique nature of mobile learning, as they are mostly based on the assumption that learning takes place in a classroom environment, controlled by teachers. Compared with previous education methods, mobile learning is a learner-centered approach. It typically takes place in an unstructured environment and seeks to tailor service for personal needs. This gap leads to a long dearth of proper theories in mobile learning research (Muyinda, 2007). In this light, Sharples, Taylor, & Vavoula (2005) proposed a list of criteria against which a mobile learning theory could be tested. These criteria also offer an important foundation for developing new theoretical underpinning, which are:

- Is it significantly different from current theories of classroom, workplace or lifelong learning?
- Does it account for the mobility of learners?
- Does it cover both formal and informal learning?
- Does it theorize learning as a constructive and social process?
- Does it analyze learning as a personal and situated activity mediated by technology?

### **2.2.1 Five mobile learning theoretical underpinnings proposed by Naismith et al.**

Currently theoretical underpinnings of mobile learning research are mostly based on the work of Naismith et al. (2004), who compared new mobile learning practices against existing learning theories, which are behaviorist, constructivist, situated, collaborated, informal and lifelong learning.

#### ***Behaviorist learning theory***

Behaviorist learning emphasizes learning experiences gained as a change in observable actions with proper stimulus and response. With the advance of mobile technologies, mobile learning makes it possible to form a 'drill and feedback' mechanism complied with the behaviorist learning theory. Specifically, mobile learning can give learners content specific questions, then gather their responses in a rapid manner and provide instant feedback, which fits with the behaviorist learning paradigm.

#### ***Constructivist learning theory***

The constructivist theory emphasizes gaining learning experience in a way that learners actively build new ideas or concepts based on both their previous and current knowledge. With a mobile phone, a learner can construct his/her own knowledge and share it freely with peers regardless of time and place. Specifically, an easy way for mobile learning to enable an immersive constructivist learning experience is to offer edutainment (e.g. handheld games).

#### ***Situated learning theory***

Situated learning emphasizes learning activities that take place within authentic contexts where the environment itself appears to be a part of education resources. For situated learning, the environments can be pre-organized, such as studying in a museum (Chang, Chang, & Hen, 2007), or naturally developed, such as watching birds in open air (Chen, Kao, & Sheu, 2003). Specifically, situated learning experience can be realized via three manners, namely problem-based learning, case-based learning, and context-aware learning.

#### ***Collaborated learning theory***

Collaborated learning experiences are promoted as a learning process with proper social interaction. The increasing availability of wireless networks in personal devices not only makes it much easier to communicate and share data, files and messages with partners, but also makes learning collaboration easier to initiate and to respond to. Taking into consideration the recent popularity of the Really Simple Syndication (RSS) as well as open source software, learning collaboration on a large scale appears to be more socialized and self-initiated.

#### ***Informal and lifelong learning theories***

Informal and lifelong learning emphasizes the learning activities that take place outside a dedicated learning environment, such as a predetermined curriculum. Informal learning can be intentional with intensive and deliberate learning efforts, or it can be accidental, such as through conversations, TV and newspapers (Naismith et al., 2004). To the extent that mobile devices facilitate instant information acquisition in a seamless and unobtrusive way, mobile learning is especially suitable for offering informal and lifelong learning experience.

### **2.2.2 Learner-centered andragogy: Self-directed learning theory**

Considering the learner-centered nature of mobile learning, Liu & Li (2009) sought to use one of the andragogy theories to explain mobile learning activities, which is a self-directed learning

theory (SDL). This theory has long been stressed and applied in problem-based, lifelong and distance learning settings (Fisher, King, & Tague, 2001; Stewart, 2007). In its broadest meaning, ‘self-directed learning describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes.’ (Knowles, 1975, p. 18) The theory indicates that the level of control that learners are willing to take over their own learning will depend on their abilities, attitude, and personality characteristics (Fisher, King, & Tague, 2001). A common aim for SDL research is to assist individuals in developing the requisite skills for engaging in self-directed learning such as planning, monitoring, and evaluating their own learning (Reio & Davis, 2005), which are also important capabilities to facilitate successful mobile learning implementation.

Liu & Li (2009) applied the self-directed learning theory to mobile learning contexts, and utilized it to explain the success and failure of current mobile learning initiatives. They suggested that mobile learning activities are typically initiated outside a pre-organized learning environment while learners are mostly physically separated from both teachers and peer students. Therefore mobile learning initiates a heightened need for proper self-direction and self-management capability. To help students finish a mobile learning course, that for instance takes tens of hours, it is important to sustain their learning desire and help them to effectively self-control and manage the learning process (Liu & Li, 2009). Further, they proposed:

- Education is not inherently a gratification process; anxiety initiated either by education or by lacking social interaction will impede learners in the pursuit of mobile learning. Hence there is a need to sustain students’ learning desire.
- Success in mobile learning initiates a requirement for SDL capability, but not all the learners have a proper SDL capability for mobile learning; hence technology and services should help learners to organize their learning process and to evaluate their learning outcomes.
- The misuse of mobile phones in a classroom happens naturally since young students inherently have a limited capability of self-management and self-direction;
- Great autonomy and freedom placed on learners do not guarantee effective mobile learning as well as positive academic outcomes;
- An unstructured learning environment tends to be the typical environment for mobile learning; this type of environment may cause anxiety for learning and lead to arbitrary learning;
- For those with a low SDL capability, solutions to reduce the requirement for SDL capability are essential; otherwise students may not use mobile learning or discontinue the use after starting to use it.
- From an SDL viewpoint, there are four alternative solutions to implement a successful mobile learning system:
  - To provide learning environments with proper guidance particularly for situated mobile learning.
  - To reduce the autonomy and freedom offered to an appropriate level that most learners feel comfortable with.
  - To help learners manage their learning process using for instance SMS reminders and distance instruction.
  - To motivate students and alleviate learning pressure using more personalized communication and a social network. (Liu & Li, 2009, p. 6)

In essence, different learning theories seek to offer different mobile learning experiences and picture mobile learning from different aspects. It is the inherent nature of mobile learning that lends itself well to motivate learners intrinsically by offering versatile learning experiences. Hence these learning experiences should be integrated and combined instead of being separated. If leveraged appropriately, mobile learning makes it possible to form a learning space which is socialized, personal and digital, trusted, pleasant and emotional, creative and flexible, certified, open and reflexive (Punie, 2007). Similarly, Naismith et al. (2004) stated that mobile learning would initiate a sort of 'highly situated, personal, collaborative and long term; in other words, truly learner-centered learning' (p. 36).

### **3. ENABLING MOBILE LEARNING FOR NEW LEARNERS**

It is evident that a rapid proliferation of mobile devices expands the reach of education to all social-economic levels. In addition to common school/university students, mobile learning appears to be an ideal conduit to deliver training and education to the learner communities unreachable through conventional education approaches. As they are of great demographic importance, these new learners can not be neglected.

#### **3.1 Engaging problem teenagers and illiterate**

In most parts of the world, it is undeniable that many teenagers are unsatisfied with classroom-based educational environments and they drop out without pursuing any further training or education. Teen dropouts are in general hard-to-reach by traditional educational approaches and are more likely to be the future illiterates, resulting in many serious social problems. For instance, it is reported that in UK, nearly 10 millions adults lack confidence in using literacy skills (BBC, 2007), while in China, the number of people deemed illiterate jumps from 30 million to 116 million from 2000 to 2005, right after India (China Daily, 2007). Further, there are still about 785 million illiterate adults aged over 15 worldwide in 2009 (Indexmundi, 2009). Early dropout of teenagers from schools would lead to serious problems for the society. It is reported that early dropouts are more prone to be unemployed, in prison, living in poverty, receiving government assistance, in poor health, divorced and single parents (Pytel, 2006).

For these learners, mobile learning appears to be an ideal solution to deliver training and education. Current young people, in particular the 'Millennial generation' that was born in or after 1982, shows a clear preference for technology applications (Oblinger, 2003; McMahan & Pospisil, 2005). With an information technology mindset and a highly developed skill for multitasking, the millennial generation is described as being focused on 'connectedness' and social interaction with a preference for group-based methods in study and social occasions (McMahan & Pospisil, 2005).

To engage millennial learners, in particular teen dropouts, mobile learning has great advantages as it accommodates the unique nature of these new learners in comparison to traditional education approaches. Also, in light of the fact that many learners might never be able to afford a personal computer or enroll into formal education again, a mobile phone, which is increasingly popular among young people, becomes an affordable conduit for delivering education. According to Attewell (2005), there are several advantages to implement mobile learning for problem teenagers and illiterates, including:

- Mobile learning helps learners to improve literacy and numeric skills and to recognize their existing abilities;
- Mobile learning can be used for promoting independent and collaborative learning experiences;
- Mobile learning helps learners to identify where they need assistance and support;

- Mobile learning helps to combat resistance to the use of ICT and can help overcome the divide between mobile phone literacy and ICT literacy;
- Mobile learning helps to remove some of the formality from the learning experience and engages reluctant learners;
- Mobile learning helps to concentrate a learner's attention for longer periods;
- Mobile learning helps to raise self-esteem;
- Mobile learning helps to raise self-confidence.

### **3.2 Supporting the informal and lifelong learning of employees**

As human societies are becoming more and more hectic and knowledge-based, employees have to adopt more learning activities to renew and update their knowledge and skills in order to remain competitive in the workplace, and to adapt to an increasingly technological environment. The growing learning requirements go with problems, as today's workforce is increasingly mobile around the world (Edwards, 2005). For instance, it is predicted that 75% of U.S. workforce and 80% of Japan workforce will become mobile by 2011 (IDC, 2008). IDC (2008) estimated that the worldwide mobile worker population will increase from 758.6 million in 2006 to 1.0 billion in 2011, which accounts for 30.4% of total workforce. Nonetheless, the time available for employees to stay in a stationary place to learn is becoming limited. In 2003, the average time available for training was less than three days (Hayes, Pathak, & Joyce, 2005). Also, there is little evidence to show that time and resources available for formal training will be increased.

In this regard, mobile learning appears to be a desirable way to provide training and education to an increasingly mobile workforce. Great benefits can be achieved through the use of mobile learning. As Koschembahr (2005) stated, mobile learning can assist enterprises in saving cost, enhancing customer services and offering better selling opportunities. On the other hand, mobile learning reflects a potential to improve job satisfaction and to reduce job stress as well as employee turnover (Koschembahr, 2005). Also, it enables employees to utilize previously unproductive time as part of people's increasingly hectic lifestyle (Geddes, 2004). With regard to ICT literacy, as Punie (2007) pointed out, mobile learning promotes ICT skills, digital competence and other new skills, and helps to fight ICT resistance. Ufi/learnDirect and Kineo (2007) indicated that mobile learning can help address some challenges faced by businesses as follows:

- Mobile learning enables business entities to provide learning to mobile staff and to distribute learning quickly.
- Mobile learning enables the delivery of key data at the point of need— particularly relevant for workers who need access to updated product specifications, pricing details or other time-sensitive information.
- Mobile learning enables companies to utilize staff downtime, those short periods of time waiting or travelling.

### **3.3 Facilitating the retraining of aging people**

Population aging is a pervasive phenomenon. In the Asia-Pacific area for instance, people aged 50 and above are expected to take up approximately 31% of the total population by 2025 (Watson, 2006), while in Japan, population ageing seems to be more significant and 28.7% of the population will age 65 and above by 2025 (NIPSSR, 2002). In addition to this, it is predicted almost one third of the working age population will be aged 50 or over by 2050 in developed countries (UN & DESA, 2007). In this light, population aging impresses people with an ongoing trend—aging people will inevitably become an incremental part of the future workforce. Due to

lack of enough qualified employees, ageing people nowadays have already been encouraged to join the workforce in some parts of the world. In Europe, a marked rise has been found in the employment rate of people aged 55-64 from 36.6% in 2000 to 43.6% in 2006 (EurActiv, 2007).

The requirement for the retraining of aging learners is intensified, but research targeted at aging learners is in short supply, also within the context of mobile learning. Unlike young and prime adults, aging learners have unique learning requirements and traits. For instance, ageing individuals need a learning approach that facilitates the review of learning materials, as they incur a biologically-based decline in fluid intelligence, which impairs rapid processing of new information (Niessen, 2006). In addition, older learners may have a lack of confidence and thereby resist trying something new. In this concern, mobile learning gains advantages as it tends to address these problems through bringing training into local areas and offering courses in less formal settings (NIACE, 2005). Also, there is little extra economical and physical effort required for aging people to learn via mobile devices in comparison to the computer-based or classroom-based learning approaches.

#### **4. CONCLUSION**

In sum, it is apparent that the potentials of mobile learning are profound and far-reaching. With a worldwide diffusion and increasingly educational use of mobile devices, mobile learning extends learning opportunities to all social-economic levels and the people who can benefit from mobile learning is increasing. For both learners and society, mobile learning is particularly cost-effective in terms of its capability to be centrally processed and updated with a fast and economical allocation of educational resource in a 24X7 manner for all mobile phone owners regardless of location. As such, in addition to common students, more attention is needed to learners who are previously hard-to-reach or incompatible with traditional educational approaches so as to realize the full potential of mobile learning.

This chapter in general offers some background knowledge on mobile learning with regard to its theoretical and technological underpinnings and potentials. This basic knowledge is important if one wants for further evaluating and understanding the significance of a mobile learning application, its potential and contexts of use, such as open source mobile learning applications.

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## **Research paper 4**

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# A Case Study on Mobile Learning Implementation in Basic Education

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**Abstract**—Recent years has seen an incremental amount of mobile learning experiments for the purpose of implementing mobile ICTs into mainstream education. However, the adoption of mobile learning in basic education—primary and secondary schools, is still disappointingly slow, rather than exponential. This case study portrays a unique and novel education concept derived from the Chinese mobile learning industry, in which Noah Education Holding Co., Ltd (Noah) acts as a premier provider of mobile learning services and devices. In China, mobile learning has already formed a booming market. In 2008, 6 million educational electronic devices are predicted to be sold which digital learning devices (DLDs) appear to be leading the trend. Astonishingly, these devices are not mobile phones and the vast majority of them can't even connect to wireless networks. However, they embrace a wide range of new technologies and are widely accepted by students and teachers in particular. As a result, the success of Noah challenges the popular understanding of mobile learning and offers an alternative to implement mobile ICTs into the basic education.

**Keywords**—mobile learning; mobile technology; online learning; basic education; pedagogy; blended learning;

## I. INTRODUCTION

Even if it is widely praised as a new conduit for training and learning, the adoption of mobile learning is still slow, rather than exponential. Despite a rapid development of mobile technology and widespread enthusiasm, it is a fact that mobile learning has not yet seriously impacted education and the projects addressing the adoption of mobile ICTs in schools can still be regarded as spearheads [1, 2]. In higher education, the pedagogical use of mobile devices is not widespread [3] while in basic education mobile learning largely remains on the periphery of planning of most primary and secondary schools. Thus far there is little evidence to show any wide-scale adoption of mobile learning in schools.

In this study we portray the unique and novel education concept initiated by Noah, a leading provider of new educational electronic devices, learning materials and software in China, which offers an innovative mobile learning solution and challenges the traditional mobile learning concept popular in current mobile learning applications. The paper attempts to demonstrate the implications of Noah's education concept in terms of an extreme emphasis on educational use, from devices design to built-in ICTs selection and development, from learning materials generation to learning support.

Field observations play a central role in this case study. However, the data collection process is slightly different from the typical procedure in case study research, as the second author, Miss Jun Liu, is the Deputy Team Leader of China's 11th Five-Year Plan on educational technology projects—'a portable network learning system'. This ongoing project is undertaken by Noah and Beijing Normal University, and digital learning devices are one of the key research objectives.

The paper is structured as follows: After a brief literature review, the unique education concept of Noah is introduced, after which conclusion is made. Finally, limitations and future research are specified.

## II. LITERATURE REVIEW

Adoption of innovations have been intensively investigated by researchers and practitioners of many disciplines, in which the technology acceptance model (TAM) appears to be one of most widely accepted and applied models [4]. TAM originates from the theory of reasoned action (TRA), and postulates that two beliefs (perceived ease of use and perceived usefulness) determine the attitude toward using the system and that attitude, together with perceived usefulness, determines use intention. Perceived ease of use refers to the degree to which a user believes that using a particular service would be free of effort while perceived usefulness is defined as the degree to which an individual perceives that using a particular system would enhance his or her job performance [4]. An extensive body of research has demonstrated the robustness and explanatory power of TAM in predicting use of various information technologies. In particular in the context of mobile services, the basic structure of TAM has been extended and examined in a diversity of areas as well, such as mobile chat [5], mobile credit card [6], mobile parking [7], B2C mobile commerce [8] and mobile ticketing [9]. With regard to the field of education, TAM is also used to investigate antecedents affecting people's behavioral intention in the context of for instance multimedia learning environments [10], electronic learning [11, 12], and mobile learning in particular [13, 14, 15]. In this light, it is reasonable to examine the attributes of DLDs from the viewpoints of ease of use and usefulness, which are in line with the basic beliefs of TAM.

## III. NOAH'S SOLUTION FOR MOBILE LEARNING

Despite widespread enthusiasm, the current reality is that mobile learning is used occasionally and in a supplemental

manner in education [2], and very few mobile learning solutions— even on a global scale— indicates that there is no capability to enable a large scale adoption. Guidelines and experiences for implementing mobile learning in basic education are in short supply. With this, Noah's mobile learning solution is on a large scale generated from constant experimenting and testing. Currently, Noah is becoming a chief provider of digital learning devices, software, and interactive, multimedia educational materials in China. In order for DLDs to be acceptable for users, great efforts have been made by Noah in a wide spectrum of domains.

#### A. Making mobile learning easy to use

With different advantages and disadvantages, handheld devices currently available for mobile learning are many and varied in relation to the different handheld technologies embedded, such as iPod, PDA, smart phone and laptop [16]. These technologies and handheld devices have one thing in common as they are largely developed for business or entertainment purposes rather than for educational use and usability issues are frequently reported [17]. With this, a new device specifically designed for mobile learning is necessary. It is reported that there is at present no successful case and guidelines widely acknowledged on how to develop a best device for mobile learning. As a result, based upon a selective utilization of mobile technologies presently available and an independent development of new handheld educational technologies, a series of DLDs has been developed in order to make mobile learning services easy to use. Here, similarities among the devices developed are summarized as follows:

##### 1) Layout design

A series of DLDs have been designed with a price largely ranging from 90 to 170 €, of which a big screen size appears to be a basic feature, such as  $320 \times 240$  dot matrix in both NP1100 and NP1200. The screen is designed in a way similar to a TV set or laptop instead of the typical portrait layout of smart phones. Handwriting support or a keyboard with more or less 64 keys, or both of them is used as input method. In addition, computer keyboard and mouse can now connect to recent products, such as NP1200 as shown in Figure 1. Also, NP1200, as a leading product, enables a connection to projector and displays courseware in various types of file formats. This new function purposely assists teachers to give lectures in multimedia while building on the content from DLD.

##### 2) System design

The system is designed for the purpose of a more comfortable and easier learning and operating experience. Increasingly, DLDs are utilizing a Linux and WinCE-based proprietary NP-iTECH software platform with rechargeable large-capacity lithium-ion battery, high-frequency chip, extended memory support, external loudspeakers, built-in pronunciation and dual-channel headphones. New functions, such as camera, are now embedded in recent DLDs as well.



Figure 1. The layout of NP1200

##### 3) Interface and learning materials design

Interface and learning materials are displayed with a full screen presentation, in which interactive, multimedia material appear to be the mainstream. Regarding English language study, Text-to-speech (TTS) technology is widely embedded. Further, various types of file formats, such as text, MP3, MP4, MIDI, MPEG4 etc. can be displayed in DLDs alike.

#### B. Making mobile learning useful

A wide spectrum of services and technologies is developed to offer a useful mobile learning experience. Over 30,000 multimedia courseware titles, 8,000 animations for English learning, a wide range of language dictionaries, such as English, Chinese, French, Japanese etc. and an animation dictionary with animated illustrations of 9000 commonly used words are offered. The learning material developed is mainly to complement prescribed textbooks used in China's primary and secondary school curriculum, covering English, Chinese, mathematics, physics, chemistry, biology, geography, political science and history. DLD posits to be a useful tool for students, as the general research group's statistics have shown that to varying degrees it enables to improve students' academic achievements [18].

In addition, a wide range of learning support and management functions are provided to help students arrange their studies as well as daily lives, including schedule, calendar, name card, class schedule, memo, appointment management, personal finances and many more. In addition, Noah devotes itself to a constant development of new and useful mobile learning technologies and services. Among all the new handheld educational technologies developed, the three most important ones are introduced here, which are NP-iTECH, Question Search Function, and Graphic Calculator Technology.

##### 1) NP-iTECH

NP-iTECH is short for 'Handheld Network Multimedia Integrated Technology'. It is the basic software platform for the Noah DLDs, and was introduced as the 'world's first network-aided learning player to combine animation and a time synchronous integration of reading, listening and learning tasks' [19], holding five domestic patents, eight domestic and one international patent applications until June 2007. Based on network processor technology, this technology supports and integrates mainstream multimedia formats, and enables content

developers to efficiently design and assemble multimedia content elements. Many new technology solutions are integrated in NP-iTECH, such as NMAIL, NFlashMX, DLSprite, NTrack and Nmessage technologies.

a) *NMAIL*: This is a multimedia mail sending and receiving software, enabling students to write and read nMail on DLDs. Once Internet connection is available, DLDs will send and receive the nMail automatically.

b) *nFlashMX*: nFlashMX is a visual design tool used to design cartoons, MTV, Electronic Album and courseware. It is easy to understand for both teachers and students. This software is introduced by Noah as to ‘you can make a cartoon if you can use a mouse; you can make courseware if you can use a computer.’ With this, teachers are capable to make courseware for their classes on their own terms.

c) *DLSprite*: Integrated with a ‘One-key download function’, DLSprite is used for fast updating and downloading of learning material from Internet to DLDs. DLSprite also offers students an easy and fast way to delete, transfer and edit the files inside DLDs.

d) *NTrack and Nmessage*: NTrack is a technology used to support the learning track record and intelligent analysis system. It records the learning process of students and then transmits the record to the remote database of Noah. The final analysis of records will be sent to parents or students by Noah.

### 2) Question Search Function

In July 2007, Noah launched its question search function on DLDs, as shown in Figure 2. The question search function is a powerful vertical search engine developed for the common educational user. With this portable search engine, students are able to search the database for the answer to their questions anytime and anywhere. These questions initially focus on the subjects of mathematics, physics and chemistry, and now extend to other topics such as Chinese, English, history, political science, geography and biology. The search is built on questions, books, encyclopedia, English words and phrases. As for the encyclopedia, more than 200,000 titles are available, covering the subjects of astronomy, geography, science and nature. Meanwhile, nearly 10,000 outstanding ancient and modern books are also offered referring to popular science, biography, philosophy, the humanities, modern economy, and so on. Further, both the question search engine and NP-iTECH software are scalable and have the potential to be used on a variety of platforms.



Figure 2. One of main interfaces of NP1200

### 3) Graphic Calculator Technology

This technology is China’s first handheld graphic calculator technology (GCT), which integrates five basic functions namely: math sketch pad, algebra calculus, mathematical functions and programming, geometric dictionary, and classic courseware. The technology is particularly useful for mathematics teaching, as it converts abstract mathematical concepts and theory to form comprehensible images in an intuitive and dynamic way. GCT is launched on DLDs at the end of 2007, and is currently available in NP1100 and NP1200.

### C. Motivating students intrinsically

Intrinsic motivation is an important factor affecting user adoption of mobile services, as indicated by a number of studies [20, 21]. With regard to mobile learning, intrinsic motivation appears to be of especial importance, as education does not always bring a sense of gratification but also pressures.

In this light, many fashionable edutainment solutions are initiated in DLDs, like MP3, E-books, My Blog, Electronic Album, RPG games etc. In addition, three kinds of well-organized digital magazines are offered monthly referring to extra-curricular learning, entertainment information, friends making, and Flash development skills. These magazines are increasingly downloaded by students. From different resources, thousands of E-books, such as ancient and modern masterpieces, are now available and downloadable via Internet. Also, Noah initiates four RPG games downloadable for DLDs, in which knowledge is learned in a lighthearted learning environment. As a result, the availability of various edutainment products accommodating varied learning interests in turn motivates students intrinsically.

Further, Noah offers different learning solutions according to the level of learners and engages students with personalized learning materials. A new textbook, ‘Mobile Mind English’, is offered in concert with the use of DLDs, in which new pedagogy theories are being researched [22]. In addition, a range of new learning and teaching methods are embedded in this textbook to order to inspire students.

### D. Facilitating a continuous use of mobile learning

A constant provision of updated learning material is a popular challenge for education organizations. It is well understood that it is impossible for a few teachers and researchers to create all the learning materials needed for the students due to a lack of necessary resources. Nevertheless, an in-time updating is a basic requirement in order for students to continuously use mobile learning services. To this, Noah now offers an alternative.

DLDs package a wide spectrum of learning content once being sold, while new learning content can be subsequently downloaded at over 8,500 points of sale, approximately 2,000 download centers, or via its website: [www.noahedu.com](http://www.noahedu.com). As both computers and Internet are becoming popular in China, updating the DLDs appears to be much easier for students today. Further, new learning materials are continuously produced and sold to students, in turn forming a good cycle for

learning materials production. The learning content produced actually includes the topics covering nearly all walks of student's lives, making it to arouse and retain the learning enthusiasm for a longer time.

Unlike most mobile learning services available at present, DLDs and learning materials are not public goods. The devices are largely purchased by parents, and new learning content will be sold subsequently. In the Fiscal Quarter Ended March 31, 2008 for instance, Noah has generated net revenues of US\$26.3 million [23]. The revenue generated in turn supports a further updating and development of new products.

In order to consistently supply high-quality education resources, Noah attempts to collect the knowledge of well-known teachers and professors in China. It established a "Teacher's Alliance" which consists of over 250 experienced teachers and 17 education experts from more than 100 top schools in 15 provinces throughout China. A team of approximately 100 full-time and more than 400 part-time producers, editors and graphic artists is organized to constantly produce learning materials adaptive to DLDs. On the other hand, Noah is actively seeking partners for developing high-quality education resources. Hitherto, Noah has gained copyright from many national and international publishing companies for new content, such as Longman Publish, Oxford University Publish, People's Education Press and Translation Publishing house etc. Riverdeep Fun Mathematics is brought to students largely based on the original Riverdeep textbooks. All of these efforts in turn give Noah a capability to constantly supply high-quality learning materials.

#### *E. Integration with classroom learning and online learning*

Misuse of mobile devices in class has been reported to be one of the main challenges when employing mobile learning in basic education [24, 25]. By an exclusive use of high-quality learning material stored in devices, Noah makes its devices acceptable for a majority of teachers and successfully alleviates the disrupting effect of mobile learning. Further, as learning materials are largely developed in accordance with the prescribed textbook, teachers gain an opportunity to utilize DLDs in teaching. Consequently, a wide adoption of DLDs not only promotes the use of ICTs in education, but also supports and initiates a new learning environment, resulting in a harmonious integration of classroom teaching and mobile learning.

In addition, Noah offers a new method to take advantage of online learning. Online learning appears to be advantageous in terms of fast connection and operating speed, high bandwidth and ease to operate. A high dropout rate however is frequently found in online courses, in which a sense of isolation, lack of personal contact and immediate instructor feedback are widely acknowledged to be the Achilles heel when offering education to distance learners [26]. In Noah, after-school tutoring programs have been provided online since July 2007, in which students can log-on and post questions regarding their homework. Video is used for experienced teachers of Noah to answer these questions everyday. In addition to this, online community, chat rooms and bulletin boards are opened to facilitate interaction among students, teachers as well as

parents, where an incremental amount of users across different schools and provinces make the forum booming and effective.

#### IV. CONCLUSION

Noah believes that the success of DLDs contributes to its capability to 'present traditional education content in an engaging multimedia format at a pace and in the order selected by each individual student, creating a more tailored and more enjoyable teaching and learning environment' [27]. While a vast majority of current mobile learning projects is heavily depending on the use of mobile devices mainly developed for business or entertainment use, Noah initiates an innovative mobile learning solution by intensively utilizing and developing handheld technologies to accommodate education, not by making education accommodate technologies. From the DLD design to built-in ICTs selection and development, from learning content provision to learning support, education is always the focus and target, resulting in a new device which is easy to use and useful for students and accepted by teachers and parents in particular.

In order for learners to accept the physical restrictions of portable devices and changing environments, interactive and multimedia learning materials are required. To some extent, the attractiveness of learning material displayed in the digital devices tends to retain students' attention for the long term and therefore facilitates the adoption of ICTs packaged as a whole. Also, a provision of various learning materials stored in DLDs reduces the requirements on the wireless network as well as the efforts needed to access education.

If leveraged appropriately, an ICT-implementation in mobile learning can be used in a 'natural' way without destructively disrupting the learning environment in class. Noah offers a success case in which the application of mobile learning will accommodate current pedagogy theories; however, it also shows a potential to facilitate a transformation and evolution of pedagogy. With this, mobile learning tends to be more acceptable for teachers who are always important stakeholders when it comes to the adoption of mobile learning methods in schools.

Education technologies, including mobile learning, online learning and conventional fact-to-face learning, are integrated in accordance with respective advantages, in which mobile learning appears to be a bridge and therefore forms a new style of blended learning. Online learning complements DLD-based mobile learning by offering relatively high bandwidth for learning material and system updating, and by providing essential connectivity, such as sending NMAIL to peers or teachers, visiting a forum and receiving after-school tutoring.

Advertisement and marketing campaigns are continuously launched by Noah as well as its competitors to persuade parents to purchase educational electronic devices for their children. The business-oriented model enables Noah to develop and market new DLDs and learning materials so as to further explore the potential of the mobile learning market.

Currently, the mobile learning industry is booming in the Chinese market and the DLD is apparently a high-end product leading the trend of educational electronic devices



development. According to the prediction of SINO Ltd (2006), 3.39 million educational electronic devices from both Noah and its competitors were sold in 2006, which would increase to 4.6 million in 2007 [28]. The figure is expected to reach 6 million in 2008 [29]. A series of studies on DLDs are being carried out in a number of schools across several provinces in China, which is included in China's "11th Five-Year Plan" as a key research subject on educational technology, and is led by Beijing Normal University and Noah. It can be expected that DLDs as well as mobile learning will be increasingly popular and embedded in the student's lives. In this regard, the success of Noah actually offers a possible 'killer app' in basic education.

## V. LIMITATION AND FUTURE RESEARCH

The field of mobile learning is still in its infancy [30]. To date limited understanding has been achieved on how mobile learning could be implemented in basic education. As the research and application of DLDs is in an initial stage and a series of research and experimenting are still projects in process, the empirical data support from a learner's perspective is relatively limited. In relation to this, future research will exert more efforts to investigate how DLDs could improve academic performance as well as factors affecting users' intention to use mobile learning in basic education.

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## **Research paper 5**

Liu, Y. Han, S-N. and Li, H-X. (2010). Understanding the factors driving m-learning adoption: A literature review. *Journal of Campus-Wide Information Systems*, Volume 27, Issue 4, pp. 210-226.





# Understanding the factors driving m-learning adoption: a literature review

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## Abstract

**Purpose** – By surveying current literature, the purposes of this paper are twofold: to identify current situation of mobile learning (m-learning) adoption and specify the challenges and to identify the factors driving m-learning adoption.

**Design/methodology/approach** – The paper reviews literature related to: m-learning applications and challenging issues and adoption researches on m-learning and related topics. A reflection on the unique nature of m-learning adoption building upon the literature reviewed contributes to a new conceptual model.

**Findings** – Even if m-learning is fast evolving, the review of literature reveals a challenge as to how to promote m-learning adoption. In this light, the paper extends the scope of literature reviewed to the theories and factors relating to different roles m-learning users have into consideration, namely, technology user, consumer and learner, in an attempt to offer a more complete understanding of m-learning adoption. Insights are drawn from the proposed model.

**Practical implications** – A number of m-learning projects have been initiated worldwide while guidelines drawing from m-learning adoption research are in short supply. A research in this regard will contribute to a better understanding of developing acceptable m-learning service.

**Originality/value** – Based on a literature review, the paper not only specifies the current situation of m-learning adoption, but also develops factors influencing m-learning adoption to enrich our understanding of m-learning adoption – which help to facilitate and promote future empirical research.

**Keywords** Learning, Technology led strategy

**Paper type** General review



## 1. Introduction

Along with the popularity of mobile telephony, mobile learning (m-learning) presents to be a new education conduit helping people to acquire knowledge and skill in a ubiquitous manner with the support of mobile technologies. Over the past decade m-learning has grown from a minor research interest to be a thriving research field. It is increasingly used in workplaces, museums, schools, enabling a wide spectrum of new education possibilities. Naismith *et al.* (2004, p. 36) point out that m-learning would initiate a kind of “highly situated, personal, collaborative and long term; in other words, truly learner-centered learning”. Since nearly half of the world’s population are mobile phone owners and the figure will expand to 75 percent in 2011 (Portio Research, 2007),

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m-learning enables citizens covering all social-economic levels to access training and education in a ubiquitous and even lifelong manner, using their personal devices.

Despite widespread enthusiasm, m-learning is still in an embryonic stage, and its theoretical underpinnings have not yet matured (Muyinda, 2007). In particular, the issues regarding how to promote learners' acceptance of m-learning are largely unsolved. Research in this regard is in short supply. Note that even if mobile technology is one of the prerequisites of m-learning, the availability of mobile technology *per se* does not guarantee that its potential will be realized. First, recent reports show that whilst advanced phones along with 3G mobile telephony are increasingly diffused, advanced mobile services have not yet found their ways into the consumers' everyday lives and consumers in general are still hesitant to use these services (Carlsson *et al.*, 2005, 2006a; Walden *et al.*, 2007). There is no reason why m-learning services should be an exception. Second, from the perspective of distance learning, a high dropout rate is frequently reported in for instance online courses, which can be as high as 50 percent in some cases (Sulcic and Sulcic, 2007). As m-learning is frequently described as a subset of technology-mediated distance learning, there is some concern whether a high dropout rate will also happen. For instance, in the research conducted by Attewell and Savill-Smith (2003), Attewell (2005), an important proportion of learners did not show any preference for future use of m-learning at the end of the projects. In order to deliver acceptable m-learning services and to retain the developing cost of service providers, it is important to investigate the learners' adoption process of m-learning.

It is important to note that in m-learning contexts learners are trusted with great autonomy and that they are in charge of their own learning. Unlike learning in conventional formal contexts, the use of m-learning posits to be a new option rather than a compulsory responsibility. Hence, the key issues for the success of m-learning lies in an individual's subjective willingness and cognitive engagement in m-learning activities. Based on previous researches on mobile information system (IS), we consider different roles m-learning users have when adopting m-learning services, namely technology user, consumer, and learner. Two theories, namely subjective task value and readiness for online learning, are integrated with technology acceptance model (TAM) in combination with two new ingredients – perceived quality and perceived mobility, in order to develop a sound conceptual model. The rest of paper is structured as follows. After a review of current m-learning research in Section 2, a conceptual model for m-learning adoption is proposed and elaborated in Section 3, followed by a brief conclusion of the study in Section 4.

## 2. Outline of m-learning researches and applications

Both for education and business, m-learning potentials and benefits abound. In addition to common students, learners “who were hard to reach, hard to engage, or hard to access – for example young offenders, traveler communities, disengaged teenagers and work-based learners in difficult contexts” appears to be a hot topic for m-learning research (Attewell, 2005; Stead, 2006, p. 1; Duncan-Howell and Lee, 2007). Funded by the European Commission, a pan-European project – m-learning for instance has been run since 2001 for educationally disadvantaged young adults, such as dropouts and unemployed, to improve their literacy and numeracy skills. Further, m-learning in many countries has been developed to be a sort of new education products, generating new sources of revenue for business communities. In the USA, Ambient Insight (2008)

reports that despite current economic crisis, m-learning market in USA is still growing. It reached \$538 million in 2007 and will continue to develop at a five-year compound annual growth rate of 21.7 percent. "In the last 18 months", stated Ambient Insight (2008, p. 5), "all the major educational publishers have launched mobile content" in the USA. Astonishingly, m-learning also attracts the interest of leading handheld device manufacturers, such as Nokia and Apple, to make a step into this growing market. For instance, in China market, almost all the mobile manufacturers have started to offer m-learning services in their products since 2007.

Despite aforementioned potentials, the uptake of m-learning services in general is much slower than expected. Patten *et al.* (2006) classify current m-learning services into seven distinct categories, namely administrative, referential, interactive, micro-world, data collection, location aware, and collaborative. They further conclude that much of the work presented across the categories has limited success "in the field" (Patten *et al.*, 2006). By investigating the behavior of both teachers and students, Corbeil and Valdes-Corbeil (2007) state that familiarity with handheld devices and technologies does not ensure that teachers and students would like to use them in teaching and learning scenarios (Corbeil and Valdes-Corbeil, 2007). Pozzi (2007) points out that m-learning service in most cases is still used occasionally and in a supplemental manner in education settings. In fact, these research findings support the proposition made by Carlsson *et al.* (2005), who argue that the adoption of mobile technology and services is asynchronous and that the adoption of mobile technology *per se* does not guarantee the adoption of mobile services.

From a technology viewpoint, many scholars state that there are many technical restrictions that may impede m-learning adoption. Wang *et al.* (2009) note that technical challenges make the adaptation of existing e-learning services to m-learning difficult, and that users may not be inclined to accept m-learning. These restrictions, as discussed by Maniar and Bennett (2007), include following eight aspects:

- (1) small screen size and poor screen resolution;
- (2) lack of data input capability;
- (3) low storage;
- (4) low bandwidth;
- (5) limited processor speed;
- (6) short battery life;
- (7) software issues and interoperability; and
- (8) lack of standardization.

Based on two m-learning projects in the UK and a review of usability findings from the empirical studies of m-learning, Kukulska-Hulme (2007) points out that m-learning activity continues to take place on devices which are not designed for educational use, and that therefore usability issues are frequently reported. These issues may include physical attributes (e.g. size, weight, memory, and battery life), content and software applications (e.g. students seem to be more comfortable with built-in functions), network speed and reliability, and physical environment (e.g. use in rainy conditions, risk of loss and theft).

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A handful of adoption studies are carried out to investigate learners' m-learning activities. Phuangthong and Malisawan (2005) put forward an adoption model in their preliminary research on m-learning, and propose that perceived enjoyment would have a direct impact on people's attitudes. Based on 245 completed questionnaires, Ju *et al.* (2007) indicate that perceived usefulness significantly affects users' attitude, which further impact users' intention to use m-learning. Building upon TAM, Huang *et al.* (2007) point out that individual differences significantly influence a user's acceptance of m-learning in which the perceived enjoyment and perceived mobility predict users' adoption intention. Through a study of 330 usable responses from five organizations, Wang *et al.* (2009) find that performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management of learning are significant determinants of the behavioral intention to use m-learning. Despite these studies, it has to be noted that thus far m-learning has not yet had great impact on education context and the studies which address the adoption of mobile information and communications technologies in school settings are still lacking (Pozzi, 2007; Perry, 2002). Consequently, insufficient research on m-learning adoption results in a lack of a complete view of m-learning adoption. In light of this, we believe that in addition to current m-learning literature, a more extensive review to the relevant adoption literature is essential in order to extend the scope of our theoretical support and to identify the possible predictors of m-learning adoption.

In a meta-analysis of mobile commerce literature which covered several key publication sources from 2000 to 2006, AlHinai *et al.* (2007) extend the researching findings of Kim *et al.* (2007) and Pedersen *et al.* (2002), and contend that it is necessary to consider the threefold roles people played in adoption research, namely technology user, network member, and customer. They further conclude that researchers may need to consider and integrate theories concerning the different roles people play in other than ISs (AlHinai *et al.*, 2007). Following this notion, we made an extensive review of literature from the perspective of both mobile services and consumer in general, and technology-mediated learning in particular. As m-learning is generally described as the intersection between mobile services and distance education, or as a natural extension of e-learning, the m-learning user in fact has a new role: learner. Concerning this, the topics reviewed and main findings are specified in Table I. However, as papers concerning m-learning adoption are limited but broadly distributed, our scope of review includes both conferences and journal papers, most of which are retrieved from Emerald and ScienceDirect database.

### 3. Factors driving m-learning adoption

In this section, we summarize the finding from reviewing the literature concerning three roles m-learning users play as aforementioned. Key theories and factors in relation to m-learning adoption are specified.

#### 3.1. M-learning user as a technology user

3.1.1. *Technology acceptance model.* Adoption of innovations has been intensively investigated by researchers and practitioners of many disciplines, in which the TAM is one of the most widely accepted and applied models (Davis, 1989). TAM originates from the theory of reasoned action (TPA; Ajzen and Fishbein, 1975, 1980). TPA proposes that beliefs affect attitude, which influences intention, while intention in turn brings



**Table I.**  
Review of adoption  
research on m-learning,  
mobile service and  
technology-mediated  
learning

Authors	IS applications	Samples	Results
Ju <i>et al.</i> (2007)	M-learning	245 university students	Perceived self efficacy significantly influences perceived ease of use, which positively impacts perceived usefulness. Perceived usefulness significantly affects users' attitude which further impacts the intention to use m-learning
Huang <i>et al.</i> (2007)	M-learning	313 university students	Individual differences have a great impact on user acceptance in which the perceived enjoyment and PMV can predict users' intention of using m-learning
Wang <i>et al.</i> (2009)	M-learning	330 useful responses from five organizations	Performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management significantly impact behavioral intention
Liu (2008)	M-learning	A conceptual model	Based on the basic structures of UTAUT, a model is proposed with an integration of self-efficacy, mobility, attainment value, perceived enjoyment, and self-management of learning, to explain learners' behavior intention
Phuangthong and Malisawan (2005)	M-learning	Preliminary research with 385 responses	In addition to basic constructs of TAM, perceived enjoyment was included to explain users' behavior
Liao and Lu (2008)	E-learning web sites	137 university students	Perceptions of relative advantage and compatibility are significantly related to users' intention to the use of e-learning; prior experience affects learners' adoption of technology
Liaw (2008)	Blackboard e-learning system	424 university students	Perceived self-efficacy is a critical factor affecting learners' satisfaction while perceived usefulness and perceived satisfaction impact learners' behavioral intention to use the e-learning system
Saadé <i>et al.</i> (2007)	Multimedia learning	362 students	TAM is found to be a solid theoretical model where its validity can be extended to multimedia and e-learning contexts

(continued)

Authors	IS applications	Samples	Results
Shih (2008)	Web-based learning	350 part-time students	This study concludes that learners' efficacy control and efficacy expectations can be used to guide their adaptation learning behaviors on the web
Chiu and Wang (2008)	Web-based learning	286 part-time students	Performance expectancy, effort expectancy, computer self-efficacy, attainment value, utility value, and intrinsic value were significant predictors of individuals' intentions to continue the use of web-based learning while anxiety had a negative effect
Chiu <i>et al.</i> (2007)	Web-based learning	221 students of a web-based learning program	Attainment value, utility value, intrinsic value, distributive fairness, and interactional fairness are predictors for learners' satisfaction, while utility value and satisfaction exhibited significant positive effects in shaping learners' intention to continue using web-based learning
Chiu <i>et al.</i> (2005)	E-learning	189 students using e-learning services	The result suggest that perceived usability, perceived quality, perceived value, and usability disconfirmation impact perceived satisfaction while perceived satisfaction determine users' continuance intention to use e-learning
Eom and Wen (2006)	Online education	397 students enrolled in web-based courses	The research found that course structure, self-motivation, learning styles, instructor knowledge and facilitation, interaction, and instructor feedback significantly influenced students' satisfaction
López-Nicolás <i>et al.</i> (2008)	Advanced mobile services	542 valid questionnaires by households	Social factor is found to have an important impact on people's decision to adopt advanced mobile services. The results also suggest that both ease of use and perceived usefulness can be linked to diffusion-related variables, such as social influence and perceived benefits
Koivumäki <i>et al.</i> (2008)	Mobile services	243 service users	Whilst duration of the use does not effect consumers' perceptions of mobile services, the familiarity of the device and user skills have an impact on the perceptions of the services (continued)

Table I.

Table I.

Authors	IS applications	Samples	Results
Kargin and Basoglu (2007)	Mobile services	A qualitative research with 12 interviewees	Ease of use and usefulness are the most significant factors in mobile service adoption. Content and mobility are dominant factors from a service perspective while social influence is also important
Carlsson <i>et al.</i> (2006b)	Mobile services	300 Finnish consumers	Performance and effort expectancies are found as predictors for behavioral intention, but the social influence cannot be used as predictor
Shin (2007)	Mobile internet	986 adult Koreans	Perceived quality and perceived availability are found to have significant influence on users' extrinsic and intrinsic motivation to use mobile internet in Korea
Cheong and Park (2005)	Mobile internet	1,279 replies from an online survey	The research identified the positive impact of perceived playfulness and the negative impact of perceived price level in forming the attitude and adoption intention. Perceived content and system quality are positively affecting the perceived usefulness. In addition, there is a causal relationship between internet experience and perceived ease of use
Lu <i>et al.</i> (2005)	Wireless internet services	357 MBA students	The research revealed strong relationships between personal innovativeness and social influences and the perceptual beliefs – usefulness and ease of use, which further affect intentions to adopt innovation
Lu <i>et al.</i> (2008)	Wireless mobile data services	1,432 individuals living in five cities in China	The research revealed the importance of perceived usefulness, ease of use, personal innovativeness in IT and mobile trust belief in affecting individuals' intention to use wireless mobile data service

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about behaviors. TAM adapts this belief-attitude-intention-behavior relationship and further postulates that two beliefs (perceived ease of use and perceived usefulness) are the key beliefs leading to user acceptance of information technology (IT). Perceived ease of use refers to the degree to which a user believes that using a particular service would be free of effort while perceived usefulness is defined as the degree to which an individual perceives that using a particular system would enhance his or her job performance (Davis, 1989). Further, perceived ease of use is supposed to influence perceived usefulness, which directly affects both attitude and intention (Davis, 1989).

An extensive body of research has demonstrated the robustness and validity of TAM in predicting the acceptance of various IT innovations. Regarding advanced mobile services, TAM have been widely examined in for instance mobile chat (Nysveen *et al.*, 2005a, b), mobile credit card (Amin, 2007), mobile games (Ha *et al.*, 2007), mobile parking (Pedersen, 2005), business-to-consumer mobile commerce (Khalifa and Shen, 2008), and mobile ticketing (Mallat *et al.*, 2008). Concerning educational innovations, TAM offers a concrete theoretical background to investigate learners' adoption intention in multimedia learning environments (Saadé *et al.*, 2007) and e-learning (Lee, 2006; Ngai *et al.*, 2007). As TAM is developed to be a parsimonious model (Davis, 1989), many scholars seek to increase its explanatory power by integrating related theories, like flow theory (Liu *et al.*, 2009; Lu *et al.*, 2009), media richness theory (Liu *et al.*, 2009) and task technology fit theory (Dishaw and Strong, 1999). In light of this, the basic structures of TAM therefore are adopted as the key foundation for our research model.

*3.1.2. Unique nature of mobile services: perceived mobility.* Mobility is perceived to be the most significant feature of mobile services (Mallat *et al.*, 2006). According to Kakihara and Sørensen (2001), the concept of mobility consists of three distinct dimensions of human interaction, namely spatial, temporal, and contextual mobility. As mobile technology conforms to the increasingly mobile nature of people's lifestyle, mobility is accordingly perceived as the critical advantage of m-learning that makes it distinct from traditional education approaches, such as computer-based learning. Using mobile technology, learners can access education without the restrictions of place and time. Also, to tolerate the small screen of mobile phones, learners' perception of the benefits from increased flexibility and mobility is important. The research by Kaigin and Basoglu (2006), and Mallat *et al.* (2008), provide clear evidence that perceived mobility can affect individuals' decision to adopt particular mobile services. Huang *et al.* (2007) state that perceived mobility value (PMV) has a significant influence on user intentions of using m-learning. Hence, we propose that perceived mobility is an important variable impacting m-learning adoption.

### *3.2. M-learning user as a consumer: perceived quality*

Currently, m-learning courses and products are mostly sold as a kind of education products, such as in USA and China. M-learning users therefore gain a role as consumers as well. For customers perceived quality of products or services impacts customer's intentions to use them. Perceived quality is defined by Zeithaml (1988) as "the consumer's judgment about a product's overall excellence or superiority". Quality research tends to be most important stream of services research. Specifically, many researches tend to divide perceived quality into different dimensions regarding different research subjects (Parasuraman *et al.*, 1985, 1988), due to the fact that perceived quality is product-related (Chu and Lu, 2007). Concerning IS, a number of scholars

suggest that the quality of both technology infrastructure and service delivered would impact perceived overall quality, which further affects users' acceptance intention. Delone and McLean (1992) propose the notion of information quality and suggest that information quality plays an important role in building successful ISs. Cheong and Park (2005) show that perceived system quality and perceived content quality are positively related to users' perceived usefulness of the mobile internet. Lin and Lu (2000) employ information quality as a part of IS quality, and argue that information quality is an important determinant of perceived usefulness. From a knowledge management viewpoint, Dai *et al.* (2007) suggest that content quality is one of the significant determinants of perceived usefulness of online social information services. Further, many scholars tend to study perceived quality of IS in a global view. Yang *et al.* (2005) outline six dimensions of quality and further find a positive causal relationship between the perceived overall service quality and a user's satisfaction towards a web portable. Measuring both the system issues and content issues, Chiu *et al.* (2005) and Liaw (2008) found that perceived quality is a significant predictor of perceived satisfaction with e-learning. Since m-learning can also be perceived as a kind of advanced information service, it stands to reason to use perceived quality as an important component of our model. Also, based on prior studies, the quality perceived in our research model includes both two dimensions: perceived content quality and perceived system quality.

### *3.3. M-learning user as a learner*

*3.3.1. Subjective task value of expectancy-value theory.* Expectancy-value theory of achievement motivation is proposed by Eccles *et al.* (1983) based on the work of Atkinson (1964). According to the theory, achievement behavior is predicted by two structures: expectancy for success in a given task and the value an individual places on the task. With the same belief of behavioral outcome, people may hold different evaluations of the attractiveness of that outcome (Bandura, 1997). The one who values the outcome will be more motivated to attain the outcome, which may compensate for low probabilities of success as well as the monetary and nonmonetary cost perceived. In contrast, even when individuals feel competent that they can successfully accomplish a task, they may not choose to participate if the task value perceived is low (Cole *et al.*, 2008). Eccles and Wigfield (1995) outline four motivation components of subjective task value:

- (1) attainment value;
- (2) intrinsic value;
- (3) utility value; and
- (4) cost.

Attainment value is personal importance of doing well with regard to self-schema and core personal values, such as achievement (Chiu and Wang, 2008; Mori and Gobel, 2006). Wigfield and Eccles (1992) argue that tasks will have higher attainment value to the extent that they allow the individual to confirm salient aspects of a learner's self-schema. A positive relationship between attainment value and continuance intention has been identified in, for instance, Mathematics, English studies as well as web-based courses studies (Meece *et al.*, 1990; Mori and Gobel, 2006; Chiu and Wang, 2008). Utility value is the extent to which individuals perceive the task relates to their current and future goals.

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It is self-evident that learning activities on a large-scale do not bring an instant reward, but more frequently, benefit the learner in the long run. In this regard, utility value posits to be a kind of extrinsic motivation which also has a major influence on students' learning behaviors (Chiu and Wang, 2008). Intrinsic value is the extent to which an activity is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated (Davis *et al.*, 1992). Intrinsic value is closely related to perceived entertainment, perceived enjoyment and perceived playfulness, and is widely applied to investigate people's perception of education innovation (Wang *et al.*, 2009; Chiu and Wang, 2008). As the process of learning may also bring a sense of pressure, it is necessary to make learning activities more enjoyable in order to be accepted. It is also reported that when the process is novel, interesting, enjoyable, exciting, and optimally challenging, students will be intrinsically motivated to pursue the learning activities. Cost refers to how the decision to engage in a learning activity limits access to other activities (e.g. playing a mobile game or talking to friends) (Wigfield and Eccles, 2000). It may also include emotional cost needed to accomplish the activity, such as fear of failure. A sense of isolation, anxiety, lack of personal contact, delay in responses and risk of arbitrary learning may contribute to the cost of distance learning based on the studies of Fozdar and Kumar (2007) and Chiu and Wang (2008). This theory has already been widely used in explaining learners' educational motivation and academic achievement in a number of studies (Eccles *et al.*, 1984; Eccles, 1987; Meece *et al.*, 1990; Mori and Gobel, 2006; Cole *et al.*, 2008). Eccles *et al.* (1983) and Wigfield and Eccles (1989) found that the components of the subjective task value can be used to predict students' intentions to carry out mathematics and English studies in traditional classroom education contexts. Testing the subjective task value of expectancy-value theory in web-based learning, Chiu *et al.* (2007) found that attainment value, utility value, and intrinsic value are significant variables to predict a learner's satisfaction and these variables further influence a learner's continuance intentions.

*3.3.2. Readiness for online learning.* The notion of readiness for online learning is first proposed by Warner *et al.* (1998). The theory focuses on the differences of personal attributes in influencing learners' academic performance and learning behaviors in online learning contexts. The theory is further developed and empirically studied by McVay (2000) and Smith *et al.* (2003), who yield two-factor structures to explain the personal attributes. According to their studies, the factors for understanding readiness for online learning include the "comfort with e-learning" and "self-management of learning". Self-management of learning refers to the degree to which an individual perceives he/she is self-disciplined and able to engage in autonomous learning (Smith *et al.*, 2003). When away from pre-designed learning environment which help to guide learners on their learning activities, a capability and willingness to take control of and self-manage their own learning is especially important for the success in distance settings. Indeed, the need for self-direction, or self-management of learning, runs clearly across the distance education and resource-based flexible learning literature (Smith *et al.*, 2003). Similarly, in m-learning contexts, learners are frequently socially and physically separated from both teachers and peer students, where learners themselves become in charge of their own learning. This initiates a strong requirement for learners to be able to self-manage their personal learning issues. McFarlane *et al.* (2007) point out that, the increased learner autonomy from m-learning posits a heightened requirement for appropriate capabilities of locating and evaluating resources, critical thinking,

and reflecting on their own learning. The research of Wang *et al.* (2009) found that learners with a higher level of self-management capability would more likely engage in m-learning activities. Also, self-directed learning is widely found to be a strong factor for predicting learners' academic success in a traditional classroom as well as in online learning contexts (Long, 1991; Hanna *et al.*, 2000).

The conceptual model is shown in Figure 1.

#### 4. Conclusion

Indeed, there has to date seldom any communication equipment used as popular as a mobile phone. It comes as no surprise that people are eager to find ways to apply these portable and personal handhelds for education purposes. Currently, m-learning has not reached its maximum potential and the gap between what is offered and what is used is apparent. Whilst digital learning materials of different formats are generally available, very limited use of it has been made by learners via mobile phones. Owing to the limited screen size and input difficulties, individuals may be reluctant to adopt this new education approach. Therefore, technology alone does not bring about m-learning, and the key success factor is to understand the concerns of learners and to identify the determinants which lead to learners' willingness to adopt m-learning.

However, it is a challenge to apply traditional adoption models in an m-learning context. For instance, Carlsson *et al.* (2006b, p. 8) argue that, TAM and unified theory of acceptance and use of technology (UTAUT) were developed to describe and explain IT innovation adoption in organizational contexts, "but the mobile technology adoption is more individual, more personalized and focused on the services made available by the technology". In addition, an m-learning user behaves as a learner instead of employee, and on the other hand, m-learning is a kind of education services, which is different from traditional services. Based on an extensive review of researches on m-learning, technology-mediated learning as well as mobile services, this paper offers a comprehensive, yet parsimonious model. It contributes to the growing literature on m-learning by grounding new theories and variables into well-established model (TAM)

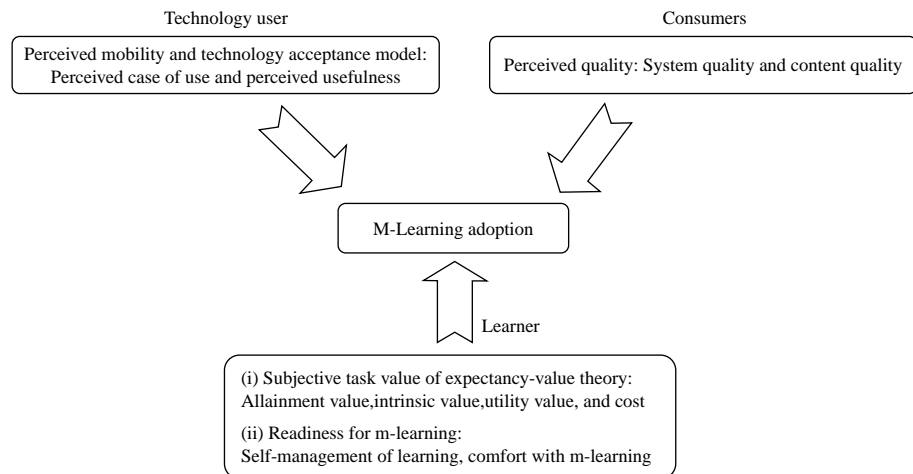


Figure 1.



and applying them to a new context of m-learning. It fills a gap by extending TAM to social contexts when technology user gains a new role – learner. Also, the paper provides several preliminary insights into the adoption of m-learning. It highlights the fact that the familiarity with and the adoption of mobile technologies *per se* does not guarantee the adoption of m-learning. To ensure a continuous and effective use of m-learning, promoting user's self-management capability of learning is essential, since it is learners themselves who are in charge of their own learning issues. Further, unlike most mobile services, m-learning does not always bring an immediate sense of gratification, but probably rewards a learner in the long term, hence the use of m-learning will depend on how learners value their education tasks. In addition, as mobile technologies and devices are used as a conduit to transmit training and education to the learner, the quality of learning materials delivered would affect the perceived quality of services as a whole. Hence, it is essential to increase the relevancy, timeliness, adequacy, and uniqueness of learning materials that are delivered. The proposed model provides a coherent framework for further empirical research. An empirical testing of the conceptual model would extend the boundaries of current theoretical foundations, and enrich our understanding of m-learning. This in turn would offer a set of possible guidelines for practitioners to promote the diffusion of m-learning.

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#### **Further reading**

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## **Research paper 6**

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# Exploring the Factors Driving M-Learning Adoption

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# Exploring the Factors Driving M-Learning Adoption

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## ABSTRACT

Mobile Learning (m-learning) is quickly spreading in many regions of the world. However, research addressing the driving factors for m-learning adoption is lacking. This study proposes a revised TAM by integrating perceived long-term usefulness and personal innovativeness. The adoption model was found to explain 60.8 percent of m-learning intentions based on 209 completed questionnaires. Perceived near-term/long-term usefulness and personal innovativeness are found to be significant motivators for m-learning adoption. The results in this study also suggest that, as most adoption theories are originated from a work-related context by employees, it is important to employ the construct of perceived long-term usefulness (the utility value) in adoption research when applied to education-related innovations.

## Keywords

M-learning, mobile learning, mobile services, TAM, long-term usefulness, technology adoption.

## INTRODUCTION

Along with a rapid proliferation of 3G mobile telephony, mobile learning (m-learning) has become a thriving research field. It is ushering us into a new era of training and learning. As Naismith et al. point out m-learning would enable a kind of 'highly situated, personal, collaborative and long term; in other words, truly learner-centered learning' (Naismith, Peter, Giasemi and Sharples, 2004, 36-36). In a similar way Sharma and Kitchens (2004) state, that the advent and subsequent development of mobile learning indicates a profound evolution from distance learning (d-learning) to electronic learning (e-learning) and then on to m-learning.

Nonetheless, recent research on m-learning reveals a new challenge as to how to promote the adoption of m-learning. In Attewell and Savill-Smith (2003, 2005), an important proportion of the learners did not show any preference for future use of m-learning at the end of the projects. A survey conducted by Corbeil and Valdes-Corbeil (2007) indicated that many students and education programs are still not ready for m-learning despite their familiarity with advanced mobile technologies. Based on a review of both current usability studies and two m-learning projects in UK, Kukulska-Hulme (2007) argued that m-learning activity continues to take place on devices which are not designed for educational use, and that usability issues are frequently reported. This is in line with the results of a series of large consumers studies (with a random sample of 1000 consumers and a response rate around 50%) of the use of mobile services carried out in Finland annually in 2002-2008 (cf. Bouwman, Carlsson and Walden (2008), Bouwman, Carlsson, Molina-Castillo and Walden (2007)). These studies show that consumers – as a general rule – do not use the technological features of advanced mobile phones but are satisfied with the traditional voice and SMS services. Maniar, Bennett, Hand and Allan (2008) suggest that there are many possible technological restrictions impeding m-learning adoption, such as small screen size, and poor screen resolution. However, research addressing the key motivators for m-learning acceptance is in short supply.

Further, as most of current IT adoption theories, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), are originated in work-oriented innovations, an examination of the validity of TAM concerning educational innovations is necessary. In this study, we include both long-term usefulness and personal innovativeness in the TAM to explain learners' intention to adopt m-learning. The rest of the paper is structured as follows: after a brief introduction of the current situation of m-learning development in the next section, a theoretical background and the research model are presented. This is followed by a detailed report on the results of the study and a discussion on a number of implications and possible conclusions. Finally, some limitations of this study are discussed.

## OUTLINE OF M-LEARNING DEVELOPMENT

Currently, m-learning is quickly spreading in many regions of the world with the support from both government and business communities. As personal phones are to a large degree the only effective approach to access marginalized citizens, m-learning posits to be a good method to tackle some difficult social problems in Europe. For instance, a pan-European project — m-learning<sup>1</sup> - funded by the European Commission has been run since 2001 for educationally disadvantaged young adults - such as dropouts and unemployed - to improve their literacy and numeracy skills. Many innovative m-learning applications have been implemented in European countries, in which a diversity of handhelds specially designed with m-learning functionalities have been offered in many tourist attractions locally, such as the Louvre Museum and the palace of Versailles. In the U.S., a recent report indicates that the tipping point for m-learning industry has been reached and that the market is growing fast (Adkins, 2008). According to the report from Ambient Insight (Adkins, 2008), despite the current economic crisis, the m-learning market reached \$538 million in 2007 and it will continue to develop at a five-year compound annual growth rate (CAGR) of 21.7%. Mobile device manufacturers, such as Apple, have a significant influence on the m-learning market. By February 2009, over 100,000 educational audio and video files supporting mobile learning are already available in iTunes U.

In China, the concept of m-learning started to become popular in 2005. Device manufacturers played a central role in offering m-learning products and services. A series of new phone models are specifically designed for m-learning. At the end of 2005, a domestic mobile manufacturer—Bird Corp., launched a marketing campaign with the theme of ‘learning in mobiles’ for selling its new mobile phones with a powerful English learning function. Well-known material for English study were included in Bird’s mobile phone, and more learning material can be downloaded to a memory card from its cooperating partners<sup>2</sup>. Bird sold 15 million mobile phones in the Chinese market in 2006, and has become one of the leading domestic mobile manufacturers in China (Yesky news, 2007). In September 2007, Nokia announced that the widely adopted BBC English teaching material will be included in its English learning service termed ‘Trip of Pioneers’. Nokia further launched an online learning platform to offer services for its mobile users, including Real English, Take Away English, Quizzes, and BBC’s other classic courses. In addition, a variety of m-learning courses are provided by Nokia, such as courses in management, golf, cooking, Yoga, health preserving and so on. Many of these courses are sold with a price of RMB¥ 2 per course. Currently, almost all mobile manufacturers, including Amoi, Lenovo, LG, OKWAP and GIGANYTE, are offering m-learning services in some of their products. A number of mobile manufacturers are marketing their m-learning enabled phones through advertisements in various media channels, particularly in influential TV channels.

## THEORETICAL BACKGROUND AND THE RESEARCH MODEL

Adoption of innovations has been intensively investigated by both researchers and practitioners of many disciplines, in which TAM appears to be one of the most widely applied models (Davis, 1989). The structures of TAM have been extended and examined in a diversity of mobile services, such as mobile chat (Nysveen, Pedersen and Thorbjørnsen, 2005), mobile credit card (Amin, 2007), mobile games (Ha, Yoon and Choi, 2007), mobile parking (Pedersen, 2005), B2C mobile commerce (Khalifa and Shen, 2008) and mobile ticketing (Mallat, Rossi, Tuunainen and Öörni, 2008). Concerning education, TAM has been used to investigate the antecedents affecting people’s behavioral intention in multimedia learning environments (Saadé, Nebebe and Tan, 2007) and e-learning (Lee, 2006; Ngai, Poonb and Chana, 2007). An extensive body of previous research has demonstrated the robustness and explanatory power of TAM in predicting the acceptance of various IT innovations.

TAM originates from the theory of reasoned action (TRA), and postulates that two beliefs (perceived ease of use and perceived usefulness) predict the attitudinal component of intention to use (Davis, 1989). User’s intention in turn is an effective predictor of the actual behavior itself. Perceived ease of use refers to the degree to which a user believes that using a particular service would be free of effort. Perceived usefulness is defined as the degree to which an individual perceives that using a particular system would enhance his or her job performance. Further, perceived usefulness is influenced by perceived ease of use.

Nonetheless TAM was met with some criticism as being a black box (Bouwman, Wijngaert and Vos, 2008), while the perceived usefulness construct suffers from being rather broadly based (Morre and Benbasat, 1991). Even if relative advantage is analogous to perceived usefulness, it has been criticized as being poorly explicated and measured (Tornatzky and Klein, 1982). Drawing from a review of IS and psychology literature, Chau (1996) argued that perceived usefulness in fact consists of two distinct aspects: near-term usefulness and long-term usefulness. He further found that both perceived

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<sup>1</sup> <http://www.m-learning.org/>

<sup>2</sup> [www.englishto.com](http://www.englishto.com)

near-term and long-term usefulness have significant impacts on the intention to use IT. Thompson, Higgins and Howell (1991) adopted the concept of near-term/long-term usefulness to analyze the adoption of personal computers. They proposed a construct of job-fit and defined it as “the extent to which an individual believes that using a technology can enhance the performance of his or her job”, which is similar to the perceived usefulness in TAM (Thompson et al., 1991, pp: 129). Meanwhile, they defined long-term consequences of use as ‘outcomes that have a pay-off in the future’ (Thompson et al., 1991, pp: 129). In their study, significant impacts of both structures on personal computer utilization were found as well (Thompson, Higgins and Howell, 1994). Regarding adoption of Internet at work, Chang and Cheung (2001) found that perceived near-term consequences have a significant positive influence on long-term consequences. In addition, perceived long term usefulness has been proposed or validated to be an important antecedent in studying a number of IS/IT innovations (e.g. Jiang, Hsu, Klein and Lin, 2000; Lu, Yu, and Yao, 2003).

Note that constructs analogous to perceived long-term usefulness are widely used in education research. Cole, Bergin and Whittaker (2008, pp: 316) defined usefulness as ‘the student’s perception that the task will be useful to meet some future goal’. Concerning math, English, science and social study, their empirical study suggest that if students don’t recognize usefulness of the exam they are being asked to complete, both their effort and test score will suffer (Cole, Bergin and Whittaker, 2008). Originated from the expectancy-value theory, utility value is similarly defined as the extent to which individuals perceive the task to be useful in the future (Eccles and Wigfield, 1995). It is self-evident that learning activities do not necessarily bring an instant reward, but tend to benefit a learner in the long run. Eccles and Wigfield (2002) stated that students may adopt a learning activity since it facilitates important future goals, even if they are not interested in the learning activity itself. In this regard, utility value (perceived long-term usefulness) posits to be a kind of extrinsic motivation which exerts significant influence on students’ learning behaviors (Chiu and Wang, 2008). In previous studies, utility value was found to significantly relate to intentions to attend graduate school (Battle and Wigfield, 2003) as well as intentions to continue mathematical study (Brush, 1980). In recent studies conducted by Chiu, Sun, Sun and Ju (2007), and Chiu and Wang (2008) on web-based learning continuance, utility value is found to be a significant variable driving educational IS/IT adoption (Chiu et al., 2007; Chiu and Wang, 2008). In a longitudinal study on IS in education settings, Mendoza, Carroll and Stern (2008) found that students may discontinue the use of IT if they can not perceive long-term benefits or are unable to resolve persistent issues. These studies suggest that perceived long-term usefulness should be a significant construct in predicting educational IT innovation adoption.

As TAM is initiated in an organizational context by employees to test work-related IT (Davis, 1989), it is essential to include a construct of perceived long-term usefulness into the model to explain the adoption of education-oriented innovations. Instead of offering instant rewards, m-learning tends to benefit learners in the future and in the long term. Learners would be more willing to accept m-learning when it complies with their future goals. This should give rise to a positive feeling of near-term usefulness. Therefore, we propose that a positive belief in long-term usefulness will also induce a positive feeling of perceived near-term usefulness. Based on previous research on TAM and perceived near-term/long-term usefulness, we have constructed the following hypotheses:

- H1:** Perceived ease of use positively relates to perceived near-term usefulness of m-learning.
- H2:** Perceived ease of use positively relates to behavioral intention to use m-learning.
- H3:** Perceived near-term usefulness positively relates to behavioral intention to use m-learning.
- H4:** Perceived long-term usefulness positively relates to perceived near-term usefulness of m-learning.
- H5:** Perceived long-term usefulness positively relates to behavioral intention to use m-learning.

In IS research, personal innovativeness refers to the degree to which an individual is willing to try out any new information technology (Agarwal and Prasad, 1998). Individuals with higher levels of personal innovativeness are more likely to develop positive beliefs towards new information technology than users with lower levels (Lu, Yao and Yu, 2005). Innovative users tend to be more venturesome and daring. Therefore, there are more possibilities for innovative users to adopt a new technology innovation though there is a high level of uncertainty in new IT adoption. In many studies, personal innovativeness has been found to be an important construct in understanding new IS/IT diffusion and usage intentions. Specifically, personal innovativeness is a positive predictor for perceived ease of use (Lu et al., 2005; Yi, Jackson, Park and Probst, 2006; Serenko, 2008), and behavioral intentions (Taylor, 2007; Crespo and Rodriguez, 2008). Additionally, in our research, a more innovative user is expected to be more likely to develop positive beliefs on m-learning, such as perceived long-term usefulness, as shown in Figure 1. Based on the above discussion on personal innovativeness, we proposed the following hypotheses:

- H6:** Personal innovativeness positively relates to perceived ease of use of m-learning.

H7: Personal innovativeness positively relates to perceived long-term usefulness of m-learning.

H8: Personal innovativeness positively relates to behavioral intention to use m-learning.

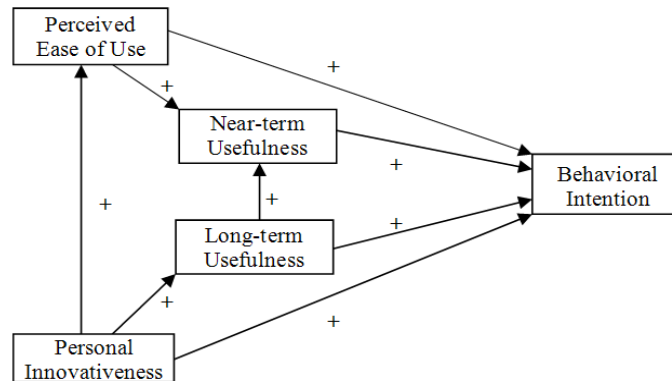


Figure 1. The Research Model

## RESEARCH METHODOLOGY

### Sample and Data Collection

As a majority of current m-learning services are targeted at university students, they accordingly will be our target group of study. In this regard, a sample was collected from undergraduate students in Zhejiang Normal University in China in November 2008. Students were invited to participate and complete the questionnaire in computer rooms after a brief introduction of our research purposes. Major websites offering m-learning products and services were introduced and made available to the students either through computers or their personal mobile phones before filling in the questionnaire. A total of 220 responses were collected from 230 participants resulting in a response rate of 95.7%. However 11 questionnaires were discarded as they were partially incomplete. The respondents consisted of 65 males and 144 females ranging from 18 to 23 years old. The demographic information of the respondents is shown in Table 1. Among the respondents, 93.3% have already used mobile phones for more than one year, and most of them (64.6%) use advanced mobile services at least once per week.

Demographic profile		Frequency	Percent (%)
Gender	Male	65	31.1
	Female	144	68.9
	Total	209	100
Length of time using a smartphone (years)	Less than 0.5	4	1.9
	0.5-1	10	4.8
	1-1.5	65	31.1
	More than 2	130	62.2
	Total	209	100
Frequency of using advanced mobile services (times per week)	Never	74	35.4
	1-5	71	34
	5-10	44	21
	More than 10	20	9.6
	Total	209	100

Table 1. Demographic Information of Participants

### Survey Instrument

The questionnaire was developed largely based on the scope and structure of previous research. A seven-point Likert-scale ranging from strongly disagree (1) to strongly agree (7) was used to measure each item. The scales for measuring perceived near-term usefulness (PNTU), perceived ease of use (PEOU) and behavioral intention (BI) were built on the instrument developed by Davis' (1989) and Chau's (1996), which have been widely validated in prior TAM research. The items for personal innovativeness (PI) came from that developed by Agarwal and Prasad (1998), while the items for perceived long-term usefulness (PLTU) were adapted from that developed by Chau (1996) and Eccles et al. (1983). Some modifications and rewording of the survey instrument were made to meet the requirements of the present study.

## Data Analysis

At first, principal components extraction with varimax rotation was performed to extract five factors with SPSS 15.0. The results indicate that all items fit their respective factors quite well. Also all the factor loadings are above the cutoff value (0.5) (Hair, Black, Babin, Anderson and Tatham, 2006). The Cronbach's alpha values ranged from 0.798 and 0.909, and all of them are over the 0.7 level, as described in Table 2. Then AMOS 7.0 were used to conduct confirmative factor analysis. The values of composite reliability (CR) and average extracted variance (AVE) satisfy the cutoff value 0.6 and 0.5 respectively, thereby demonstrating good internal consistency (Fornell and Larcker, 1981). The square root of AVE of all constructs are greater than the correlation estimate with the other constructs (see Table 3). This shows that each construct is more closely related to its own measures than to those of other constructs, and discriminant validity is supported (Fornell and Larcker 1981).

Items	Factors extracted					Cronbach's alpha	Standardized Factor Loading	CR	AVE
	1	2	3	4	5				
PNTU1	.306	.730	.031	.144	.290	.863	.802	0.865	0.680
PNTU2	.235	.825	.141	.030	.224		.832		
PNTU3	.301	.855	.070	.134	.045		.840		
PEOU1	.163	-.010	.819	.075	.213	.861	.727	0.867	0.687
PEOU2	.122	.106	.873	.215	.026		.892		
PEOU3	.090	.140	.856	.234	.043		.858		
PLTU1	.788	.374	.044	.212	.079	.909	.856	0.910	0.717
PLTU2	.792	.219	.208	.103	.196		.805		
PLTU3	.815	.314	.082	.141	.201		.902		
PLTU4	.818	.158	.194	.073	.258		.820		
PI1	.273	.012	.315	.709	.243	.798	.836	0.832	0.630
PI2	.218	.119	.208	.819	.257		.925		
PI3	.003	.134	.114	.827	-.033		.580		
BI1	.282	.367	.187	.129	.778	.867	.878	0.867	0.765
BI2	.361	.213	.126	.252	.780		.871		

Table 2. The Measurement Model

Variables	Mean	SD	PNTU	PEOU	PLTU	PI	INT
PNTU	4.63	1.33	<b>0.825</b>				
PEOU	5.32	1.24	0.254	<b>0.829</b>			
PLTU	4.68	1.27	0.627	0.351	<b>0.847</b>		
PI	4.64	1.31	0.324	0.463	0.405	<b>0.794</b>	
BI	4.80	1.37	0.585	0.368	0.635	0.455	<b>0.875</b>

Table 3. Correlation Matrix and Discriminant Assessment

(The bold items on the diagonal represent the square roots of the AVE, off-diagonal elements are the correlation estimates.)

## Results

The chi-square value for this model is significant ( $\chi^2$  of 165.605 with 82 degrees of freedom,  $p < 0.001$ ). In addition, five different fit statistics are measured, including the root mean square error of approximation (RMSEA), the goodness-of-fit index (GFI), the adjusted GFI (AGFI), the normed fit index (NFI), Tucker-Lewis index (TLI) and the comparative fit index (CFI). These model fit indices (GFI of 0.905, AGFI of 0.860, NFI of 0.922, CFI of 0.959, TLI of 0.948 RMSEA of 0.7) all satisfy the recommended guidelines, and suggest that our research model presents a good fit to the data, as shown in Table 4.

Model Fit Indices	$\chi^2/df$	GFI	AGFI	NFI	CFI	TLI	RMSEA
Recommended value	< 3	> 0.9	> 0.8	> 0.9	> 0.9	> 0.9	< 0.8
Obtained	2.020	0.905	0.860	0.922	0.959	0.948	0.700

Table 4 Model Fit Indices

The findings provide significant support for all the hypotheses, except for H1 (PEOU→BI,  $\beta = 0.063$ ,  $p > 0.5$ ) and H2 (PEOU→PNTU,  $\beta = 0.054$ ,  $p > 0.5$ ). Perceived long-term usefulness is the most influential factor motivating m-learning acceptance ( $\beta = 0.356$ ,  $p < 0.001$ ). Perceived near-term usefulness is the second important variable causing m-learning

adoption ( $\beta = 0.306, p < 0.001$ ). Personal innovativeness significantly affects behavioral intention ( $\beta = 0.233, p < 0.01$ ), perceived long-term usefulness ( $\beta = 0.501, p < 0.001$ ) as well as perceived ease of use ( $\beta = 0.537, p < 0.001$ ). Additionally, perceived long-term usefulness significantly impacts the perceived near-term usefulness ( $\beta = 0.694, p < 0.001$ ). The proposed adoption model explains 60.8% of adoption intention, while perceived long-term usefulness account for 50.5% of perceived near-term usefulness. In addition, personal innovativeness interprets 28.8% and 25.1% of perceived ease of use and perceived long-term usefulness respectively. The results are shown in Figure 2.

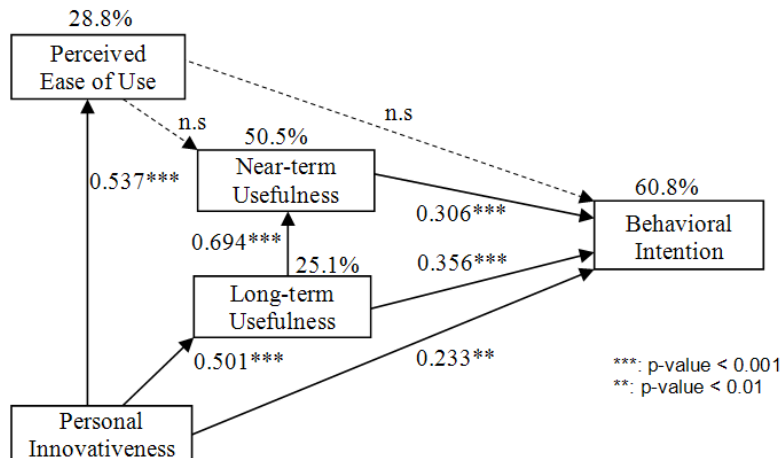


Figure 2. The Results

## IMPLICATIONS AND CONCLUSION

The results from our study indicate that the adoption of m-learning is different from that of traditional IS/IT. For learners, the usefulness of m-learning in improving their learning performance is strongly related to their expectation on the future. It is crucial to convince learners that adopting m-learning would reward them in the long run or in the future. Even if perceived near-term usefulness also significantly relates to behavioral intention, 50.5 percent of the perceived near-term usefulness can still be explained by the perceived long-term usefulness. It can be concluded that, perceived near-term usefulness is largely originated from a positive perception of long-term usefulness. Hence, it is suggested that an improvement of perceived long-term usefulness is the key to the success of m-learning, as it will promote the near-term usefulness perceived as well as the intention to use.

In consistence with previous research on perceived innovativeness, a learner who is more innovative will more possibly adopt m-learning. Additionally, personal innovativeness accounts for 28.8 percent of perceived ease of use and 25.1 percent of perceived long-term usefulness. These indicate that personal traits influence learners' decisions on m-learning acceptance. Innovative learners tend to be the early adopters of m-learning. Consequently, it would be more effective to push m-learning services to innovative users at early stages of the diffusion of m-learning methods and technology.

The perception of ease of use doesn't motivate the use of m-learning. The results of the study indicate, that among all the latent variables measured, the value of perceived ease of use is much higher than other variables ( $PEOU = 5.32$ ), as shown in Table 3. It somewhat indicates a general perception that m-learning is easy to use. In contrast to previous research, technology restrictions seem not to induce significant usability problems impeding m-learning adoption. It should largely be attributed to the efforts from both mobile manufacturers and learning content designers. In the Chinese market, a number of phone models are specially designed for m-learning purposes, therefore the passive influence of technological restrictions, such as a small screen size and cumbersome input routines, can to a great extent be alleviated. In addition there are widespread efforts to design learning software and materials suitable for handheld usage. As a result, the ease of use factor is widely accepted among students in which shows up in the study as an insignificant impact on the intention to use m-learning. To some extent, the results also suggest that an inclusion of mobile device manufacturers in the provision of m-learning products is a practical and flexible method to build a prospering m-learning market, and it will help to tackle possible technological restrictions in relation to perceived ease of use.

Traditional TAM constructs, including PEOU and PNTU, were not found as important as they were in previous TAM research. Specifically, there are no significant paths from PEOU to PNTU, and neither the path from PEOU to BI. Also,

PNTU is not the most important motivator compared with PLTU. The study indicates that adoption of IS/IT for education purposes is quite different from the adoption of IS/IT for business purposes. As TAM is initiated from studying work-related innovations, extra attention is required when it is applied to educational IS/IT contexts. More research in this regard is needed.

Taking the previous studies on education adoption research into account, perceived long-term usefulness (the utility value) should be an important construct in predicting educational IS/IT adoption. The validity of this structure has been validated in both traditional classroom based learning and technology-mediated learning, such as e-learning and m-learning. In this light, it is proposed that, in future research on IS/IT for education purposes, scholars should pay enough attention to the impact of perceived long-term usefulness.

## LIMITATIONS

As all research, there are some limitations in this study that should be considered. First, the study only measures the intention to use m-learning, and actual usage is not included. Second, this study focused on education-oriented m-learning products, therefore the results should not be generalized to the m-learning systems for communication or administration purposes. Third, as the sample was collected from undergraduate students in China, this should be taken into consideration when the results are applied to m-learning users in different age groups or with other cultural backgrounds.

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## **Research paper 7**

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## Factors driving the adoption of m-learning: An empirical study

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### ABSTRACT

Even if m-learning is spreading rapidly in many regions of the world, research addressing the driving factors of m-learning adoption is in short supply. Built on the Technology Acceptance Model, this paper proposes a hypothesized model of m-learning adoption. Employing structural equation modeling technology, the model was assessed based on the data collected from 230 participants using a survey questionnaire. Results indicate that perceived near-term/long-term usefulness and personal innovativeness have significant influence on m-learning adoption intention, while perceived long-term usefulness significantly affects the perceived near-term usefulness. Personal innovativeness is a predictor of both the perceived ease of use and perceived long-term usefulness as well. Of all variables, the perceived long-term usefulness contributes to the most influential predictor of m-learning adoption. The model accounts for approximately 60.8% of the variance of behavioural intention. The results indicated that offering high-quality contents complying with students' future targets is key to the success of m-learning in China. Both theoretical and practical implications are discussed.

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### 1. Introduction

The tipping point for the m-learning industry has probably been reached (Adkins, 2008). Despite the current economic recession, the m-learning industry is growing rapidly in many regions of the world, typically so in the US and China. According to a report from Ambient Insight (Adkins, 2008), the m-learning market in the US reached \$538 million in 2007, and it will continue to develop at a five-year compound annual growth rate (CAGR) of 21.7%. In China, offering m-learning services appears to be a new marketing strategy for mobile manufacturers to attract customers and to generate new revenue. Currently, m-learning is increasingly used in museums, workplaces and classrooms for learners inside or outside the formal education systems, such as dropouts and the unemployed, enabling a wide spectrum of educational possibilities (e.g. Attewell, 2005).

Despite the fast development of the m-learning industry, there is a lack of understanding on the factors driving m-learning adoption. Note that, other than educational institutions, business communities, such as Nokia, start to play a central role in offering m-learning devices and services in many regions, such as in China. This is expected to bring some new features to m-learning industry development in China. In this context, a survey was conducted of undergraduate students in a Chinese university to investigate learners' intention to use m-learning. In the paper, an adoption model for m-learning was proposed and then evaluated, which adds two additional ingredients to the Technology Acceptance Model (TAM)—perceived long-term usefulness and personal innovativeness.

An important theoretical undertaking endeavour of the present paper is to validate TAM in the contexts of m-learning. TAM is one of the most widely used theories in studying the adoption of IT innovations and new information systems (Davis, 1989). However, studies show that TAM excels regarding productivity-oriented (or utilitarian) systems, but the motivators to system usage may vary greatly depending on the nature of system use (van der Heijden, 2004). For instance, when TAM is applied to the adoption of pleasure-oriented (or hedonic) systems, perceived usefulness is found to lose its dominant predictive power in favour of perceived enjoyment (van der Heijden, 2004). Similarly, in the context of knowledge-acquisition-oriented (or educational) systems, there is some concern as to whether the structure of TAM would remain robust.

As a result the paper sought to answer two key research questions. (i) Given that mobile manufacturers are leading m-learning development in China, what are the key factors motivating students' intention to use m-learning? (ii) Will TAM remain robust in the context

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of m-learning in comparison with two additional structures? An investigation into the two research questions in the current study would help to identify the most influential factor of m-learning adoption, and probably of educational information systems adoption.

This paper is organized as follows. In the next section, we briefly introduce the m-learning development in China and its potentials and challenges faced. Then, theoretical background and the research model are presented, which is followed by a detailed report on the results of the study. Thereafter, results are discussed with a number of implications and conclusions. Finally, limitations of this study and implications for future studies are discussed as well.

## 2. Related research

### 2.1. M-learning in China

Since 2005, the ideas and concepts of m-learning started to become popular in China, in which mobile manufacturers played a central role in offering m-learning products and services. At the end of 2005, Bird Corp (a domestic mobile manufacturer) launched a marketing campaign with a theme of 'learning in mobiles' for selling its new mobile phones with powerful English learning functions. Well-known material for English study was included in Bird's mobile phone and more learning material could be downloaded to a memory card from its cooperating partner ([www/wap.englishto.com](http://www/wap.englishto.com)). After a successful initiation of the m-learning concept in 2005 and 2006, nearly all mobile manufacturers, including Nokia, Amoi, Lenovo, LG, OKWAP and GIGANYTE, to some extent, started to offer m-learning products and services. For instance, in September 2007, Nokia officially announced its cooperation with the BBC in the m-learning field. A number of well-known BBC English teaching modules were then included in Nokia's new mobile English Language Teaching (ELT) platform ([www/wap.mobilededu.cn](http://www/wap.mobilededu.cn)), including Real English, Take Away English, Quizzes and other BBC classic courses. Today, a wide spectrum of m-learning courses in management, golf, cooking, Yoga, health preserving, etc. are available from the platform as well. Some of these sophisticated courses are sold with a price of 2 RMB (approximately .3 USD) per course, which gives a new source of revenue. M-learning platform tends to be a built-in function for a wide spectrum of mobile phones. For instance, Nokia m-learning platform is embedded in most of recent Nokia phones. English to m-learning platform is embedded in a number of domestic mobile phones in China as well. In basic education, a series of new handheld digital learning devices has been developed especially for m-learning use by companies such as Noah Ltd. According to the prediction of the China Market Intelligence Center (CMIC), 7 million portable electronic learning products will be sold in the Chinese market in 2010 (CMIC, 2009). Along with this, a variety of advertisements were launched in various media to persuade customers to purchase m-learning devices in 2007 and 2008, particularly by influential TV channels.

### 2.2. Potentials and challenges faced

M-learning can be defined as 'the acquisition of any knowledge and skills through the use of mobile technology, anywhere, and anytime' (Geddes, 2004, p. 1). It is ushering us into a new era of training and education. For companies, mobile learning helps reduce the traditional training infrastructure, facilitates the learning process of employees and improves their productivity and effectiveness whilst on the move (e.g. Grohmann, Hofer, & Martin, 2005; Donnelly, 2009). On campus, mobile learning provides a useful mechanism to enrich students' learning experience. It facilitates the collaboration and informal interaction between peer students, which is helpful in building social capital and in motivating disengaged or at-risk students (Naismith, Peter, Giasemi, & Sharples, 2004; Sharma & Kitchens, 2004). It adds a new dimension for student-instructor interaction and a positive attitude among the students towards the instructor and learning (Vogel, Kennedy, Kuan, Kwok, & Lai, 2007; Pei-Luen, Gao, & Li-Mei, 2006; Grohmann et al., 2005). In addition, m-learning contributes to improving the accessibility, interoperability and reusability of educational resources, and to enhancing interactivity and flexibility of learning at convenient times and places (Murphy, 2006). It extends learning opportunities to all social-economic levels, in particular those previously unreachable from traditional education approaches, such as school dropouts (Attewell, 2005). As Naismith et al. pointed out, m-learning would enable a sort of 'highly situated, personal, collaborative and long-term (learning); in other words, truly learner-centered learning' (Naismith et al., 2004, p. 36). In a similar way, Sharma and Kitchens (2004) suggested that the advent and subsequent development of mobile learning indicates a profound evolution from distance learning (d-learning) to electronic learning (e-learning) and then on to m-learning.

In spite of tremendous potential, there are a number of challenges to the adoption of m-learning. The studies of Attewell (2005) and Attewell and Savill-Smith (2003) showed that an important proportion of the learners did not show any preference for future use of m-learning at the end of the projects. A survey conducted by Corbeil and Valdes-Corbeil (2007) indicated that many students and education programmes are still not ready for m-learning in spite of their familiarity with advanced mobile technologies. This is in line with the findings of a series of large consumers studies (with a random sample of 1000 consumers and a response rate of around 50%) of the use of mobile services annually carried out in Finland in 2002–2008 (cf. Bouwman, Carlsson, Molina-Castillo, & Walden, 2007, Bouwman, Carlsson, & Walden, 2008). These studies show that consumers – as a general rule – do not use the technological features of advanced mobile phones but are satisfied with the traditional voice and SMS services. As a kind of new advanced mobile service, there is, therefore, a need to find out the factors driving m-learning adoption.

## 3. Theoretical background and the research model

### 3.1. TAM

Among all the adoption theories, TAM enjoys an excellent reputation with regard to its robustness, parsimony and explanatory power (Davis, 1989). TAM is rooted in the social psychology theory of reasoned action (TRA) (Ajzen & Fishbein, 1980). TRA postulates that beliefs affect attitude, which influences intention, while intention in turn brings about behaviours. TAM adopts this belief-attitude-intention-behaviour relationship and posits that users' IT acceptance is a function of two cognitive beliefs: perceived ease of use and perceived usefulness (Davis, 1989). Perceived ease of use refers to the degree to which a user believes that using a particular service would be free of effort. Perceived usefulness is defined as the degree to which an individual perceives that using a particular system would enhance his or her

job performance (Davis, 1989). Further, perceived usefulness is influenced by perceived ease of use. TAM describes how work-related IT innovations are adopted by employees for their work and their office routines. The key constructs of TAM have been tested, refined and extended in various contexts since the original publication (Li, Qi, & Shu, 2008; Legris, Ingham, & Colletette, 2003), which has resulted in a robust adoption model in particular for utilitarian systems.

Nonetheless, recent research shows that the nature of system use offers an important boundary condition to the validity of TAM when applied to, for instance, pleasure-oriented (or hedonic) systems (van der Heijden, 2004). In hedonic systems, perceived usefulness in TAM may not be as effective a predictor as it is in utilitarian systems (van der Heijden, 2004). Concerning IS, with both utilitarian and recreational potentials, Chesney (2006) and Childers, Carr, Peck, and Carson (2001) found that perceived usefulness and perceived enjoyment are of both predictive values to system adoption. In hedonic systems, the study of van der Heijden (2004) suggested that perceived enjoyment outperforms perceived usefulness in predicting technology acceptance. In some extreme hedonic cases, such as mobile games, perceived usefulness is found to completely lose its predictive power in favour of perceived enjoyment (Ha, Yoon, & Choi, 2007). These studies indicate a need to validate TAM for the adoption of systems for other than utilitarian reasons, such as for education, which is the focus in the present study.

### 3.2. Perceived (near/long-term usefulness) usefulness

Furthermore, there is some criticism of the perceived usefulness structure, such as it being rather broadly based (Moore & Benbasat, 1991). Analogous to perceived usefulness, relative advantage, which is derived from the Innovation Diffusion Theory, has been criticized as being poorly explicated and measured as well (Tornatzky & Klein, 1982). Based on a review of IS and psychology literature, Chau (1996) argued that perceived usefulness in fact consists of two distinct aspects: near-term usefulness and long-term usefulness. These two structures were found to have significant impacts on the intention to use IT (Chau, 1996). Thompson, Higgins, and Howell (1991) adopted the concept of near-term/long-term usefulness to study the acceptance of personal computers. They developed a construct of job-fit and defined it as 'the extent to which an individual believes that using a technology can enhance the performance of his or her job', which is analogous to the perceived usefulness in TAM (Thompson et al., 1991, p. 129). Meanwhile, they defined long-term consequences of use as 'outcomes that have a pay-off in the future' (Thompson et al., 1991, p. 129). In their study, both structures were found to have significant impacts on personal computer utilization as well (Thompson, Higgins, & Howell, 1994). Regarding Internet adoption at work, Chang and Cheung (2001) stated that perceived near-term consequences significantly and positively influence long-term consequences. Additionally, perceived long-term usefulness has been proposed or validated to be an important motivator for the acceptance of a number of ICT innovations (e.g. Jiang, Hsu, Klein, & Lin, 2000; Lu, Yu, & Yao, 2003).

Constructs analogous to perceived long-term usefulness have been widely used in education research as well. For instance, in a study by Cole, Bergin, and Whittaker (2008, p. 316), usefulness is defined as 'the student's perception that the task will be useful to meet some future goal'. Concerning math, English, science and social studies, their study found that if students don't recognize the usefulness of the exam they are being asked to complete, both their effort and test results will suffer (Cole et al., 2008). Similarly, Eccles and Wigfield (1995) proposed a structure of utility value and defined it as the degree to which individuals perceive the task to be useful in the future. This structure is derived from expectancy value theory of motivation as a key component of task value, which is famous in studying students' motivation (Eccles & Wigfield, 1995). Eccles and Wigfield (2002) stated that students may adopt a learning activity since it facilitates the attainment of important future goals, even if they lack interest in the learning activity for its own sake. Mori and Gobel (2006) indicated that enabling Japanese students to get a job, travel overseas and live aboard in the future are important sources of utility value for them to do the English study. In this regard, utility value represents a kind of extrinsic motivation, which exerts significant influence on students' learning behaviours (Chiu & Wang, 2008). Also, previous studies indicated that utility value is a significant predictor of learners' intentions to attend graduate school as well as to continue mathematical studies (Battle & Wigfield, 2003; Brush, 1980). Concerning educational IT innovations, such as web-based learning, utility value is also found to be a significant factor impacting learners' intentions (Chiu, Sun, Sun, & Ju, 2007; Chiu & Wang, 2008). In a longitudinal study on IS in educational settings, Mendoza, Carroll, and Stern (2008) suggested that students may discontinue the use of IT if they can not perceive long-term benefits or are unable to resolve persistent issues. Note that an educational system can have both near-term usefulness and long-term usefulness for students at the same time. Chiu and Wang (2008) indicated that improving learning performance, effectiveness and productivity represent students' perceived performance expectancy (perceived near-term usefulness), while getting a job, a salary raise or a job promotion are sources of utility value (perceived long-term usefulness) of continuously using a web-based learning system. Both constructs are found to be significant predictors of students' behavioural intention (Chiu & Wang, 2008).

As TAM is initiated in enterprise contexts to test how productivity-oriented IT is adopted by employees (Davis, 1989), it does not consider the long-term rewards of using a system, as in education, to a great extent. It is, therefore, essential to include a construct of perceived long-term usefulness in TAM to explain the adoption of educational IS innovations. Instead of offering instant rewards, educational IS innovations, such as m-learning, tend to benefit learners in the future and in the long term. When it complies with their future goals, students would be more likely to accept m-learning. This should raise a positive feeling of near-term usefulness. Based on previous studies of TAM and perceived near-term/long-term usefulness, we constructed the following hypotheses:

- H1: Perceived near-term usefulness positively relates to behavioural intention to use m-learning.
- H2: Perceived long-term usefulness positively relates to perceived near-term usefulness of m-learning.
- H3: Perceived long-term usefulness positively relates to behavioural intention to use m-learning.
- H4: Perceived long-term usefulness is a stronger predictor of m-learning intention than perceived near-term usefulness.

### 3.3. Perceived ease of use

Ease-of-use issues have long been considered an important factor affecting m-learning adoption in literature. Wang, Wu, and Wang (2009) stated that there are several challenges facing m-learning, such as connectivity, limited processing power and reduced input capabilities. Maniar, Bennett, Hand, and Allan (2008) suggest that many possible technological restrictions impede m-learning adoption, such as small

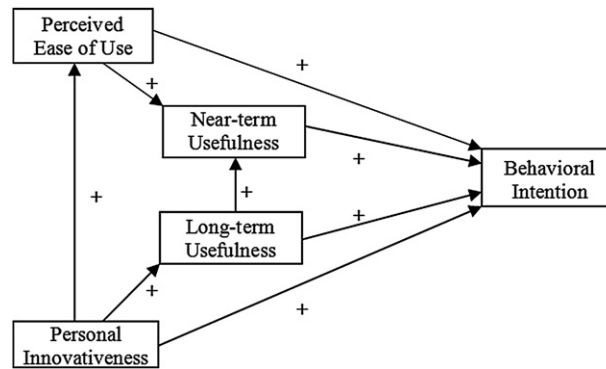


Fig. 1. Research model.

screen size and poor screen resolution. Drawing from a review of both current usability studies and two m-learning projects in the UK, Kukulska-Hulme (2007) argued that m-learning activity continues to take place on devices which are not designed for educational use, and that usability issues are frequently reported. In this light, Wang et al. (2009, p. 93) pointed out that 'these (technological) challenges mean that adapting existing e-learning services to m-learning is not an easy work, and that users may be inclined to not accept m-learning'. In other words, these studies indicate that learners would be more willing to use m-learning, if they find that the technology can be easily used.

In TAM literature, perceived ease of use has long been found to be a significant behaviour predictor in a long list of IS studies. Specifically, in two literature reviews on TAM (Li et al., 2008; Legris et al., 2003), perceived ease of use is found to be a significant predictor of perceived usefulness and behavioural intention; these findings are, in fact, supported by most IS literature. Considering both TAM and m-learning literature, we, therefore, proposed the following hypotheses:

H5: Perceived ease of use positively relates to perceived near-term usefulness of m-learning.

H6: Perceived ease of use positively relates to behavioural intention to use m-learning.

### 3.4. Personal innovativeness

In IS research, personal innovativeness refers to individuals' willingness to try out any new information technology (Agarwal & Prasad, 1998). Individuals with higher levels of personal innovativeness are more inclined to develop positive beliefs on new IS innovations compared with those with lower levels (Lu et al., 2005). As innovative users tend to be more venturesome and daring, they are more likely to adopt a new technology innovation despite a high level of uncertainty in new IT adoption. A growing set of IS literature indicates that personal innovativeness is an important construct in understanding new IS/IT diffusion and usage intentions. Specifically, personal

**Table 1**  
Demographic information of participants.

Demographic profile	Frequency	Percent (%)
Gender		
Male	65	31.1
Female	144	68.9
Total	209	100
Length of time using a smartphone (years)		
Less than .5	4	1.9
.5–1	10	4.8
1–1.5	65	31.1
More than 2	130	62.2
Total	209	100
Frequency of using advanced mobile services (times per week)		
Never	74	35.4
1–5	71	34
5–10	44	21
More than 10	20	9.6
Total	209	100
Experience		
No answer	1	.5
I do not know what m-learning is and never used it before	91	43.5
I know what m-learning is, but never used it before	88	42.1
I know what m-learning is and used it before	29	13.9
Total	209	100



**Table 2**  
The measurement model.

Items	Factors extracted					Cronbach's alpha	Standardized factor loading	CR	AVE
	1	2	3	4	5				
PNTU1	.306	<b>.730</b>	.031	.144	.290	.863	.802	.865	.680
PNTU2	.235	<b>.825</b>	.141	.030	.224		.832		
PNTU3	.301	<b>.855</b>	.070	.134	.045		.840		
PEOU1	.163	-.010	<b>.819</b>	.075	.213	.861	.727	.867	.687
PEOU2	.122	.106	<b>.873</b>	.215	.026		.892		
PEOU3	.090	.140	<b>.856</b>	.234	.043		.858		
PLTU1	<b>.788</b>	.374	.044	.212	.079	.909	.856	.910	.717
PLTU2	<b>.792</b>	.219	.208	.103	.196		.805		
PLTU3	<b>.815</b>	.314	.082	.141	.201		.902		
PLTU4	<b>.818</b>	.158	.194	.073	.258		.820		
PI1	.273	.012	.315	<b>.709</b>	.243	.798	.836	.832	.630
PI2	.218	.119	.208	<b>.819</b>	.257		.925		
PI3	.003	.134	.114	<b>.827</b>	-.033		.580		
BI1	.282	.367	.187	.129	<b>.778</b>	.867	.878	.867	.765
BI2	.361	.213	.126	.252	<b>.780</b>		.871		

innovativeness is a significant predictor for perceived ease of use (Lu et al., 2005; Yi, Jackson, Park, & Probst, 2006; Serenko, 2008), and behavioural intentions (Taylor, 2007; Crespo & Rodriguez, 2008). Based on personal innovativeness literature, we expected that innovative learners would be the forerunners of m-learning usage and are more likely to develop positive beliefs on m-learning, such as perceived long-term usefulness (Fig. 1). Hence we proposed the following hypotheses:

H7: Personal innovativeness positively relates to perceived ease of use of m-learning.

H8: Personal innovativeness positively relates to perceived long-term usefulness of m-learning.

H9: Personal innovativeness positively relates to behavioural intention to use m-learning.

#### 4. Research methodology

##### 4.1. Survey instrument and sample

In order to assess the research model, a questionnaire was designed to collect data. The scales used in the questionnaire were largely built upon the scope and structure of previous studies. Six constructs were measured based on seven-point Likert-scales ranging from strongly disagree (1) to strongly agree (7). The measures for perceived near-term usefulness (PNTU), perceived ease of use (PEOU) and behavioural intention (BI) were adapted from instruments developed by Davis (1989) and Chau (1996). The items for personal innovativeness (PI) were developed based on the study of Agarwal and Prasad (1998), while the items for perceived long-term usefulness (PLTU) were adapted from that developed by Chau (1996) and Eccles et al. (1983), as shown in Appendix A. Some modifications and rewording of the survey instrument were made to meet the requirements of the present study.

As most of current m-learning services are focused on university students, they accordingly became the target group of the study. The sample was collected from undergraduate students in Zhejiang Normal University in China in November 2008. Students were invited to participate and complete the questionnaire in computer rooms. After a brief introduction of survey purposes, major websites offering m-learning products and services were then introduced, such as [wap/www.english.to.com](http://wap/www.english.to.com) and [wap/www.mobiledu.cn](http://wap/www.mobiledu.cn). The m-learning materials for language study are quite popular among these websites. Students were asked to visit the websites either via desk computers or their personal mobile phones before actually filling in the questionnaire. The use of desk computers facilitated students to have a fast view of m-learning materials available. Desk computers were also used to facilitate downloading of the materials and transforming them to students' mobile phones for later use on their mobile phone. This phenomenon is popular among Chinese students regarding mobile phone usage, because of its advantage of avoiding downloading cost through the use of wireless Internet. In this way, we believed that more students would be possible to trial m-learning on their phones. Note that these m-learning materials can not be opened on a desk computer while they can only be opened in mobile phones with corresponding platform as mentioned in Section 2.1.

A total of 220 responses were returned from 230 participants giving a response rate of 95.7%. Eleven questionnaires were discarded due to being only partially completed. One questionnaire, which only has no answer on the question about experience, was included in analysis as well. The respondents consisted of 65 males and 144 females between 18 and 23 years old. The descriptive statistics of the sample are

**Table 3**  
Correlation matrix and discriminant assessment.

Variables	Mean	SD	PNTU	PEOU	PLTU	PI	INT
PNTU	4.63	1.33	<b>.825</b>				
PEOU	5.32	1.24	.254	<b>.829</b>			
PLTU	4.68	1.27	.627	.351	<b>.847</b>		
PI	4.64	1.31	.324	.463	.405	<b>.794</b>	
BI	4.80	1.37	.585	.368	.635	.455	<b>.875</b>

The bold items on the diagonal represent the square roots of the AVE, off-diagonal elements are the correlation estimates.

**Table 4**  
Model fit indices.

Model fit indices	$\chi^2/df$	GFI	AGFI	NFI	CFI	TLI	RMSEA
Recommended value	<3	>.9	>.8	>.9	>.9	>.9	<.08
Obtained	2.020	.905	.860	.922	.959	.948	.07

shown in Table 1. Among the respondents, 93.3% have already used mobile phones for more than one year while most of them (64.6%) use advanced mobile services at least once per week. Most respondents (56%) have already known what m-learning is before the survey, and 13.9 percent of them have even used m-learning before.

#### 4.2. Data analysis and results

Convergent validity indicates the extent to which the measure of a construct that is theoretically related is also related in reality. Convergent validity can be evaluated using three criteria suggested by Fornell and Larcker (1981): (1) all indicator factor loadings should be significant and exceed .7, (2) construct reliabilities should exceed .80, and (3) average variance extracted (AVE) by each construct should exceed the variance due to measurement errors for that construct. AVE should exceed .5 (Fornell & Larcker, 1981).

Principal components extraction with Varimax rotation was first conducted to extract five factors using SPSS 15.0. The results show that all items fit their respective factors quite well. All the factor loadings are above the threshold of .7. As described in Table 2, the Cronbach's alpha values range from .798 to .909, which are all over the .7 level. Confirmative factor analysis was then conducted using AMOS 7.0. The composite reliability values (CR) and average extracted variance (AVE) of all the constructs satisfy the recommended level of .8 and .5 respectively, thereby indicating good internal consistency (Fornell & Larcker, 1981).

Discriminant validity can be verified with the square root of the average variance extracted for each construct higher than any correlation between this construct and any other construct (Fornell & Larcker, 1981). As shown in Table 3, the square roots of AVE of all constructs are greater than the correlation estimate with the other constructs. This reveals that each construct is more closely related to its own measures than to those of other constructs, and discriminant validity is, therefore, supported in this study (Fornell & Larcker, 1981; Table 4). Model fit indices are available in Table 4.

#### 4.3. Structural model assessment and hypothesis testing

Fig. 2 gives a graphical description of the results including path coefficients and variances explained. Against expectations, perceived ease of use has no significant influence on both perceived near-term usefulness (PEOU  $\rightarrow$  PNTU,  $\beta = .054$ ,  $p > 0.5$ ) and behavioural intention (PEOU  $\rightarrow$  BI,  $\beta = .063$ ,  $p > 0.5$ ), which indicates that hypotheses 5 and 6 are not supported. Consistent with hypotheses 1 and 3, both perceived long-term usefulness ( $\beta = .356$ ,  $p < 0.001$ ) and perceived near-term usefulness ( $\beta = .306$ ,  $p < 0.001$ ) have significant impacts on m-learning adoption. Furthermore, perceived long-term usefulness significantly influences the perceived near-term usefulness ( $\beta = .694$ ,  $p < 0.001$ ). Hence, the total effect<sup>1</sup> of perceived long-term usefulness ( $\beta = .568$ ) is much higher than that of perceived near-term usefulness ( $\beta = .306$ ). This supports our hypothesis that perceived long-term usefulness is a stronger predictor than perceived near-term usefulness. Note that perceived long-term usefulness accounts for 50.5% of the variance of perceived near-term usefulness. Additionally, personal innovativeness was found to significantly relate to behavioural intention ( $\beta = .233$ ,  $p < 0.001$ ) as well as perceived ease of use ( $\beta = .537$ ,  $p < 0.001$ ). Personal innovativeness interprets 28.8% and 25.1% of the variances of perceived ease of use and perceived long-term usefulness respectively. In total, the proposed adoption model explains 60.8% of the variances of adoption intention.

## 5. Implications and conclusion

### 5.1. Key findings and managerial implications

The results specify three significant motivators of m-learning acceptance, which are perceived near/long-term usefulness and personal innovativeness. Note that even if perceived near-term usefulness is a significant predictor of use intention, 50.5 percent of perceived near-term usefulness can still be interpreted by the perceived long-term usefulness. In other words, students' perception of near-term usefulness is mainly derived from a positive feeling of long-term usefulness. In practice, we tend to interpret this finding as follows: previous studies suggested that m-learning is of great usefulness in promoting learning productivity by using previously unproductive time, such as travelling and commute time (e.g. Geddes, 2004; Corbeil & Valdes-Corbeil, 2007); however, offering students the m-learning content with long-term usefulness will be the key reason to persuade them to utilize this unproductive time for learning purposes. Content is king.

Of these factors, perceived long-term usefulness is found to be the strongest determinant of use intention. Hence, an improvement of perceived long-term usefulness is the key to the success of m-learning, as it will promote both the near-term usefulness perceived as well as the usage intention. This is in line with the phenomenon that m-learning for language-studying purpose is popular in China, as language capability is important for university students in China in their pursuit of advancement in studies and in their future work. Specifically, there are language requirements when applying for Master and Ph. D positions in China, or when applying for a good work position or study abroad. For designers, this finding suggests that, to facilitate the adoption of m-learning, it is important to offer students the m-learning content that is useful for their future lives, in other words, with long-term benefits. There are three possible methods to realize this, including that (i) the topics of the m-learning course offered should be well selected, that comply with students' long-term objects, such as career development, job promotion, or have the potential to benefit learners in their future daily lives, such as cooking or health preserving;

<sup>1</sup> Total effect = direct effect (.356) + indirect effect (.306  $\times$  .694).

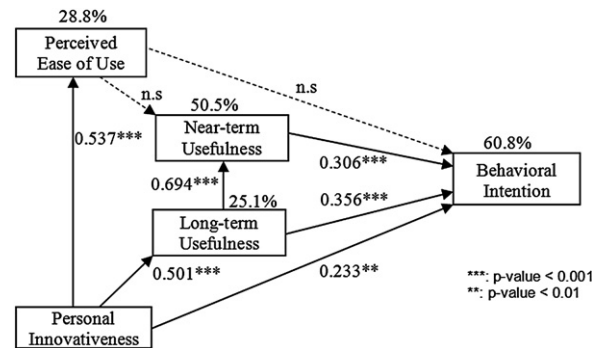


Fig. 2. The results.

(ii) students should be well informed about the long-term benefits of an m-learning course, in particular when introducing the course; (iii) an m-learning course should offer practical ways for students to practice the knowledge learnt in specific real-life or work situations, convincing students that the knowledge will be useful sometime in the future.

Consistent with previous studies of personal innovativeness (e.g. Taylor, 2007; Crespo & Rodriguez, 2008), innovative learners would more possibly develop positive beliefs on new IT, which appears as positive feelings about long-term usefulness. Also, innovative individuals would be more inclined to use m-learning. This shows that personal traits have a significant impact on learners' intentions to adopt m-learning. In this regard, it would be a more effective strategy to push m-learning services to innovative users at the early stage of the introduction of m-learning methods and technology.

In contrast to previous studies (e.g. Li et al., 2008; Legris et al., 2003), a perception of ease of use has no significant effect on m-learning intention. Note that among all the latent variables measured, the mean value of perceived ease of use is much higher than other variables (PEOU = 5.32), as shown in Table 3. It indicates, to some extent, a general feeling that m-learning is easy to use. Contrary to popular belief in m-learning literature, technological restrictions seem not to induce significant usability problems inhibiting m-learning adoption. This should largely be attributed to the efforts from both mobile manufacturers and learning content designers. In the Chinese market, a number of devices are specially designed for m-learning purposes; hence, the negative impact of technological restrictions, such as a small screen size and cumbersome input routines, can, to a large degree, be alleviated. Also, there are widespread efforts to design learning software and materials in a manner suitable for handheld usage. As a result, the feeling of ease of use is broadly perceived among students, which shows up in the study as an insignificant predictor of m-learning intention. To some extent, the results also indicate that an inclusion of mobile device manufacturers in the provision of m-learning products is a practical and flexible strategy to establish a prosperous m-learning market, and this will help to tackle possible technological restrictions in association with perceived ease of use.

## 5.2. Theoretical implications

The present study also made several contributions to the IS literature. Based on an integration of the findings from IS and education literature, the paper systematically presents the conception of perceived long-term usefulness. Also, significant influences from personal innovativeness to perceived long-term usefulness and to perceived near-term usefulness were found for the first time, at least in m-learning.

Traditional TAM constructs, including perceived ease of use and perceived (near-term) usefulness, were not found as robust as they were in previous TAM studies. Specifically, there are no significant paths from perceived ease of use to perceived (near-term) usefulness, and neither the relationship from perceived ease of use to behaviour intention. In particular, perceived (near-term) usefulness is not the most dominant motivator in comparison with perceived long-term usefulness. The research indicates that the adoption of educational IS innovations is also different from that of utilitarian IS innovations. As TAM is initiated from studying work-oriented innovations, extra attention is required when it is applied to educational systems contexts. For instance, an inclusion of perceived long-term usefulness might be a good alternative to build a sound adoption model in studying the acceptance of educational information systems.

Moreover, the results support the hypotheses that perceived long-term usefulness is a stronger determinant of intention to use an education IS than perceived (near-term) usefulness. Explicitly, perceived usefulness loses its dominant explanatory power in favour of perceived long-term usefulness. In concert with research on hedonic systems (van der Heijden, 2004), the findings suggest that the nature of system use is an important boundary condition to the validity of the TAM. Accordingly more attention should be given to the important role of system purpose: when the purpose of a system is educational rather than utilitarian, the predictive power of the determinants will be different. Also, it is suggested that perceived long-term usefulness for educational systems should be as important as perceived usefulness for utilitarian systems, and perceived enjoyment for hedonic systems. A classification based on the nature of systems purpose (utilitarian, hedonic or educational) would contribute to a better understanding of the essence of IT innovation adoption.

Finally, taking the previous studies on both education and IS into account, perceived long-term usefulness (the utility value) should be an important factor in predicting the adoption of educational system. The validity of this factor has been verified in both traditional classroom-based learning and technology-mediated learning, such as web-based learning (e.g. Chiu & Wang, 2008) and m-learning in the present study. Hence, it is proposed that, in future research on educational IS, scholars should pay attention to the impact of perceived long-term usefulness.

## 6. Limitations and implications for future studies

As with all research, we acknowledge some limitations in this study that should be considered. First, the study only considered the intention to use m-learning, while actual usage is not included. Second, this study focused on education-oriented m-learning products; thus,

the results should not be applied to the m-learning systems for communication or administration purposes. Third, as the survey was based on undergraduate students in China, the results should not be generalized to m-learning users in different age groups or with other cultural backgrounds. Finally, more female students than male students were willing to take part in the survey. So the sample may somewhat over-represent the female group, even if ANOVA revealed no significant difference in all constructs between two gender groups. Hence, it might be helpful if further research could be conducted to investigate the m-learning adoption of users from different age groups and culture backgrounds and for different purposes, such as administration purposes. Note that, adoption is just a first step of m-learning success; there is also a need to find out how to make the use of m-learning methods and technology continuous.

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## Appendix A measurement indicators

### Perceived near-term usefulness

PU1: I think using m-learning can increase the efficiency of my studies and work. PU2: M-learning is useful for my studies. PU3: I think using m-learning can increase the effectiveness of my studies.

### Perceived ease of use

PEOU1: I think learning to use m-learning is very simple. PEOU2: It would be easy for me to become skilful at using m-learning. PEOU3: I think using m-learning is easy.

### Personal innovativeness

PI1: I like to experiment with new information technology. PI2: If I heard about a new information technology, I would look for ways to experiment with it. PI3: Among my peers, I am usually the first to try out new information technology.

### Perceived long-term usefulness

PLTU1: Using m-learning helps me to gain success in the future. PLTU2: Using m-learning benefits me in the long run. PLTU3: Using m-learning helps me to realize my future target. PLTU4: Using m-learning benefits me in the future.

### Behavioural intention

BI1: I intend to use m-learning in the future. BI2: I believe I will use m-learning in the future.

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