EMPIRICAL RESEARCH ON MOBILE LEARNING DIFFUSION FACTOR BASED ON MRT THEORY AND INTERNET INTERACTION CHARACTERISTICS: A CASE STUDY OF STUDENTS IN CHINA'S HIGHER EDUCATION INSTITUTIONS

BY

Mr. Wei Meng

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Researcher	Wei Meng
Program	Doctor of Philosophy (Education Management)
Principle Supervisor	Dr. Ren-Cheng ZHANG
Co-Supervisor	

Has been approved by

..... Chairman of the Committee
(Dr. Poschanan Niramitchainont)

..... Committee Examiner
(Dr.Yuan-Cheng CHANG)

..... Committee Examiner
(Dr. Hsuan-Po Wang)

..... Committee Examiner
(Dr. Renee Chew Shiun Yee)

..... Principal Supervisor
(Dr. Ren-Cheng ZHANG)

Approved by the DPU China-ASEAN International College

..... ~~Dean of~~ China-ASEAN International College
Dr.Chun-Shuo Chen

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Author: Wei Meng

Dissertation Principle Supervisor: Dr. Ren-Cheng ZHANG

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ABSTRACT

The aim of this study is to propose a theoretical model to explain the higher education environment factors that influence the learners use mobile learning. The survey sample selected three universities with regional and level representation in China. An expanded UTAUT2 theoretical model was proposed to explain the main factors influencing for the adoption of using mobile learning. our study showed that perceived credibility，para-social relationship, media richness and compatibility were proved to be the important external extension variable in the UTAUT model. Additionally, tests of moderated effects indicated that learners with high level of personal innovativeness pay more attention to perceived credibility in the process of m-learning. Based on the previous studies, this paper discussed the influence of mobile education in higher education and puts forward some suggestions.

Keywords: M-learning, Performance Expectancy, Effort Expectancy, Compatibility, Media Richness, Para-social Relationships, Personal Innovativeness

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CHAPTER 1

INTRODUCTION

This chapter is to explain the background and motivation, the purpose, the problems and the significance of this research, to clarify the meaning of the nouns related to the research topics.

1.1 Rationale and significance of research

With the development of information technology, Internet has brought significant change to education, more and more colleges and universities in the form of Internet education teaching this kind of change management and organization is not only reflected in the breakthrough time and space, also make the mobile education is becoming more flexibility and diversity of mobile learning is defined as a form of e-learning, it inherits the many advantages of e-learning (Wagner, 2005; Cheng, 2015). Many scholars combine mobile learning with u-learning (Ebner, Stickel, Scerbakov, & Holzinger, 2009; Yahya, Ahmad, & Abd Jalil, 2010; Pimmer, Mateescu, & Gröhbiel, 2016). It is suggested that mobile and ubiquitous learning activities can be highly diverse, provide different educational qualities, and depend on and interact with complex social systems and situational influences. At present, mobile learning has become a new digital learning method, which has gradually attracted the attention of scholars at home and abroad (Huang & Ou, 2018). With the development of ICT,

learning in informal environment has been paid more and more attention by scholars. Recent mobile learning research has highlighted new models of connected social learning and research design around the possibilities of digital tools (Cook & Santos, 2016). With the development of cognitive computing, the process of simulating human activity or thought in computer models is maturing (D. S. Modha, 2011). Essentially, it involves self-learning systems that use data mining and machine learning techniques to solve specific problems (Shorfuzzaman, Hossain, Nazir, Muhammad, & Alamri, 2019). With the application of 5G technology, high-speed data communication is possible, improving the learning experience through a variety of learning content types, from simple videos and files to possible interactive collaborative learning games, thus making the personalized and adaptive learning experience more available and reliable (Leligou , Zacharioudakis, Bouta , & Niokos, 2017).

Currently, the number of course activities that students can complete using mobile devices is still very limited.Many students are not aware of the advantages of mobile learning and are reluctant to access course materials via mobile devices.In addition, many teachers are not ready to prepare course content for mobile learning. Therefore, in order to take advantage of this new approach to education, we are eager to know the key factors in the acceptance of mobile learning (Li, 2020). Next, the theoretical basis and background of this research will be elaborated in detail with the following contents.

1.1.1.The value and significance of mobile learning research in the context of higher education.

Mobile learning is defined as a form of e-learning, which inherits many advantages of e-learning. However, with the development of wireless technology, mobile learning can further expand the flexibility of e-learning (Cheng, 2015). With the rapid development of mobile technology and the growth of mobile phone users, mobile applications have had a profound impact on people's study life and social contact. Higher education is a particularly suitable place to integrate student-centered mobile learning, as mobile devices have become ubiquitous on university campuses (Cheon, Lee, Crooks, & Song, 2012). However, the results of using mobile learning do not always meet the expectations of some educational institutions(Aburub & Alnawas, 2019). Many researchers believe that the drivers of willingness to use mobile learning remain unexplored. The education market sees mobile devices as a technology that could affect learning, and previous research has predicted that in the near future, mobile devices will be heavily used to support learning in both formal and informal environments. However, certain other conditions must be met for mobile devices to be effectively integrated into the educational environment, such as universities (Hao, Dennen, & Mei, 2017). Today, not only people can obtain information from a mobile device and learning resources, but also make mobile education special period must rely on effective teaching resources. For example, during the quarantine of novel coronavirus in the spring semester of 2020, about 270

million students in China needed to go to school through online platforms under the requirement of the ministry of education to suspend classes, which led to a surge in the number of users of online education platforms, CCTV reported. According to big data, the average daily activity of Chinese learning apps increased by more than 100% during the Spring Festival.According to data released on the UNESCO website on March 13, COVID 19 has affected 421 million children and young people in 39 countries and regions, including 354.5 million from preschool to high school and 66.88 million from higher education. During the school closure due to the outbreak, UNESCO recommended a list of apps and platforms for parents, teachers and schools to use, with nailing as the preferred platform for live video conferencing and collaborative team communication (unesco, 2020). Mobile education has become the main means of maintaining the normal teaching order in most colleges and universities.Therefore, the combination of formal education and informal education has become the new normal for colleges and universities to ensure normal teaching order, enrich teaching resources and expand teaching methods.

Crompton and Burke (2018)'s systematic review of research shows that there are many positive benefits to using mobile devices in informal research. Further research should focus on the use of mobile devices in informal environments to explore the significance of mobile learning in these situations. In addition, previous studies have shown that mobile learning has not yet been explored in all subject areas. It is important for teachers in higher education to make data-based decisions when

using mobile learning in the classroom, and it is important to explore all subject areas and branches in order to provide this information. Based on the characteristics of mobile learning system, the factors affecting learners' adoption behavior have been proved in many empirical studies. But, previous studies were more based on the background of K-12 educational environment (Liu *et al.*, 2014). These studies are valuable, but many have regional limitations, and since m-learning is not conducted in a vacuum, it is important to understand the factors and variables that affect the effectiveness of use and successful implementation of m-learning (Crompton & Burke, 2018). The results of a systematic review of relevant studies show that research in the field of mobile learning is fragmented and heterogeneous, based on the understanding of individual researchers (Alrasheedi, Capretz, & Raza, 2015).

At present, the research field of mobile learning in higher education has begun to expand (fully), and relevant scholars have even confirmed the potential of MGBL in helping students achieve learning goals, and emphasized its role in the effectiveness, efficiency and satisfaction of learners in the higher education environment(Troussas, Krouska, & Sgouropoulou, 2020).

Therefore, it is of certain timeliness and application value to study the relevant factors affecting the effectiveness of mobile learning in higher education under the new network environment.

1.1.2.The value and significance of mobile learning application research in the context of ICT dynamic development.

In education, primary and secondary schools, universities and life-long learning education organizations use the latest advances in information and communication technology (ICT) to facilitate the teaching process and improve learning outcomes (Ramirez et al., 2018; Crompton & Burke, 2018). These include the development of educational web environments and mobile applications, and the use of personal computers and mobile devices as learning tools (Troussas *et al.*, 2020). Unlike previous technology, mobile technology developing at an unprecedented speed in the past few years due to the dynamic development of mobile technology and rapidly changing, mobile learning research also need to update from the early SMS technology in the application of mobile learning, to support u-learning mobile Internet technology, mobile learning research areas continue to expand (Yengin, Karahoca, Karahoca, & Uzunboylu, 2011; Pimmer *et al.*, 2016). In order to make the interface more natural, the development of u-learning system is considering advanced user interface technologies such as augmented reality wearable computing technology and multi-mode interface (Yoo, Kwon, & Lee, 2016). In various types of mobile learning scenarios, the analysis strategy needs to understand the learner's communication mode and the specific interaction between the learner and the learning content.

With 5G technology mature, related researchers according to the survey, 5G technology is expected to significantly improve mobile learning, because it

effectively meet the needs of high-priority users, define efficient learning scenario for teacher/trainer provides more abundant means 5G technology support, performance and high data rate affect state related data communication possible, thus promotes the availability and reliability of learning experience of personalized and adaptive scholars pointed out that 5G mobile network will provide suitable for mobile AR/VR infrastructure, and increase support and implementation of the touch of the Internet AR/VR technology used in education over the past 10 years, at the same time, the sense of touch the Internet can introduce a new method of interactive education, allowing students to interact with the remote object touch 5G these technologies will be applied to all kinds of education under the network environment, and develops the content of research in the field of ICT, such as students and education workers to participate in different laboratory experiments or remote project cooperation. For different specialties, remote performance and practice are also useful. A low-latency network environment will ensure accurate synchronization of audio, video, and tactile interactions. The popularity of smart mobile devices suggests that in the near future, all these educational activities can be conducted on mobile devices (Sukhmani, Sadeghi, Erol-Kantarci, & Saddik, 2019). This means that mobile learning will be increasingly rich in content and channels, enabling a more personalized learning experience through a variety of learning content types, from simple video and file sharing to Mobile Game-Based Learning (MGBL). 5G will provide educators with a wealth of tools to enable unprecedented new learning solutions, meet the needs of

learners and trainers, and make learning more enjoyable and efficient than ever before.

With the continuous development of ICT technology, the theory of media richness has been continuously enriched and expanded. According to Media Richness Theory (MRT), face-to-face interactions are the richest (Daft & Lengel, 1986). Because of its ability to provide immediate feedback, including the use of multiple cues and natural language, plain text is the least rich mode of interaction. Research based on the traditional MR theory only considers the type of content (such as text, audio, video or combination of these). For the relatively new e-learning technology, research in media richness (MR) field should give more new content, such as mobile learning (Yoo et al., 2016). Fulk (2007) attempted to integrate new ICT such as email into the MRT hierarchy and concluded that the new ICT were not as rich as traditional media (Illia & Lawson-Body, 2007). But other studies have shown that the new ict offers a wealth of forms that MRT does not take into account when compared to traditional media (Rice, 1993). For new mobile learning functions (such as mobile VR, AR and touch interaction, etc.) , will be more help learners understand the message, which MR rich theory through the virtual learning environment create a face-to-face interaction is an important characteristic of mobile learning need to implement, compared with the traditional electronic learning systems, mobile learning system by technical means such as audio and video interaction VR, AR and tactile interaction and instant feedback system design provides more face-to-face interaction. Thus, with

the development of ICT technology, new mobile Internet technologies are embedded in the e-learning environment, which enhance the richness of mobile learning media and enrich the interaction of mobile learning (Yoo *et al.*, 2016). Therefore, in this study, the concept of technology richness refers to a new richness discovered with the development of new ICT.

1.1.3.research background based on the limitations of mobile learning research

After more than 20 years of mobile learning research, there is still a lack of systematic knowledge, especially the application of mobile technology in different educational designs and the relevant educational effects in the higher education environment (Pimmer *et al.*, 2016). Previous studies have shown that mobile learning programs are the largest in Asia and that developing countries place more emphasis on mobile learning programs than developed countries (Alioon & Delialioglu, 2015). However, previous studies lack mobile learning models and frameworks based on empirical studies in developing countries (Hsu & Ching, 2015).

While some researchers surveyed students about mobile learning, they assessed their perceptions of mobile learning Chen (2018), Chintalapati and Daruri (2017),Troussas *et al.* (2020), these studies focused on students' personal impressions of specific mobile applications or mobile learning systems. In addition, the results of these studies do not reflect the unique psychological characteristics of learners. Research shows that the success of technology system implementation depends not only on other factors, but also on individual differences. Alrasheedi *et al.* (2015)

reviewed 30 studies from 2005 to 2013 and their analysis identified 14 key factors that strongly influenced the implementation of mobile learning. Their findings suggested that the most critical factor for success is whether students are aware that their learning efficiency has improved through mobile learning (Alrasheedi, Capretz, & Raza, 2015). Thus, perceived credibility is an important factor to study the effectiveness of mobile learning.

In the previous researches on mobile learning, there are few researches investigating the teaching methods used in mobile learning (Crompton & Burke, 2018). Consider that mobile devices are a tool that aims to improve student achievement, and pedagogy is how the tool achieves that goal (Crompton, 2013). This is a problem of concern, and no more research has been done in this area. Meanwhile, most of the study of mobile learning in colleges and universities study was conducted in a traditional classroom environment because mobile devices are born with portability, related study system data show that further research should focus on the use of mobile devices in an informal environment, to explore in the case of mobile learning (Crompton & Burke, 2018). With the development of mobile technology, the mobile education network environment has changed at the same time that the teacher-student relationship and the organizational form of teaching have also changed dramatically. College students are formally or informally integrating social media into their learning experience. In addition, university teachers are increasingly using social media to support teaching activities (Dabbagh & Kitsantas, 2012).

Combined with the characteristics of the current development of mobile Internet, mobile learning in colleges and universities pay more attention to the use of online social media and education system, the combination of formal and informal learning integrated into education or education method in the higher education environment of many colleges and universities have begun to study design about mobile education teaching method, in Jakarta, Indonesia, for example, the design of mobile learning model, of the university of what makes the focus of the learning is not learned, but how to let students experience the learning process, that is, the method of material and organizational goals.The method of the course and how to manage the learning, through mobile learning to create learning scenarios, learning period will lead students to autonomous learning full learning network and active learning(Lestari, Maksum, & Kustandi, 2019). In this context, in order to reflect the personal characteristics and psychological characteristics of learners in the process of participating in mobile learning, this study combines the theory of para-social relationships (PSR) with personal innovativeness (PI) to study the psychological identity of students in the process of mobile learning. Para-social relationships (PSR) was originally studied in the field of mass media, but it has also been found to be an important and relevant concept in the exploration of social media (Munnukka, Maity, Reinikainen, & Luoma-aho, 2019). Research shows that the success of technology system implementation not only depends on other factors, but also depends on personal innovativeness (Turan, Tunç, & Zehir, 2015). personal innovativeness has

also been termed as ‘innate innovativeness’ (Hirschman, 1980), or ‘innovative predisposition’ (Midgley & Dowling, 1978), The innovation involved in this study refers to the innovation in the field of information technology, so it is defined as the willingness of individuals to try any new information technology (Agarwal & Prasad, 1998). Individual innovation ability has been tested not only in innovation diffusion research Rogers (2002, 2005), but also in the field of information systems (Agarwal & Prasad, 1998). It plays an important role in determining the outcome of user acceptance of the technology (Mun, Jackson, Park, & Probst, 2006).

To sum up, with the development of mobile technology, the change of mobile education network environment brings space for the development and reform of higher education. The goal of using mobile technology in education is to expand and enhance student learning (Crompton & Burke, 2018). In the process, combination of formal and informal education, social media and education system. Previous studies on mobile learning are mostly conducted in the context of formal education (Taleb and Sohrabi 2012; Spiegel and Rodríguez 2016; Criollo-C et al. 2018). The research process may be constrained by majors’ characteristics and teachers’ technology. The respondents are mainly undergraduates who use mobile devices, and the definition of the application environment of mobile learning is vague. Therefore, it is of practical value and significance to carry out applied research on mobile learning under the background of dynamic development of ICT.

1.2 Objectives of research

Previous studies have not neglected the application of ICT technology characteristics in mobile learning, but the research IS not comprehensive and lacks certain timeliness compared with the traditional IS/IT. In previous literature on the role of ICT characteristics in empirically explaining learners' acceptance of mobile learning, variables such as students' cognitive, emotional and personal creativity were examined separately from technical characteristics (Aburub & Alnawas, 2019; Cheng, 2015; Hamidi & Chavoshi, 2018). Therefore, this study developed a hybrid model to explore the effectiveness of mobile learning. In order to make a comprehensive analysis of students' cognitive emotions in the context of the development of new ICT technology by combining technical characteristics and teaching methods, this study used media richness theory (MRT) Daft & Lengel (1986) to design relevant research variables. In order to fully understand the real attitude of students' interactive experience in mobile learning, the research was carried out in combination with the para-social relationship theory (PSR) Horton and Wohl (1956); In order to build a bridge between students' cognitive emotion and the adoption of mobile learning system, innovation diffusion theory (IDT) Rogers(2003) was adopted to expand the unified theory of acceptance and use of technology model (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). At the same time, in order to truly integrate personal characteristics into the research of technical acceptance model, the external expansion

variables of the model are designed in combination with personal creative characteristics. It is of theoretical and practical significance to carry out empirical test from these four theoretical aspects.

Based on the above statement, the purpose of this study was to combine media richness theory and social relations theory, will extend the UTAUT model combined with the theory model of IDT, to test can reflect the characteristics of the learners' cognitive emotion and individual antecedent of media richness feature para-social relations, and personal creativity is influenced by their willingness to use a mobile learning.

This study aims to propose a new theoretical model to explain the influencing factors of mobile learning in the context of higher education in China. This study uses quantitative research methods to explain the factors influencing mobile learning in higher education under the new network environment. In the quantitative research stage, according to the experience of the previous studies, this paper proposes a new theoretical model in this model, around the characteristics of mobile learning system and learners' learning and interaction. This paper discusses the influence of mobile learning the elements in this model, around the mobile learning system technology and interaction characteristics and the process of learning and teaching method, using the elements of affecting mobile learning is discussed. According to the extended UTAUT mobile learning model, the differences of different majors in mobile learning were compared. In this process, we will study and analyze

the new interactive relationship formed in the learning process of different majors brought by the current innovative form of mobile education. Finally, on the basis of previous researches, the research results of the two parts of this study are discussed, and the influence and Suggestions of the application of mobile education in the higher education environment in China are put forward.

Compared with traditional education, mobile education has certain particularity. Due to diverse population characteristics, learning cycle, uncertainty of learning environment, and different needs of applied professional knowledge, learners of mobile learning education have different characteristics in different time and regions.Therefore, in order to make the content of this study representative and of regional application value, this study first needs to investigate and describe the current situation and characteristics of mobile learning in China.

In general, the purpose of this study has the following aspects. Firstly, in order to carry out research on the specific situation in the process of mobile learning of Chinese college students, the current situation of mobile learning in China is investigated and described. Second, in the process of research, a model of influencing factors of new mobile education which can combine pedagogy education with new information and communication technology is established. This study will examine whether the UTAUT2 model based on IDT extension is valid in the current research on the influencing factors of mobile learning in China, and whether the compatibility, media richness, para-social relationship as an external variable has a positive impact

on the adoption of mobile learning. Thirdly, whether para-social relationships mediate the relationship between perceived media richness and perceived credibility in mobile learning; Whether perceived credibility can affect the effectiveness of mobile learning in the dynamic process, and how does it affect the effectiveness of learning under the joint action of perceived performance and perceived efforts？ Fourth, the study also tested whether the effects of the mediation mechanism would be contingent on the students' innovativeness. We propose a structural model with mediation, which illustrates the relationship between each influencing factor and the potential role of regulation in mobile learning. That is: how do Chinese college students perceive influencing factors in the process of mobile course learning affect the learning effectiveness, In which case the adoption of mobile learning will be greater. Lastly, multiple group analysis was made on the difference of influencing factors of mobile learning in different majors by using the expansion model, it further proves the theoretical value of the research model and makes the research have practical significance. The research process and method of theoretical discussion model design in this study will be designed and carried out around these problems.

1.3 Benefits to be derived from the research

1.3.1 From the perspective of theoretical research, the benefits of this research process can be seen：

At present, new information technology is constantly updated and applied in the field of education, thus speeding up the development of mobile education in the process of higher education. At the same time, there are also some problems that need to update the existing mobile learning models and methods. So the theoretical benefits of this study are as follows: (1) In the model of studying the influence factors of mobile learning in higher education, what kind of model can combine the relationship between pedagogy and education with the new information and communication technology? (2) With the development of mobile Internet technology, mobile education presents the characteristics of diversity and richness. Based on these characteristics, what are the opportunities and challenges for the application of mobile learning in higher education? (3) with the popularization of mobile education, will the relationship between teachers and students in colleges and universities change accordingly? How to establish a reasonable and effective teacher-student relationship in mobile education environment by using the theory of para-social relations? (4) As adopters in the diffusion process of mobile education innovation, after the popularization of ICT, will students' individual innovation ability still have an important impact on the adoption of mobile education?What are the specific aspects?

Based on previous studies, this study will discuss the results of quantitative and qualitative research, and finally put forward the influence and Suggestions of mobile learning in higher education environment.

1.3.2.Benefits of this research in teaching management practice:

In order to carry out more comprehensive research, the research scope covers mobile learning in formal education and informal education. This is an explanatory study that conducts quantitative surveys on the scale and geography of students at three representative universities in China, and tracks typical respondents purposefully based on the results of quantitative studies to explore these results in greater depth.Through the research, we will gain the following benefits in the application and management of mobile education in colleges and universities：Firstly, under the development trend of mobile education in higher education, the existing research models and methods are discovered and updated； Second, in the context of the integration of social media and mobile education, mobile learning is carried out in the form of formal education and informal education. Facing the relevant influencing factors correctly, a harmonious and orderly teacher-student relationship and a teaching organization form suitable for mobile learning will be established. Thirdly, based on the diversity and richness of mobile education, the opportunities and challenges of using mobile learning in higher education will be found. Fourth, as the adopters in the diffusion process of mobile education innovation, after the popularization of innovative technology, how should students exert their individual innovation ability to

have a continuous positive impact on the mobile learning process? By solving the above problems, people can have a deeper understanding of the factors that influence the spread of mobile education in higher education, and have a more detailed theoretical understanding of the teaching effects of different mobile learning arrangements.

CHAPTER 2

LITERATURE REVIEW

This research aims at propose a theoretical model to explain the higher education environment factors that influence the learners use mobile learning. In the quantitative research stage, an expanded UTAUT2 theoretical model was proposed based on the media richness theory to explain the main factors influencing the adoption of this learning style in the mobile learning environment. In this model, external factors are conceptualized as a combination of media richness, compatibility, para-social relationships and personal innovativeness.

In order to untangle the connotation of this research theme, the author will review and organize the literature about independent variable, moderating variable, mediating variable and dependent variable.

2.1. Research on mobile learning in higher education

The definition of mobile learning is that learners acquire information anytime and anywhere through mobile technology and conduct real learning activities in the learning environment (F. Martin & Ertzberger, 2013). With the continuous development of information technology, more and more innovative e-learning systems have been developed as an innovative e-learning system. Mobile learning enables

learners to receive education through portable electronic devices anytime and anywhere. It is also an ubiquitous learning system (u-learning) (Ebner et al., 2009; Yahya et al., 2010; F. Martin & Ertzberger , 2013). With the development of information technology, mobile education has become more flexible and diversified. Many scholars combine mobile learning with u-learning (Ebner et al., 2009; Yahya et al., 2010 ; Pimmer et al., 2016). Therefore, the in-depth understanding of this emerging phenomenon requires not only the consideration of quantitative research, but also the choice of qualitative and mixed research methods for research design (Pimmer et al., 2016).

In the SCI document library, mobile learning, mobile education, mobile teaching and mobile learning were searched and repeated articles irrelevant to this research were eliminated, and finally more than 5,000 valid articles were obtained. From 2012 to 2019, the number of papers published on mobile learning has been on the rise, with a particularly rapid growth in 2017-2018. The main research areas are: mobile learning platform of learning resources mobile library and development technology mobile learning application environment and application population (Crompton & Burke, 2018).

Relevant scholars have conducted a systematic review of the literatures in the field of mobile learning from 2005 to 2015, and found that mobile learning has always been considered to be mainly used in the K12 environment rather than in higher education, and the overall scale of mobile learning project is small (Alioon &

Delialioglu, 2015). In recent years, with the development and maturity of mobile Internet technology, mobile learning, as a special learning mode, has attracted more and more attention from academic and practical circles. Many years ago, scholars mentioned that, with the popularity of mobile devices on college campuses, higher education was regarded as a gathering place for student-centered mobile learning (Cheon *et al.*, 2012). Scholars have noted the advantages of higher education environments in mobile learning environments, with more than half of mobile learners coming from higher education environments (W.-H. Wu *et al*., 2012).

With respect to higher education, some authors expect mobile learning to fundamentally transform the field by providing new strategic practice tool applications and resources to deliver on the promise of ubiquitous personalized and connected learning (Wagner, 2005). Relevant scholars have systematically reviewed and analyzed the application of mobile learning in higher education, and found that the main purpose and contents of mobile learning research in higher education environment include: “student achievement, students' perception of mobile learning pedagogy, specific applications or mobile learning systems” (Crompton & Burke, 2018). The frequency of the above research decreased from high to low. This research will combine the factors affecting mobile learning with the specific learning environment of relevant pedagogy application. Mobile learning can help expand limited educational programs and connect learning within and outside the higher education environment. However, the key to achieving these goals is not the

implementation of technology, but the creation of new and extensible learning designs by connecting different teaching strategies through educational implementors in the process of mobile education (Pimmer *et al*., 2016). Most previous research on mobile learning in colleges and universities has been conducted in traditional classroom environments, and systematic data suggest that further research should focus on the use of mobile devices in informal environments to explore mobile learning in these situations (Crompton & Burke, 2018). With the development of mobile technology, the mobile education network environment has changed at the same time that the teacher-student relationship and the organizational form of teaching have also changed dramatically. College students are formally or informally integrating social media into their learning experience.In addition, university teachers are increasingly using social media to support teaching activities (Dabbagh & Kitsantas, 2012). Combined with the characteristics of the current development of mobile Internet, mobile learning in universities pays more attention to the combination of network social media and education system, and integrates formal and informal learning into the pedagogy or educational methods of higher education environment.

From 2010 to 2016, scholars found that most of the subjects were undergraduates (Crompton & Burke, 2018). The lack of investigation on the use of mobile learning by high-level students is a problem, because the use of mobile learning by high-level graduate and doctoral students is more flexible and abundant, which leads to the one-sidedness of the study on the influencing factors of mobile

learning in the informal learning process. Based on the above issues, in order to clarify the real attitude towards mobile learning of university students, build a using mobile learning system in the process of real bridge of cognitive emotion between teachers and students, this study will design suitable for all levels of colleges and universities students compatible model framework of study, and take appropriate scale of the project for different groups.

2.2 UTAUT2 model based on IDT theory

The use of the model in the research needs to combine the past theoretical research basis and the current trend of systematic analysis, which is taken as the theoretical foundation framework of empirical research. Relevant scholars systematically reviewed the models adopted in the study and the factors affecting the adoption of mobile learning, and found that the models used in the study included : formal methods (includes models used from literature TAM, UTAUT, TPB and TTF *etc*) and informal methods (includes methods derived by the researchers) (Kumar & Chand, 2019). Analysis shows that mobile learning adopts the research do not have a specific model, and designed for research techniques using universal model are used in most cases these model is extended to modify integration or use with other models in the use of a formal model of mobile learning in the research literature, using model is TAM, followed by the UTAUT (Kumar & Chand, 2019). Next, the model used in

this study is discussed.

2.2.1 Comparison and adoption of theoretical research models

Firstly, in terms of the theoretical research foundation in the past, the most commonly used model for studying mobile learning includes the " technology acceptance model " Davis (1989). Innovation diffusion theory Rogers (2003). And " a unified theory of the acceptance and use of technology" Venkatesh, Morris, Davis, and Davis(2003). Among all these theories/models, relevant studies indicate that TAM is one of the most commonly used models for measuring IS acceptability due to its adaptability, simplicity and reliability (Al-Emran, Mezhuyev, & Kamaludin, 2018). UTAUT is considered to be a theoretical advance on existing theories used to test the adoption and dissemination of relevant research, and to help examine users' intentions to use the information system and their subsequent use behavior (Dwivedi, Rana, Chen, & Williams, 2011). Venkatesh (2003) integrated the following eight theories and models through their research: technology acceptance model (TAM), theory of reasoned action (TRA), theory of planned behavior (TPB), motivational model (MM), a combined theory of planned behavior/technology acceptance model (C-TPB-TAM), model of PC utilization (MPCU), social cognitive theory (SCT) (Venkatesh, Morris, Davis, & Davis, 2003), and innovation diffusion theory (IDT). The author is by eliminating redundant and repeat to form a unified point of view, because there are several kinds of common structure in these theories, at the same time because the UTAUT and technology acceptance theory (TAM) and the theory of planned behavior

(TPB) on the structure and relationship of similarity, the current and future research may be more inclined to use and spread of the use of UTAUT (Dwivedi *et al.*, 2011). The results of that empirical study demonstrated that the UTAUT model is the most effective model for analyzing technology acceptance (Chao, 2019). The UTAUT model contains four essential determining components and four moderators. According to the model, the four determining components of BI and usage behavior are social influence(SI), facilitating conditions(FC), performance expectancy(PE), and effort expectancy(EE) (Venkatesh et al., 2003). Age, gender, experience are the moderators that affect usage of technology (see Figure 2.1).

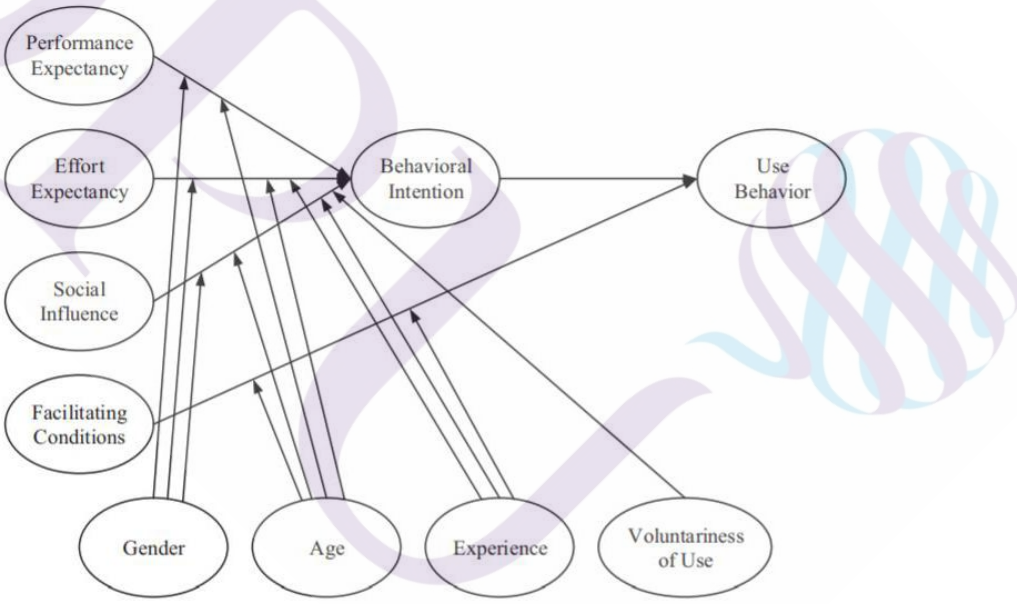


Figure 2.1 The unified theory of acceptance and use of technology (UTAUT) model. Source: (Chao, 2019)

As a comprehensive model, the UTAUT model can be applied to a variety of applications and has proven to be an effective tool for predicting the adoption

behavior of a variety of technology-based systems (Tarhini, El-Masri, Ali, & Serrano, 2016). Due to its simplicity and effectiveness, UTAUT is one of the most widely used models (Gupta Kriti, Manrai, & Goel, 2019). It is proved to outperform other prevailing competing models (Venkatesh *et al.*, 2003). UTAUT is considered by scholars to be one of the most powerful models for studying the factors that influence the adoption of mobile learning (Bere, 2014). Since this study discusses the influencing factors of mobile learning intention, it is particularly suitable to take UTAUT model as the basic theoretical model of the study.

However, it is difficult to prove whether UTAUT model will replace TAM model in empirical research. Although UTAUT is used as the research model in this study, TAM model will be compared with the research environment and objects in a specific context for a comprehensive discussion and analysis. In order to expand the UTAUT model reasonably and effectively according to the research objectives, we will follow the TAM's four groups of modifications as per (King & He, 2006) (Figure 2.2). The four groups are: 1) prior factors (external factors): these are the factors used for predicting the two main constructs of TAM; 2) Factors from other theories/ models: these are the factors or components from other models or theories in various contexts; 3) Contextual factors, and 4) Consequent Factors. In this study, the first group and the second group of modification schemes are adopted to expand the original model.

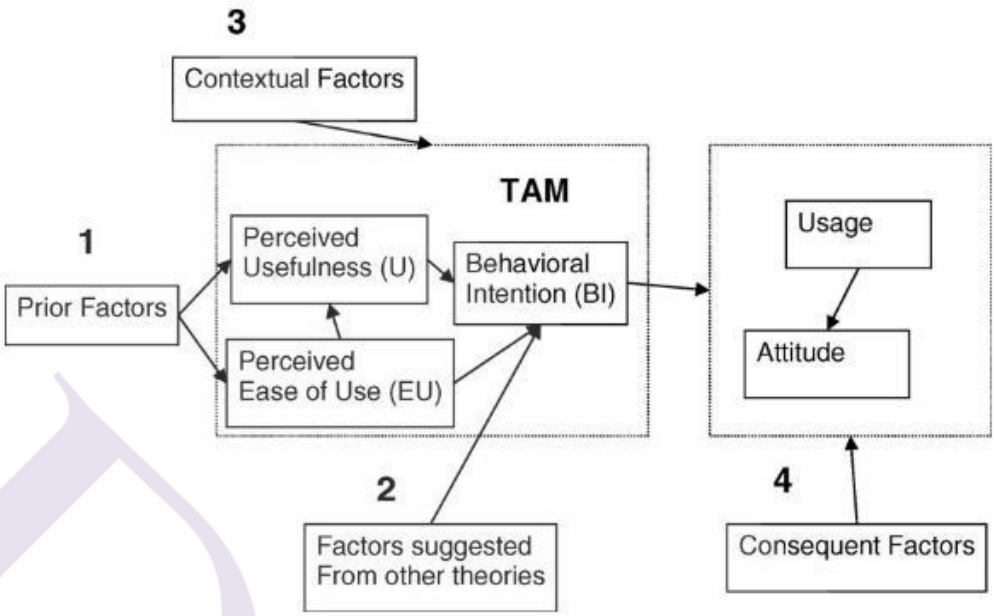


Figure 2.2 TAM's four groups of modifications, King and He, 2006

In the research aspect, TAM proposed two specific beliefs, perceived usefulness (PU) and perceived ease of use (PEOU), which explained the main driving factors for users to accept a particular type of system(Davis, 1989). The external variables of TAM can affect PU and PEOU, and both PU and PEOU can affect a person's attitude towards the use of the system, which determines the behavioral intention and leads to the actual use of the system (Bagozzi & Warshaw, 2019). Perceived usefulness can be understood as the degree to which a person thinks that using a particular system will improve his or her performance, and perceived ease of use can also be understood as the degree to which a person thinks that using a particular system is effortless (Davis, 1989). In this model, perceived usefulness and perceived ease of use are considered the major determinants of technology adoption.

In terms of mobile learning, TAM made a lot of modifications and improvements. TAM' s research on mobile learning mainly focused on the extension of external variables to the model, followed by factors in other theoretical models (Al-Emran et al., 2018). In order to enhance the explanatory power of TAM in mobile learning research, previous studies have shown that TAM can be further integrated with IDT to solve the compatibility problem (Ryu et al., 2009; Tung & Chang, 2008; J.-H. Wu & Wang, 2005; Cheng, 2015). IDT is a famous theory proposed by Rogers (1962). Rogers (2003) proposed IDT five attributes of an innovation, namely, relative advantage, complexity, compatibility, trial ability, and observability. Research shows that only relative advantage, complexity and compatibility are consistently associated with innovation adoption (Ryu, Kim, & Lee, 2009; J.-H. Wu & Wang, 2005; Cheng, 2015). Relative advantage refers to the degree of benefits, image improvement, convenience and satisfaction brought by innovation compared with traditional methods. Relative advantage is considered as one of the most important innovation characteristics for predicting innovation diffusion. The greater the relative advantage of innovation, the higher the degree of diffusion. Complexity refers to the degree to which innovation is considered difficult to understand to learn or exploit (Rogers, 2003). IDT has obvious similarities with TAM, that is, the concept of relative advantage is similar to PU, while the concept of complexity is opposite to PEOU. Therefore, relative advantage and complexity can be replaced by PU and PEOU, respectively (Tung & Chang, 2008; J.-H. Wu & Wang, 2005;Ryu *et al*., 2009; Cheng,

2015). In a unified theoretical model for the acceptance and use of technology (UTAUT) postulated that the four core constructs i.e. PE, EE, SI, and FC are direct determinants of IS/IT behavioral intention and ultimately actual use behaviour (Venkatesh *et al*., 2003). Two of its constructs are similar to TAM constructs: performance expectation (PE) can be mapped to perceived usefulness (PU) whereas effort expectation (EE) can be mapped to perceived ease of use (PEOU) (Dwivedi et al., 2011). In the current higher education environment where online social media, education system and formal and informal learning are integrated, the use of these two constructs to conduct research can better reflect the psychological characteristics of students' adoption of mobile learning.

2.2.2 Cognitive factors: performance expectation and effort expectation

In previous studies of technology acceptance using the UTAUT2 model, performance expectancy (PE) and effort expectancy (EE) are key factors contributing to the success of e-learning (Ong & Lai, 2006, 2007; Ong, Lai, & Wang, 2004). For adoption of e-learning systems, perceived usefulness (or PE) and perceived ease of use (or EE) are determinants of acceptance (ŠUmak *et al.*, 2011). In the UTAUT2, which is the model used in this study, performance expectancy (PE) and effort expectancy (EE) are representative factors associated with technology adoption or purchase intention. The contribution of these two constructs in explaining adoption behavior has been clearly confirmed by studies based on IT adoption theories. In previous studies of technology acceptance using the UTAUT2 model, PE and EE are

key factors contributing to the success of e-learning (Ong & Lai, 2006, 2007; Ong, Lai, & Wang, 2004). Yoo, Kwon, and Lee (2016) have confirmed that performance expectancy (PE) and effort expectancy (EE) are positively associated with intention to adopt robot-assisted learning systems. According to one study, (Venkatesh *et al.*, 2003; Šumak and Šorgo, 2016; Hoque and Sorwar, 2017; Khalilzadeh *et al*., 2017; Šumak *et al.*, 2017) performance expectancy (PE) and effort expectancy (EE) are direct determinants of behavioral intention (BI). The present study hypothesized that PE and EE can significantly influence students intention to use m-learning. The following hypotheses were proposed.

[H1]: Performance expectancy (PE) will positively affect intention to use m-learning.

[H2]: Effort expectancy (EE) will positively affect intention to use m-learning.

2.2.3 The model extension variable : perceived credibility

In the research on the application of UTAUT model, scholars found that attitude, anxiety, trust, self-efficacy, PEOU, PU, perceived risk and perceived credibility were the most commonly used external variables (Dwivedi *et al*., 2011). This research process needs to combine the network social media and the education system to discuss together. At present, the mobile education system is complicated. Different mobile education platforms, such as MOOCS, blackboards, nails, etc.,

provide different services for mobile learning with their own characteristics, leading to different universities using different mobile education systems. In the context of informal learning, the choice of mobile learning content largely depends on learners' learning purpose and interest, and then they make choices among massive mobile education resources, which are mainly based on network endorsement of mobile education content providers.According to the source credibility theory Ohanian (1990), endorsement validity is driven by endorser's perceived credibility. High demonstration quality and good matching between endorser and endorsee brand cultivate trust, honesty and professional cognition, which leads to positive attitude towards endorsement message and brand (Ohanian, 1990).

The important theoretical basis of this study is the media richness theory, Trust is an implicit construct at the heart of media richness theory. Van Koert (2003) have proposed that the fuzziness of information is related to trust issues. In addition, the development of communicative relations may lead to increased trust by reducing fuzziness through the characteristics of rich media such as response feedback. While media richness theory suggests computer-based communication media may eliminate the type of communication cues that individuals use to convey trust (Jarvenpaa & Leidner, 1999), we expect many users of electronic networks to still develop high levels of trust.In particular, using richer media may lead users to develop a greater degree of credibility, or perceived trust, in the communication of the other party. Scholars theorize that: Leaner modality formats, by producing a limited cues

environment, may reduce not only the total amount of information available upon which people rely to form credibility and other social judgments but may decrease redundant and complementary information that contributes to mutual understanding (Burgoon *et al*., 2002). Richer media may lead to more positive social judgment, thus creating a greater degree of user trust in the multimedia capabilities of the online environment. Richness and interactivity have the potential to attract users (i.e., arouse emotions) in a way that other media cannot.Therefore, presentation is very likely to engender emotional reactions, credibility is thought to be part of this emotion (Agarwal & Venkatesh, 2002). In the new mobile Internet learning environment, learners can access learning resources anytime and anywhere, and the content and channels of mobile learning are increasingly rich. On this basis, students' perceived credibility in mobile learning content is closely related to the influence of media richness.In the experimental research of relevant scholars, it is believed that the operation of "credibility" is divided into two parts: trust and ability, and it shows that the richness of communication media is positively correlated with trust level (Burgoon *et al*., 2002). Drawing on the source credibility theory Ohanian (1990), credibility is an important construct in persuasion and attitude-change research. Expertise is the second dimension of source credibility. This dimension is also referred to as "authoritativeness", "competence", "expertness", or "qualification". So perceived credibility (PC) is defined as " the belief that a partner is trustworthy and has the required expertise to carry out transactions" (Erdem & Swait, 2004). In the

process of mobile learning, teachers, as the endorsers behind the curriculum, need to enhance the recognition of the curriculum through students' direct perception of their expertise.

Since credibility is an important principle of media richness theory, it is necessary to explore how to apply this variable to the study of mobile learning. According to Erdem and Swait (2004), perceived credibility (PC) is defined as " the belief that a partner is trustworthy and has the required expertise to carry out transactions". Therefore, this study used perceived credibility as the extension variable of UTAUT model. In this study, performance expectancy (PE), effort expectancy (EE) are defined as direct formative indicators that affect mobile learning intention. Perceived credibility (PC) may influence the relationship between performance expectancy (PE) and intention to use m-learning. According to Oliveira, Faria, Thomas (2014), apart from being a direct determinant of behavioral intention (BI) , performance expectancy (PE) is a significant predictor of initial trust (Oliveira, Faria, Thomas, & Popovič, 2014) . Relevant scholars showed that perceived credibility (PC) partially mediates the positive effect of performance expectancy（PE) on the behavioral intention (BI) to adopt payments banks services (Gupta Kriti et al., 2019). Thus, we hypothesize that:

［H3］Performance expectancy (PE) will positively affect perceived credibility (PC) of m-learning.

［H4］Perceived credibility (PC) will positively affect effort expectancy (EE)

of m-learning. .

Satisfaction and trust are critical factors for predicting individuals' behavioral intention toward adopting IS or IT (Koufaris and Hampton-Sosa, 2004; DeLone and McLean, 2016; Kabra et al., 2017). Previous studies have shown that perceived credibility has a significant positive effect on users' behavioral intention to adopt Internet products (Gupta Kriti *et al*., 2019). Therefore, we can hypothesis that:

[H5]: Perceived credibility (PC) will positively affect intention to use m-learning.

Mobile learning models and frameworks based on empirical research in developing countries have some shortcomings. Developing countries face challenges related to their unique culture, infrastructure and learning environment.In high-context cultures (such as China), people need more cues and more immediate feedback in their interactions than in low-context western countries (Hall, 1989). Different cultures place different values on standards of media richness, such as the ability to convey clues. Therefore, more attention should be paid to the characteristics of media richness in the research of Chinese higher education. Like other teaching methods, mobile learning has many advantages, such as increased teaching resources, increased two-way interaction, and the flexibility of teaching to understand when and where individuals need to learn (Tang & Hew, 2017). In the new mobile Internet environment, the richness of media brings the increase of teaching resources. The enhanced two-way interaction leads to the change of teaching relationship in mobile

learning based on network environment，Therefore, this study takes the characteristics of media richness and para-social relationship as external variables for effective expansion, and further mixes the expansion model, so as to more comprehensively discuss the influencing factors in the current mobile learning process of Chinese universities,The discussion of these two aspects will be carried out in the following chapters.

2.3. Media richness(MR)

The theory of media richness is the symbolic basis for studying the continuous evolution of communication technology and media use behavior (Ishii, Lyons, & Carr, 2019). In the field of education media richness theory has been applied to determine whether a particular channel is more effective than other learning environments. MR (media richness) is the ability to process rich information (Daft & Lengel, 1986), the degree of richness measured by the quantity and quality of four attributes: (a) the availability of instant feedback, (b) the use of multiple cues such as voice inflection, body gestures and graphic symbols, (c) the use of natural languages, and (d) the personal focus of the medium. The purpose of this theory is to explain how to resolve uncertainty and fuzziness by providing a wealth of information through a comparable organizational structure (Daft & Lengel, 1986). The theory was then expanded to explain the impact of rich and poor media on user perception and to

categorize social media (Power & Phillips-Wren, 2011; D. K. L. Lee & Borah, 2020). In the research of e-learning system, it is considered to be an important factor affecting the learning performance (Lan & Sie, 2010), The scholar studied the successful dissemination of educational information in mobile learning, adding accuracy and adaptability to the criteria of media richness.

With the continuous development of ICT technology, the theory of media richness has been continuously enriched and expanded (Kumar & Benbasat, 2002). Research based on the traditional MR theory only considers the type of content (such as text, audio, video or a combination of these). For the relatively new e-learning technology, research in MR field should give more new content, such as mobile learning (Yoo *et al*., 2016). Fulk *et al*. attempted to integrate new ICT such as email into the MRT hierarchy and concluded that the new ICT were not as rich as traditional media (Illia & Lawson-Body, 2007). But other research suggests that new ict offers a wealth of forms that MRT does not take into account when compared with traditional media, such as the ability to use video, audio, images and text at the same time; Ability to read and store information and data storage; 24-hour service and synchronization (Rice, 1993). With the development of ICT technology, the new mobile Internet environment integrates AI, VR, AR and other new technologies into e-learning, enhancing the richness of mobile learning media and enriching the interaction of mobile learning (Yoo *et al*., 2016). Therefore, in this study, the concept of technology richness refers to a new richness discovered with the development of

new ICT technology. Different cultures place different values on standards of media richness, such as the ability to convey clues. Especially in high-context cultures (such as China), people need more cues and more immediate feedback in their interactions than they do in low-context western countries (Hall, 1989). At the same time, scholars point out that high uncertainty avoidance, high inequality gap of social status, high collectivism value and high cultural context will lead to high demand for media richness (Illia & Lawson-Body, 2007), And Chinese universities have these characteristics.Therefore, more attention should be paid to the characteristics of media richness in the research of Chinese higher education. Previous research on mobile learning that investigated the pedagogy used in mobile learning has rarely considered that mobile devices are a tool aimed at improving student performance, and pedagogy is the way the tool achieves its goals (Crompton, 2013), this is a matter of concern, and no more research has been done in this area. The choice of different media means for teaching in mobile learning is itself a problem of education method research. The research on mobile learning with MRT theory can combine the use of teaching tools with the application of education method, so as to more comprehensively investigate the process and results of mobile education.The combination of technologies may be more effective than their effectiveness alone; The combination of media channels may be richer than the simple sum of individual media channels (Shepherd & Martz, 2006). The main focus of this paper is not to determine which specific media are more likely to be adopted and used in mobile education, but to determine the characteristics of

different media or which characteristics are more likely to be needed in mobile learning.More specifically, the study will attempt to answer two questions.

Past research has shown that media features can provide intuitive hints about what the platform supports so more features can enhance the user's understanding of the platform (Waterloo, Baumgartner, Peter, & Valkenburg, 2017)，for perceived functionality, this can be explained by the user's perception of the platform (Sheer, 2011)， In the research of robot-assisted learning system, relevant scholars found that MR plays an important role in the formation of the relationship between robots and learners, and MR has a positive impact on learners' effort expectancy (Yoo *et al*., 2016). Using a richer medium may lead to a greater degree of trust in the other party in the communication (Cho, Phillips, Hageman, & Patten, 2009); Media richness and perceived ease of use also have significant effects on perceived usefulness (ZhangYan-Zhi, 2009). At the same time, the relevant literature also confirms that the media influence also has a positive influence on the social influence (López-Nicolás, Molina-Castillo, & Bouwman, 2008). So that's the hypothesis:

[H6] Perceived media richness will positively affect perceived credibility (PC) of m-learning.

According to the MR theory, face-to-face interactions are the most abundant because of its ability to provide immediate feedback, including the use of multiple cues and natural language, while plain text is the least abundant mode of interaction

(Daft & Lengel, 1986; Yoo *et al.*, 2016). Face-to-face interaction is one of the basic features of mobile learning systems (Ally & Prieto-Blázquez, 2014). Compared with other traditional e-learning systems, the application of innovative ICT technology in mobile learning systems provides stronger face-to-face interaction through direct audio and video interaction of search engines and real-time feedback cloud storage of virtual reality, augmented reality, tactile Internet and other functions. Relevant studies suggest that the higher the level of ICT technology, the higher the perception of media richness (Illia & Lawson-Body, 2007; Yoo *et al*., 2016). Para-social relationship (PSR) is defined as the emotional affinity between people and the role of media, similar to face-to-face relationship, which is also an illusion of "face-to-face relationship". PSR may have been created because people tend to associate and feel familiar with roles in the mass media (Horton & Wohl, 1956), PSR was originally studied in the field of mass media, but in the process of exploring e-learning, it has also been found to be an important and relevant concept to explain the emotional connection between humans and computers (Lee & Kwon, 2013). The courses offered in colleges and universities not only lay emphasis on cultivating students' basic theory, but also cultivate their practical ability (Xinyue & Xin, 2019). The practical instruction course in the course requires more face-to-face communication. Relevant scholars have confirmed that media richness is positively affect the development of para-social relationships between users and robot-assisted learning systems (Yoo, Kwon, & Lee, 2016). Compared with other e-learning systems, the current mobile learning system applying

innovative ICT technology provides stronger face-to-face interaction through search engine, audio and video interaction, directness and instant feedback, cloud storage, virtual reality, augmented reality, tactile Internet and other functions. At the same time, it also provides compatibility guarantee for students with different study habits to participate in mobile learning. Thus, we hypothesize that:

[H7] Perceived media richness (MR) will positively affect Para-social relationship (PSR) of m-learning.

[H8] Perceived media richness (MR) will positively affect compatibility (COM) of m-learning.

2.4 Para-social relationships in mobile learning（PRS）

Para-social relationship “PSR” is a social relations term originally used in the study of mass media.It is defined as the emotional affinity between people and media roles, similar to the face-to-face relationship, which is also an illusion of “face-to-face relationship”. PSR may have been created because people tend to associate and feel familiar with roles in the mass media (Horton & Wohl, 1956), Para-social interaction (PSI) is a related concept that refers to the “illusory interaction” with media characters (Horton & Wohl, 1956). These two concepts are often used interchangeably in the research literature. PSR was originally studied in the field of mass media, but it has also been found to be an important and relevant

concept in the exploration of social media (Lee & Watkins, 2016; Hwang & Zhang, 2018). The concept of PSR has been used to explain the emotional connection between humans and computers (N. Lee & Kwon, 2013). Mobile learning environment is a communication environment and a social environment, just like a social network , which allows the development of interpersonal relationships between members, which can be para-social, social, or both (Tsiotsou, 2015). Research has confirmed that Para-social relationship positively affected social relationships in social networks. In the research of mobile learning UTAUT model, social relationship is often used as an important variable to explore its influencing factors.

In this world, digital media has not only changed our relationship with technology, but also with people we may admire, like, love, or hate but don't actually know (Alperstein, 2019). The possibility of multi-channel interaction enhances the illusion of intimacy experienced by fans at a distance, which is the potential intimacy spontaneously constructed by fans, while enhancing personal meaning and deeper emotions through effective connection channels. The difference between traditional and new media is the latter's ability to interact, including the ability of users to create their own content (UGC). Moreover, users of digital technology have the ability and the opportunity to become more engaged.Mobile media is considered to be the fastest growing social platform in the world (Sheldon & Bryant, 2016). In the process of mobile learning, traditional media and new media are fused together in this way to form a mixed experience.The technology itself is unimaginative, so interactions with

ICT technologies may not inspire imaginative thinking in real time.Imaginary social relationships may affect our direct experience of mobile learning. The ways in which we operate socially and culturally in a society saturated by older and newer technologies neither helps nor hinders the imagination, but these technologies do mediate social connections. At present, there are many mobile education platforms in the network environment, and different platforms, such as MOOCS, blackboards, studs, and WECHAT small programs, all provide different services with their own characteristics for mobile learning, resulting in different mobile education systems used by different universities. In the state of informal learning, the choice of mobile learning content largely depends on the learner's learning purpose and interest, and then makes a choice among the massive mobile education resources, and the selection is mainly based on the network endorsement of mobile education content providers. The types of fans are attracted to include physical attraction, social attraction and task attraction, Perceptual realism and affinity are the main requirements for the development of PSR. (Rubin, Perse, & Powell, 1985)

In previous studies in the field of educational psychology, the teacher-student relationship has been found to affect students' academic performance and learning motivation. Many theorists and researchers in the educational literature have found that high-quality teacher-student relationships are related to students' intrinsic motivation to learn (Decker, Dona, & Christenson, 2007;Haidet & Stein, 2006; Hamre & Pianta, 2006; Hughes & Kwok, 2007;Margonis, 2004). In

self-systems theory, the relationship between positivity, enthusiasm and openness has been shown to promote students' learning motivation and encourage positive tasks (Ames, 1992;Roorda, Koomen, Spilt, & Oort, 2011;Wentzel, 2009). The role of PSR as a social relationship factor is also very important in educational theory, in which the relationship between students and teachers is represented and measured by the degree of intimacy, conflict and dependence (Yoo *et al*., 2016). Relevant studies in the media field show that the more the audience participates, the higher the degree of PSR(Munnukka, Maity, Reinikainen, & Luoma-aho, 2019), para-social and social relationships affect social loyalty (Tsiotsou, 2015). Although mobile online learning platform is a rich medium, the interaction in mobile learning is still one-sided. Compared with the formal education environment, students know a lot about teachers through the mobile Internet, and teachers' understanding of students and between students is limited. So, we can learn from relevant studies in the field of social media, such as (Brown, 2015) and (Munnukka *et al*., 2019), and emphasize that the para-social experience of whether a teacher or a student is a media role will be developed during and after learning. Previous media researchers have pointed out that the more audience members participate, the higher their para-social relationship will be, because they will be more integrated with the media content, so as to increase their self-investment in the media content, so as to enhance perceived credibility (Munnukka *et al.*, 2019). Thus, in the context of mobile Internet learning, both the perception of virtual teacher-student relationship and the perception of the

relationship between learners may be related to the adoption of mobile learning.In the mobile network environment, learners with positive PSR may have better learning effects than those without positive PSR. The development of communication relationship may lead to the increase of trust by reducing ambiguity through the characteristics of rich media such as response and feedback (Koert, 2007)

Thus, we hypothesize that:

[H9a] Para-social relationship (PSR) will positively affect performance expectancy (PE) of m-learning.

[H9b] Para-social relationship (PSR) will positively affect perceived credibility (PC) of m-learning.

In this model, it can also be expressed as: the relationship between media richness and perceived credibility of mobile learning content is mediated by para-social relationship, in which the rich media characteristics lead to high para-social relationship, which leads to perceived credibility of mobile learning content.

2.5. Personal Innovativeness

There are many factors driving the diffusion of innovation, and individuals who innovate are among them.These people make the innovation and acceptance process faster, They are important determinants of the process (Turan, Tunç, & Zehir,

2015). Innovativeness is " the degree to which individuals or other adoptive units adopt new ideas earlier than other members of the social system."(Rogers, 2003). Personal Innovativeness is a person's willingness to try any new information technology. Research shows that the success of technology system implementation not only depends on other factors, but also depends on individual differences (Turan *et al.*, 2015). Personal innovativeness has also been termed as 'innate innovativeness' (Hirschman, 1980), or 'innovative predisposition' (Midgley & Dowling, 1978). The innovation involved in this study refers to the innovation in the field of information technology, so it is defined as the willingness of individuals to try any new information technology (Agarwal & Prasad, 1998). Individual innovation ability is not only tested in innovation diffusion research (Rogers, 2002, 2005), And it has been tested in the field of information systems (Agarwal & Prasad, 1998). It plays an important role in determining the outcome of user acceptance of the technology(Mun *et al*., 2006).

Based on the idea of innovation diffusion theory, technology innovators and early adopters tend to tolerate inconveniences and technological complexity or lack of performance and seek new experiences because they are focused on the possible long-term benefits of innovation. The higher the level of individual innovation, the more positive the belief in new technology, because innovators are relatively willing to adapt to new technologies, they tend to expect high performance in information systems (Turan *et al.*, 2015). The characters' boldness and curiosity not only greatly

enhance their awareness of the potential benefits, but also their confidence in their ability to handle the technology being adopted. Innovators are more confident in their ability to handle and use new technology, which should make it easier to do so (Z. Lin & Filieri, 2015). At the same time, as individuals with higher levels of personal innovation tend to take greater risks, research confirms that they have a more positive willingness to use system services provided by the mobile Internet (Lu, Yao, & Yu, 2005). Extended technology acceptance model based on the diffusion of innovation theory point of view, and relevant scholars has already confirmed that the intrinsic motivation and extrinsic motivation to the analysis of mobile learning acceptance shows clear results show that the learners' beliefs on the mobile learning intention depends largely on the influence of their innovation tendency (Cheng, 2014).The individual's ability to innovate is considered a prerequisite for the technology acceptance process and has been confirmed by research (Lu, Yao, & Yu, 2005; Lin & Filieri, 2015). Agarwal and Prasad (1998) theorized that personal innovativeness could moderate the effects of individuals perceptions of IT on their usage intention, and they inferred that individuals with higher innovative personality were more likely to have a stronger intention to use the IT for the same level of perceptions about the IT. People with more innovative personalities are more likely to be involved in or interested in new IT, and they may tend to tolerate the complexity of new IT, perceive its comparative advantages, and further adopt new technologies, aiming for potentially more long-term benefits than those who are less innovative (Rogers, 2003).

Research has confirmed that：Personal innovativeness positively moderated the effect of PU (perceived usefulness) and negatively moderated PEU (perceived ease of use) on intention to use m-learning (Cheng, 2014). Thus, we hypothesize that:

[H10a] Personal innovativeness will positively moderate the effect of PE(performance expectancy) on intention to use m-learning.

[H10b] Personal innovativeness will positively moderate the effect of PC(Perceived Credibility) on intention to use m-learning.

[H10c] Personal innovativeness will negatively moderate the effect of EE(effort expectancy) on intention to use m-learning.

2.6 Compatibility

Compatibility refers to the degree to which innovation is considered consistent with the beliefs, lifestyles, existing values, experiences and current needs of the adopters. High compatibility can lead to better adoption of innovation (Rogers, 2003). Therefore, this study integrates the concept of compatibility into the original UTAUT2 to form an extended UTAUT model, and further combines the extended UTAUT model with IDT to solve the concept of compatibility. Previous scholars have combined TAM model's perspective with IDT to address the compatibility construct to explain user acceptance of IS/IT, as such integration may provide a more powerful model than using IT alone (Cheng, 2015). In the extended model, using compatibility

as the external variable can more truly reflect the adoption of ICT-based mobile teaching advantages by students through course learning. Through theoretical discussion and analysis, the compatibility of system and environment in students' mobile learning process is taken as an effective extension variable.

Compatibility is described as the intensity with which innovations are perceived to align with the current needs, values, and prior experiences of their probable adopters (Rogers, 1995). Tung and Chang (2008) explored what were the important factors making students use online courses. Cheng (2015) explored what were the important factors making students intention to use mobile learning. Both studies found that compatibility directly affects perceived usefulness and willingness to use. Research model using compatibility as external variables, is for the sake of more realistic response based on ICT technology advantage through learning by students using mobile teaching situation, in this process reflects the technical compatibility and the compatibility of learning contents, to enable students to learn easily switch mode and the choice of learning environment thus given to expect greater expectations. However, the change of learning form does not bring about the change of learning objectives, so the effect of compatibility on learning performance expectation is not obvious.Thus, we hypothesize that:

[H11a]: Compatibility (COM) will positively affect effort expectancy (EE) of m-learning.

[H12]: Compatibility (COM) will positively affect intention to use

m-learning.

Compatibility has been shown to be an important predictor of attitude formation, because if an individual perceiving a strong fit between an innovation and their needs, the individual will show a more positive attitude toward the innovation (Bianchi & Andrews, 2018). Previous studies have indicated that compatibility is often the most important factor in online behavior identified in the literature (J. Wang, Gu, & Aiken, 2010). If a person believes that social media is incompatible with these needs, he or she is likely to have a negative distrust of the use of social media and not engage in such behavior. Isaac *et al.* (2019) found in the study of online learning that compatibility significantly affected user satisfaction (Isaac, Aldholay, Abdullah, & Ramayah, 2019). Thus it can be seen that the compatibility features of mobile learning system, such as easy operability, user habit compatibility, and content matching, can increase students' trust in mobile courses. Thus, we hypothesize that:

[H11b]: Compatibility will positively affect Perceived credibility (PC) of m-learning.

2.7 The difference of mobile learning in different majors

Previous research results have confirmed that there is no significant difference in college students' attitudes towards the use of mobile learning in their academic majors (Al-Emran, Elsherif, & Shaalan, 2016; Taleb & Sohrabi, 2012). In

many studies, some scholars (Ng & Wong , 2020; Al-Emran *et al.*, 2016) also draw the conclusion that Major made a significant difference in some Internet attitude dimensions of mobile learning. According to the different research results, it is speculated that the reason may be related to the particularity and region of the research object group, which need further research and analysis. Based on the application of new information technology in the field of mobile learning, this study integrates personal characteristics into the technology acceptance model to study the influencing factors of mobile learning. Previous comparative studies on major differences in mobile learning mainly focus on students' attitudes and learning styles towards mobile learning, while there are few studies on the influencing factors of mobile learning. In order to make the research have practical significance and practical value for mobile learning in higher education in China, different majors need to be discussed separately. Therefore, the question and hypothesis was raised, H13: Is there any difference among students of different study majors in terms of influencing factors of mobile learning?

CHAPTER 3

METHODOLOGY

Based on innovation diffusion theory (IDT) and media richness Theory (MRT), this study proposed an expanded UTAUT2 theoretical model to explain the main factors influencing the adoption of this learning style in mobile learning environment. To achieve the above research objectives, the literature was first analyzed to determine the research framework, and then the data were collected and analyzed.

This chapter is divided into 8 sections. The first part is the research process; The second part is the research framework. The third part is the research hypothesis; The fourth part is the participants and sample size; The fifth part is the procedure of data collection. The sixth part is the research instrument or measures; The seventh part is the description and analysis of the formal questionnaire.

3.1 Research Process

The implementation steps of this study are divided into six steps: determining the research topic and research scope; collecting and reading relevant materials, literature theory discussion;collect and compile research questionnaires;

collecting statistical analysis conclusions of data; discussing and completing paper writing. The specific implementation process is as follows:

1. Determine the research topic and scope

After reading the relevant literature and discussing with the instructor, the research topic was determined. During my doctoral study, I have been engaged in relevant research in the field of mobile education. Through a comprehensive review of the literature, the research framework, research steps and research methods were developed.

2. Collect and read relevant literature

According to the guidance of teachers of literature retrieval, guide to commonly used Internet database retrieval system of collecting and reading about the development trend of mobile learning model and a series of factors that affect mobile learning the related literature on this basis, further combed the research purpose and sample forms according to the teacher's advice, puts forward the further research plan.

3. Review of Literature

Systematic retrieval of commonly used Internet database websites,such as Google Academic , Science Direct, Springer，Woley Inter Science, EBSCO, Blackwell, CNKI, IELTS, ACM and Taiwan PhD Thesis Value System, Search for relevant papers, research reports and collect theoretical data. After reading, data are systematically classified and sorted out through EndNote to form systematic research

content, which serves as the basis for further discussion of theoretical models, design of research hypotheses and improvement of research tools.

4. Developing research tools

By referring to the collected literature and under the guidance of the instructor, relevant scales of this study were obtained: Mobile learning Influencing Factor Scale, Media Richness scale, Para-social Relationship scale, Perceived Credibility scale, Personal Innovativeness scale and Compatibility scale. In many discussions and guidance teachers adopt the Suggestions of experts and part on behalf of the students, after modifying the content of the scale, the formation of predictive questionnaire survey is determined, using the convenient sampling method of random sampling, Yunnan university student affairs office send papers after a pretest questionnaire data collection, item analysis, exploratory factor analysis and reliability analysis, according to the results of the analysis to the project further revised formal questionnaire, and then again to issue a formal network questionnaire, data collection and analysis.

5. Questionnaire Recovery and Statistical Analysis

After questionnaires are collected, invalid questionnaires are eliminated first and then coded. The data is corrected and confirmed to be correct.According to research needs,The statistical analysis software packages used to perform these processes were AMOS , SPSS ,Smart PLS and PROCESS macro for SPSS .

6. Conclusion Discuss and complete the thesis writing

Finally, according to the research purpose, literature discussion and the statistical analysis of the questionnaire results, the data were sorted out and the qualitative analysis results were combined to complete the paper.

3.2 Research Framework

Research framework is the structure of research questions and hypotheses, which is formed according to the research purpose, research motivation and literature discussion. The research framework of this study is shown in Figure 1.

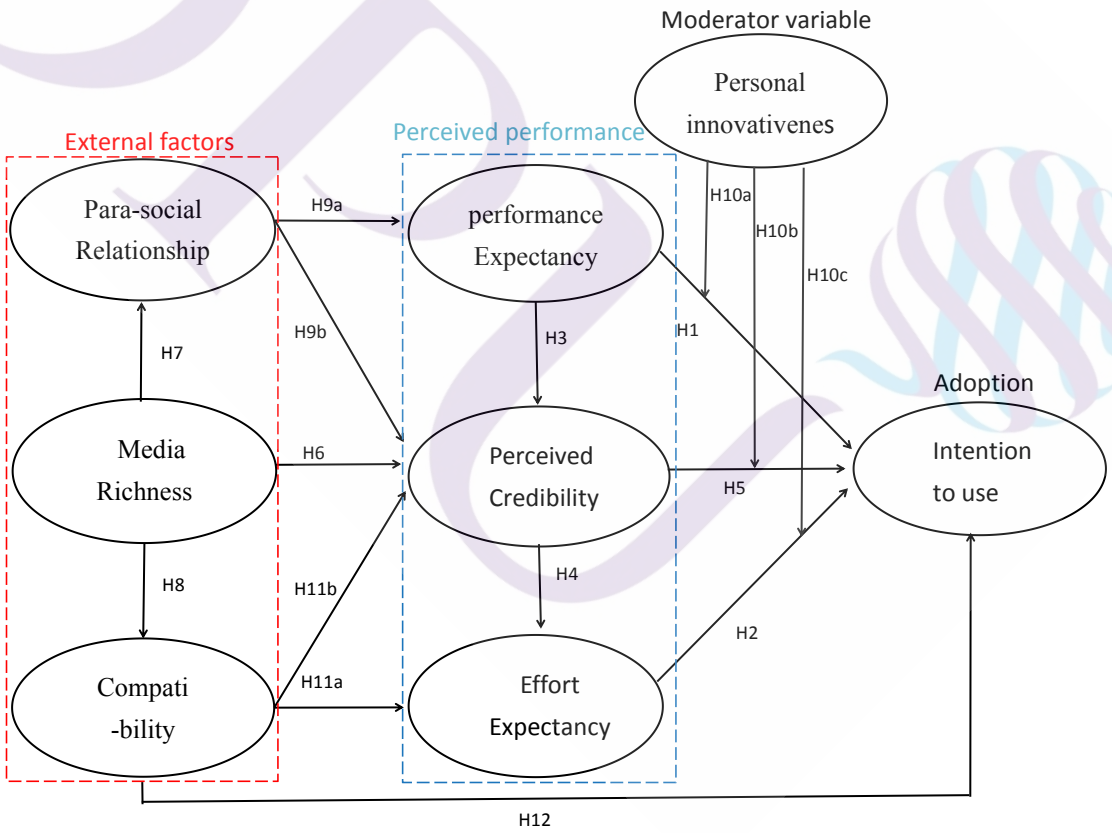


Figure 3.1 Research Framework

An expanded UTAUT2 theoretical model was proposed based on the media richness theory to explain the main factors influencing the adoption of mobile learning.In this model, Perceived performance factors are conceptualized as a combination of performance expectancy, perceived credibility, effort expectancy; external factors are conceptualized as a combination of media richness, compatibility, para-social relationships and personal innovativeness. These factors are considered as the possible determinants of the degree of relationship between learners' cognition and emotion and the adoption of mobile learning system in the mobile network environment.

The above research framework was created based on Daft and Lengel's (1986) media richness theory (MRT), Rogers's (2003) Innovation diffusion theory (IDT) and Venkatesh's (2003) a unified theory of the acceptance and use of technology model (UTAUT); as well as a large number of previous research results and conclusions(Hall, 1989; Agarwal & Prasad, 1998; Mun, 2006; Koert, 2007; Sheer, 2011; Cheng, 2014; Oliveira, 2014; Lin & Filieri, 2015; Yoo, Kwon, & Lee, 2016; Munnukka , 2019; Ishii, Lyons, & Carr, 2019).

3.3 Research Hypothesis

Based on the research questions and the above research framework, the following research hypotheses are proposed and verified one by one.

H1: performance expectancy(PE) will positively affect intention to use m-learning.

H2: Effort expectancy (EE) will positively affect intention to use m-learning.

H3: performance expectancy (PE) will positively affect perceived credibility (PC).

H4: perceived credibility (PC) will positively affect Effort expectancy (EE).

H5: Perceived credibility (PC) will positively affect intention to use m-learning.

H6: Perceived media richness (MR) will positively affect perceived credibility (PC) of m-learning.

H7: Perceived media richness (MR) will positively affect Para-social relationship (PSR) of m-learning.

H8: Perceived media richness (MR) will positively affect compatibility (COM) of m-learning.

H9a: Para-social relationship (PSR) will positively affect performance expectancy (PE) of m-learning.

H9b: Para-social relationship (PSR) will positively affect perceived credibility (PC) of m-learning.

H10a: Personal innovativeness (PI) will positively moderate the effect of performance expectancy (PE) on intention to use m-learning.

H10b: Personal innovativeness (PI) will positively moderate the effect of perceived credibility (PC) on intention to use m-learning.

H10c: Personal innovativeness (PI) will negatively moderate the effect of effort expectancy (EE) on intention to use m-learning.

H11a: Compatibility will positively affect effort expectancy (EE) of m-learning.

H11b: Compatibility (COM) will positively affect perceived credibility (PC) of m-learning.

H12: Compatibility (COM) will positively affect intention to use m-learning.

H13: Is there any difference among students of different study majors in terms of influencing factors of mobile learning?

3.4 Participants and Sample size

The data was collected through an anonymous online survey of art and design majors at three Chinese universities in 2020. Participants' informed consent was obtained before the online survey began.The ethical standards in relevant studies were respected in this study. Although reflecting the personal characteristics and psychological characteristics of learners in the process of participating in mobile learning is the key of this study, the whole data collection is anonymous, and the data

has nothing to do with the identity of participants. Therefore, this study does not constitute an invasion of privacy and confidentiality.

The sample data for this study were collected from mobile learning users of Chinese universities, including undergraduate and graduate students. The analysis unit is for college students in China who have used mobile phones to participate in classroom mobile learning or have experience of autonomous mobile learning. Specifically, the target population of this study is college students from three representative universities in China, who have been or are using mobile learning. The survey samples were selected from three representative universities of different levels and regions in China, which are from the central, western and southeastern coastal regions of China, including provincial key comprehensive universities, “Double First-Class” universities directly under the administration of the ministry of education and provincial key universities. The research subjects ranged from undergraduate freshmen to graduate students, and the samples covered three major categories: Humanity, science and arts.The criteria for selecting participants include: (1) undergraduate or postgraduate students currently enrolled in the university; (2) have the experience of participating in formal course learning organized by teachers by using "learning link" or related APP; (3) have relevant experience of informal learning through mobile applications.

According to the statistics of The Ministry of Education of China, the total number of college students in 2019 in China is 276 million. Under the condition that

the parent group is 276 million, the sample reference size of this study is 385 under the assumption that the margin error is no more than 5% and the confidence level is 95%. Some researchers believe that SEM needs a larger sample size, for example, N = 200 (Boomsma & Hoogland, 2001; Kline, 2005). The simulation results show that the reasonable sample size of the simple CFA model is about N = 150 (Muthen & Muthen, 2002). For multiple modules, the rule of thumb is that at least 100 samples per group is appropriate (Kline, 2005). A generally accepted rule of thumb is to use 10 cases/observation variables per indicator variable as the lower limit of the sample size (Nunnally, 1967). Structural equation modeling (SEM) and partial least squares (PLS) analysis was used for model analysis in this study. One of the most fundamental issues in PLS-SEM is that of minimum sample size estimation, where the '10-times rule' method has been a favourite (Hair *et al.*, 2011), which builds on the assumption that the sample size should be greater than 10 times the maximum number of inner or outer model links pointing at any latent variable in the model. According to 40 items among the 8 study variables used in this study, the sample size calculator for structural equation models (Soper, 2015) showed a Minimum sample size for model structure of 100 and a Minimum sample size of 177. Therefore, this study is expected to require at least 400 valid questionnaires. But invalid questionnaires are considered, the number of samples in this study was set at 400-500, and each school was required to complete at least 150 electronic questionnaires.

3.5 Procedure of Data Collection

The sample data of this study were collected through mobile Internet.The electronic questionnaire was designed and collected by the questionnaire star system and distributed to three different universities using a convenient sampling method. According to research needs， Each school is required to complete at least 150 electronic questionnaires, which are organized and filled out online by professional teachers in the classroom through the coordination of professional university counselors.The questionnaire was completed within one week according to the weekly class time, and the valid questionnaire was confirmed by the electronic data of the questionnaire star feedback.

In the prediction phase, 201 available sample responses were received in the early stage and 232 available sample responses in the late stage. The mean differences between the two groups with respect to sex, age, grand, majors,and experience were tested using an unpaired t test. No significant differences were observed at the 0.05 level, indicating no systematic differences between the two groups. Because nonresponse bias does not appear to be a problem, the final sample of 432 usable responses can be regarded as representative of the population.The sample for this study included 432 students. According to the questionnaire data generated by the questionnaire star, the sample data whose filling time was less than 30 seconds was excluded from our final sample, which was composed of 403

participants. These include undergraduate students from the first year to the fourth year, and graduate students,As shown in Table 3.1.

Table 3.1 Basic Data of Effective Participant of Pre-test Questionnaire

Grade	Total Number	Valid	% of Effective
freshman	129	119	92.248%
sophomore	81	81	100%
junior	112	101	90.179%
senior	60	52	86.667%
graduate students	50	50	100%

Source: researchers collate.

3.6 Research instrument or measures

This chapter describes the sources, measurement methods, expert validity, participant analysis and reliability and validity measurement of each scale.

3.6.1 Source of scale and items effectiveness analysis

The research adopts Cross-section survey (McMillan, 2000). The survey instrument were adjusted and revised based on previous research.To ensure content validity of the scales, the items must represent the concept about which generalizations are to be made (Ong, Lai, &Wang, 2004). The items selected for the constructs in this study were adapted and modified from previous research. This scale is prepared by referring to the technology acceptance model theory of Davis (1989),

the “a unified theory of the acceptance and use of technology” of Venkatesh (2003), and the media richness theory of Daft & Lengel(1986). At the same time, the scale of para-social relationship of Sokolova and Kefi (2019), Munnukka (2019) is cited;The scale of the compatibility of Hoi (2020); As well as the scale on the personal innovativeness variable of Lu (2005),Turan (2015).

Most of the previous relevant research literature is in English, while the questionnaire of the project survey is distributed to students in Chinese. Therefore, the semantic accuracy of the questionnaire must be ensured to ensure the validity of the scale items(Larsen, Nevo, & Rich, 2008).To this end, we has carried on the standard to the questionnaire of back translation, the original questionnaire was prepared in English, and then by a double top universities in Yunnan professional English teacher will lead three graduate students questionnaire will translate into Chinese, the other one can speak two languages English professional doctoral student questionnaire in Chinese translation into English.Lastly, to ensure the cross-cultural uniformity in translation (Sperber, Devellis, & Boehlecke, 1994), two other English major graduate students also provided independent inspection of backward translation, and then I implanted the semantics related to the research. In order to further ensure the accuracy and validity of semantics,a pretest is carried out.Following a convenience sampling method, the questionnaire was pretested on Chinese college students with experience in mobile learning. Meanwhile, the leaders and teachers of the school were interviewed and asked for their opinions. Based on the feedback, the respondents were

asked to identify any ambiguities in the meanings, and the questionnaire was revised based on their comments. Those who had participated in the pretest were excluded from the final data collection and subsequent study. In this survey scale, responses to the items in performance expectancy, effort expectancy, Perceived Credibility, Media Richness, Para-social Relationship, Compatibility, Personal innovativeness and Intention to use were measured on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) with 3 labeled as neutral. The following, according to the order of the dimensions used in the scale, the sources and references of item content items of the research tools are explained.

3.6.2 Establish Expert Validity

The scales for the constructs utilized in this study (i.e. PE, EE, PSR, MR, compatibility, personal innovativeness) were adopted from the UTAUT2 (Venkatesh *et al.*, 2003), PSR theory (Lee & Kwon, 2013), MR theory (Jahng *et al.*, 2006), and Innovation diffusion theory (IDT) (Rogers, 2003).

The Perceived credibility construct, we adapted the measurement of Mc Croskey and Teven (1999). Meanwhile, according to the scale compiled by Munnukka *et al*. (2019) and Sokolova and Kefi (2020), relevant contents of concepts were adjusted according to the characteristics of mobile network learning.

After the draft questionnaire is completed, experts are invited to review it to improve the validity of the content. After consulting expert opinions and discussing with instructor, the prediction questionnaire was modified into a formal questionnaire.

In the process of establishing expert validity, four experts in the field were invited to ask for Suggestions on modification. The revision principle is as follows: if the proportion of experts in the same topic is more than 50%, it shall be deleted or modified; If the proportion of experts suggested to delete or modify the same topic is less than 50%, it can be retained or modified after discussion with the instructor. The information of expert reviewers is shown in Table 3.2.

Table 3.2 Information on Expert Reviewers (sort by first name alphabetically)

Name	Current Status	Relevant Experience
Zhang Ren-Cheng	Doctoral Advisor	4 years experience as university teacher. Experts in the field of information statistics
Zhang Yuan-Cheng	Doctoral Advisor	Deputy Dean of China-ASEAN International College ;Experts in the field of educational management research
Xiong Yong-Xiang	Doctoral Advisor	Dean of School of Communication, Yunnan Normal University;23 years experience as university teacher.
Li Wei	Doctoral Advisor	Dean of International College of Yunnan University;25 years experience as university teacher.

Source: researchers collate.

3.6.3 Item Analysis

The purpose of item analysis is to screen items in the questionnaire by statistical method and assume that each question has the same value. To determine the quality items in the questionnaire according to whether there is any difference is the basic work of scale development. Its main purpose is to evaluate the applicability of pre-test items, that is, to test the reliability of individual items in the scale.

In this study, Wu's item analysis criteria (2009) was used to analyze the pre-test data, which included three categories: critical ratio, detection correlation and homogeneity test.The evaluation criteria are as follows: critical ratio (CR-value), correction and total correlation, correction and deletion correlation, Cronbach's Alpha (α-value) of correction and deletion, commonality and factor load.If the total number in a project is less than the standard number, up to three, the item is removed.

1 Critical Ratio

According to the total score, the participants are divided into high group (top 27% of question score) and low group (end 27% of question score), and then makes independent participant t-test with the comparison average to test,the critical ratio of all items were greater than 3.0, and the P-value reached a significant level (P<0.05) (Wu, 2009).

2 Detection Correlations

SPSS was used for correlation test.A correlation coefficient between the item and the total score above 0.4 is good, and the P value reaches a significant level (P<0.05).The revised total score correlation method is to calculate the Pearson product moment correlation coefficient between each item and the total score of sub-grades (excluding this score).

3 Homogeneity Test

In this study, the homogeneity test consists of three items: Cronbach's Alpha (-value) after deleting the items, commonality and factor load.

Cronbach alpha coefficient was used to verify the internal consistency of the questionnaire items to evaluate the reliability and stability of the whole scale. The A - value after item deletion refers to the Cronbach coefficient of the whole scale after item deletion.According to many scholars (Cooper, 1998; DeVellis, 2003; Hair et al., 2006; Henson, 2001), Cronbach's alpha coefficient value greater than 0.70 is reliable, indicating good internal consistency of the scale.According to Wu (1985) 's suggestion, the reference range of reliability is as follows: Cronbach alpha coefficient is greater than 0.9, indicating high reliability; A range of 0.9 to 0.7 indicates very reliable; 0.5 to 0.7 expresses confidence; A range of 0.4 to 0.5 indicates credibility; A range of 0.3 to 0.4 is barely credible;Lower than 0.3 is the lowest reliability and cannot be taken.

The purpose of homogeneity test of factor analysis is to extract common basic factors from the project. The main purpose is to reduce the factor analysis of main factors according to the degree of correlation between multiple variables, so as to simplify the complexity between variables and to construct the maximum possible interpretation of the original variables.

Therefore, in the part of factor analysis, the items are deleted based on the commonality and factor loading, so as to have the maximum homogeneity among common factors. Using the principal component analysis method, the entire scale is extracted under the largest component, the items whose commonality is less than 0.2, and the item whose factor load is less than 0.45 are recommended to be deleted.

3.6.4 Cognitive factors from the TAM (including PE and EE) scale

The researchers combined the TAM model scale compiled by Davis (1989) and the Modified UTAUT Survey items compiled by Chintalapati *et al.*(2017), Hio (2020) as the basic measurement methods of UTAUT2 in this study.Two dimensions, performance expectation and effort expectation, were selected to develop the research scale of influencing factors of mobile learning.

Performance expectancy are the extent to which a person believes that using a mobile learning system will help him or her gain in learning and performance at work.five factors from previous models helped in formation of performance expectancy variable consisting of perceived usefulness,external motivation, job fit, relative advantages and outcome expectations.

Effort Expectancy: Effort expectancy is the extent of convenience perceived for using mobile learning system. From a semantic point of view, the similar structure in other models and theories is: easy to use (technology acceptance model), complexity (PC utilization model and innovation diffusion theory) (Ghalandari, 2012).

These two dimensions include a total of 13 questions, including 6 questions on performance expectations and 7 questions on effort expectations.Based on the current status and characteristics of mobile learning in China, relevant modifications were made to the contents of the original scale items, and then expert opinions were solicited and discussed with the instructor to ensure expert validity. Through the

pre-test the instrument's reliability was evaluated, and the Cronbach's α values (ranging from 0.83 to 0.97) exceeded common requirements for exploratory research, indicating a satisfactory level of reliability (Hair, Anderson, Tatham, & Black, 1998; Nunnally, 1978). The items are presented in Table 3.3 along with their sources.

Table3.3 Cognitive factors from the TAM (including PE and EE) scale

Construct	Item	Measure	Source
Performance Expectancy	PE1	The diversity of mobile learning content covers my learning interests.	Chintalapati *et al.*(2017); Davis (1989); Hoi (2020)
	PE2	Mobile learning is useful for acquiring learning-related content.	
	PE3	Mobile learning enhances my learning efficiency.	
	PE4	Mobile learning improves the quality of my study.	
	PE5	Mobile learning has improved my learning ability.	
	PE6	Mobile learning systems enhance learning environments and experiences.	
	PE7	Using m-learning gives me greater control over learning.	
Effort Expectancy	EE1	Mobile learning is easy for me.	Chintalapati *et al.*(2017); Hoi (2020)
	EE2	Mobile learning makes it easy for me to access teaching resources.	
	EE3	Mobile learning makes it easy for me to search the learning content by my interests.	
	EE4	It is easy for me to learn to use a mobile device.	
	EE5	The functional services provided in the process of mobile learning are simple and easy to operate.	
	EE6	I find it convenient to use mobile devices for course practice.	

Source: researchers collate.

1. Establishing Expert Validity

According to the suggestion of the advisor, the items in the dimensions were sorted out. In order to facilitate the expert review and revision, Suggestions for revision and deletion were provided to ensure at least 6 items above each dimension.

According to the statistical table, at least 60% of the experts' opinions are on the "appropriate" and "revised appropriate" items. Except for question 7 in the PE dimension, three experts believe that there are ambiguities in the content and suggest deleting. Other items of in the 2 dimensions are discussed with the advisor in accordance with the expert opinions, and then modified for pre-test. The results of the review are shown in Table 3.4.

Table 3.4 Expert Review Opinions on PE and EE Scale

Construct	Original Number	Number in Revised	Code	Appropriate		Revised Appropriate		Result	
				N	%	N	%	Reserve	Delete
Performance Expectancy	1	1	PE1	4	100	0	0	√	
	2	2	PE2	4	100	0	0	√	
	3	3	PE3	4	100	0	0	√	
	4	4	PE4	4	100	0	0	√	
	5	5	PE5	3	75	1	25	√	
	6	6	PE6	4	100	0	0	√	
	7	7	PE7	1	25	3	75		√
Effort Expectancy	8	8	EE1	4	100	0	0	√	
	9	9	EE2	4	100	0	0	√	
	10	10	EE3	3	75	1	25	√	
	11	11	EE4	4	100	0	0	√	
	12	12	EE5	4	100	0	0	√	
	13	13	EE6	4	100	0	0	√	

Source: researchers collate.

Note: PE--Performance Expectancy, EE--Effort Expectancy.

2 .Item Analysis

According to the above criteria, the items in the PE and EE scale of this study were tested and compared. Delete EE3 in the original scale according to the principle of deleting more than three items that are not up to standard. The results are shown in Table 3.5.

Table 3.5 Item Analysis of PE and EE Scale

	Critical Ratio	DetectionCorrelations		HomogeneityTest			
Item	CR-value	Corrected Item-total Correlation	Corrected Item-deleted Correlation	Cronbach's Alphaif Item Deleted (α-value)	Communalities	Factor Loading	Remarks
PE1	-14.621***	0.878**	0.855	0.912	0.502	0.610	reserve
PE2	-15.345***	0.855**	0.822	0.905	0.552	0.656	reserve
PE3	-15.150***	0.853**	0.821	0.923	0.539	0.643	reserve
PE4	-14.846***	0.838*	0.816	0.911	0.512	0.622	reserve
PE5	-16.365***	0.873**	0.879	0.932	0.561	0.672	reserve
PE6	-15.483***	0.889**	0.858	0.930	0.554	0.653	reserve
EE1	-15.231***	0.838**	0.854	0.912	0.542	0.613	reserve
EE2	-15.345***	0.855**	0.822	0.905	0.544	0.676	reserve
EE3	-10.450**	0.513*	0.691	0.923	0.309	0.414	delete
EE4	-15.846***	0.578**	0.874	0.851	0.402	0.422	reserve
EE5	-16.365***	0.873**	0.878	0.932	0.341	0.672	reserve
EE6	-15.483***	0.889**	0.858	0.930	0.384	0.663	reserve

Source: researchers collate

3.6.5 Perceived Credibility.

The credibility construct, we adapted the measurement of Mc Croskey and Teven (1999). At the same time, according to the scale compiled by Munnukka *et al*. (2019) and Sokolova and Kefi (2020), audiences' perceived credibility in online media has been modified accordingly. The content of audience's perceived credibility in network media is modified into students' perceived credibility in mobile learning. Meanwhile, the leaders and teachers of the school were interviewed and asked for their opinions. Based on the feedback, the respondents were asked to identify any ambiguities in the meanings, and the questionnaire was revised based on their comments. According to Erdem and Swait (2004), perceived credibility is defined as "the belief that a partner is trustworthy and has the required expertise to learning". perceived credibility in mobile learning content is closely related to the influence of media richness. It is believed that the operation of credibility is divided into two parts: trust and ability. Generally, if the source is considered being trustworthy, attractive and perceived as an expert, it can influence the attitude and behavior of the audience (Ohanian, 1990; Petty and Wegener, 1998) including purchase intention (Gunawan and Huarng, 2015).

The dimension include a total of 7 questions. According to the characteristics of China Mobile learning environment, the contents of the original scale items have been modified. Experts were then consulted and discussed with the lecturer to ensure expert effectiveness. Through the pre-test the instrument's reliability

was evaluated, and the Cronbach's α values (ranging from 0.87 to 0.96) exceeded common requirements for exploratory research, indicating a satisfactory level of reliability. The items are presented in Table 3.3 along with their sources.

Table3.6 Mobile learning Perceived credibility dimension Scale

Construct	Item	Measure	Source
Perceived Credibility	PC1	I found that the mobile course teachers are experts in this field.	Mc Croskey and Teven (1999); Sokolova and Kefi (2020); Munnukka *et al*.(2019)
	PC2	I find the course of mobile learning very efficient.	
	PC3	I think mobile learning programs are trustworthy.	
	PC4	I think mobile teachers understand the needs of students.	
	PC5	The mobile online learning course I participated in will update the teaching content regularly.	
	PC6	I think mobile learning teachers are serious and responsible.	
	PC7	The comprehensive ability of mobile course teachers is trustworthy (innovative technology use, professional knowledge update, etc.)	

Source: researchers collate.

1. Establishing Expert Validity

After the expert review, the questionnaire was collected, the researcher collected the revised opinions provided by the experts into a table. According to the statistical table, at least 75% of the experts' opinions are on the "appropriate" and "revised appropriate" items. All items are discussed and modified under the guidance of the advisor according to expert opinions, and then conducted for pre-test. The results of the review are shown in Table 3.7.

Table 3.7 Expert Review Opinions on Perceived Credibility Scale

Construct	Original Number	Number in Revised	Code	Appropriate		Revised Appropriate		Result	
				N	%	N	%	Reserve	Delete
Perceived Credibility	14	14	PC1	4	100	0	0	√	
	15	15	PC2	4	100	0	0	√	
	16	16	PC3	2	50	2	50	√	
	17	17	PC4	2	100	0	0	√	
	18	18	PC5	4	100	0	0	√	
	19	19	PC6	4	100	0	0	√	
	20	20	PC7	4	100	0	0	√	

Source: researchers collate.

2 .Item Analysis

According to the above criteria, the items in the Perceived Credibility scale of this study were tested and compared. Delete PC4 in the original scale according to the principle of deleting more than three items that are not up to standard. The results are shown in Table 3.8.

Table 3.8 Item Analysis of Perceived Credibility Scale

Item	Critical Ratio	Detection Correlations		Homogeneity Test			Remarks
	CR-value	Corrected Item-total Correlation	Corrected Item-deleted Correlation	Cronbach's Alphaif Item Deleted (α-value)	Communalities	Factor Loading	
PC1	-14.803***	0.831**	0.866	0.922	0.516	0.628	reserve
PC2	-16.365***	0.873**	0.879	0.932	0.561	0.672	reserve

Table 3.8 (continued)

Item	Critical Ratio	Detection Correlations		Homogeneity Test			Remarks
	CR-value	Corrected Item-total Correlation	Corrected Item-deleted Correlation	Cronbach's Alphaif Item Deleted (α-value)	Communalities	Factor Loading	
PC3	-15.813***	0.835*	0.873	0.928	0.521	0.633	reserve
PC4	-10.461**	0.512*	0.692	0.841	0.309	0.416	delete
PC5	-15.345***	0.855**	0.822	0.905	0.544	0.676	reserve
PC6	-15.345***	0.855**	0.822	0.905	0.544	0.676	reserve
PC7	-16.365***	0.873**	0.879	0.932	0.561	0.672	reserve

Source: researchers collate.

3.6.6 Compatibility Scale

Compatibility refers to the extent to which the innovation is perceived to be consistent with the adopters' beliefs, lifestyle, existing values, experience, and current needs (Rogers, 1983, 1995, 2003). In this study, compatibility refers to the degree to which mobile learning is considered to be consistent with learners' learning styles, perceptions, experiences, and current needs. This scale is prepared by referring to the Innovation diffusion theory (IDT) of Rogers (2003). At the same time, this scale also refers to the content of compatibility scale in the research of Chen (2015) regarding technical characteristics and compatibility as influencing factors of mobile learning, and the content of compatibility scale used by Agarwaland Prasad (1998) in the research of personal innovation. Since the research objects of the scale in the references are all mobile learning, the contents of the items are directly quoted.

The dimension include a total of 6 questions. The expert validity of the content is ensured through expert consultation and consultation with the instructor. Through the pre-test the instrument's reliability was evaluated, and the Cronbach's α values (ranging from 0.85 to 0.98) exceeded common requirements for exploratory research, indicating a satisfactory level of reliability. The items are presented in Table 3.9 along with their sources.

Table3.9 Mobile learning Compatibility dimension Scale

Construct	Item	Measure	Source
Compatibility	COM1	Using mobile learning is compatible with most aspects of my learning.	Rogers(2003); Agarwal and Prasad (1998); Cheng,Yung-Ming(2015)
	COM2	I can quickly adapt to the learning style of mobile learning.	
	COM3	Using mobile learning fits my learning style.	
	COM4	The technical support provided by the mobile learning environment is compatible with my online learning habits.	
	COM5	Many of the mobile applications I use on my mobile device are compatible with other learning methods.	
	COM6	I have the skills needed to use mobile devices for mobile learning.	

Source: researchers collate.

1. Establishing Expert Validity

According to the suggestion of the advisor, the items in the dimensions were sorted out. In order to facilitate the expert review and revision, Suggestions for revision and deletion were provided to ensure at least 6 items above each dimension.

According to the statistical table, at least 75% of the experts' opinions are

on the "appropriate" and "revised appropriate" items. Except for question 7 in the Compatibility dimension, three experts believe that there are ambiguities in the content and suggest deleting. Other items of in the dimension is discussed with the advisor in accordance with the expert opinions, and then modified for pre-test. The results of the review are shown in Table 3.10.

Table 3.10 Expert Review Opinions on Compatibility Scale

Construct	Original Number	Number in Revised	Code	Appropriate		Revised Appropriate		Result	
				N	%	N	%	Reserve	Delete
Compatibility	21	21	COM1	3	75	0	25	√	
	22	22	COM2	4	100	0	0	√	
	23	23	COM3	4	100	0	0	√	
	24	24	COM4	3	75	1	25	√	
	25	25	COM5	3	75	1	25	√	
	26	26	COM6	4	100	0	0	√	
	27	27	COM7	1	25	3	75		√

Source: researchers collate.

2 .Item Analysis

According to the above criteria, the items in the Compatibility Scale of this study were tested and compared. All items met the standard and were retained. The results are shown in Table 3.11.

Table 3.11 Item Analysis of Compatibility Scale

Item	Critical Ratio	Detection Correlations		Homogeneity Test			
	CR-value	Corrected Item-total Correlation	Corrected Item-deleted Correlation	Cronbach's Alphaif Item Deleted (α-value)	Communalities	Factor Loading	Remarks
COM1	-16.365***	0.873**	0.879	0.932	0.561	0.672	reserve
COM2	-15.483***	0.889**	0.858	0.930	0.554	0.703	reserve
COM3	-11.232***	0.543**	0.634	0.832	0.342	0.423	delete
COM4	-15.846***	0.578**	0.874	0.931	0.502	0.422	reserve
COM5	-16.365***	0.873**	0.878	0.932	0.541	0.672	reserve
COM6	-15.483***	0.889**	0.858	0.930	0.584	0.663	reserve

Source: researchers collate

3.6.7 Media Richness Scale

This scale is prepared by referring to the media richness theory of Daft & Lengel(1986). Meanwhile, the contents of the MR scale in the study on media enrichment theory and distance education environment by Morgan M. Shepherd (2006) were also referred. Meanwhile, the contents of the MR scale in the study on media enrichment theory and distance education environment by Morgan M. Shepherd (2006) were also referred. In addition, according to the study semantics, the content of MR scale in Hio (2016) study on robot learning was modified.

In this study, the concept of technology richness refers to a new richness discovered with the development of new ICT technology. Research based on

conventional MR theory considers has only considered the type of content (such as text, audio, video, or a combination of these). For mobile learning, MR must include representational richness due to the development of ICT technology, more and more new technologies can be applied in mobile learning (such as AI, VR, AR, *etc.*). The main focus of this paper is not to determine which specific media are more likely to be adopted and used in mobile education, but to determine the characteristics of different media.

The dimension include a total of 7 questions. The expert validity of the content is ensured through expert consultation and consultation with the instructor. Through the pre-test the instrument's reliability was evaluated, and the Cronbach's α values (ranging from 0.89 to 0.96) exceeded common requirements for exploratory research, indicating a satisfactory level of reliability. The items are presented in Table 3.12 along with their sources.

Table3.12 Mobile learning media richness dimension Scale

Construct	Item	Measure	Source
media richness	MR1	I think new technologies (AR,VR, short video, AI) have been effectively utilized in mobile learning.	Daft and Lengel(1986); Morgan M. Shepherd （2006); Yoo *et al.*(2016)
	MR2	The interaction with teachers and other students in mobile learning is what I expect.	
	MR3	Mobile learning allows me to learn in multiple ways simultaneously (e.g. text, audio, video, live).	
	MR4	I got personalized feedback from my teacher.	

Table 3.12 (continued)

Construct	Item	Measure	Source
media richness	MR5	Mobile learning gives me a feeling of face-to-face communication.	Daft and Lengel(1986); Morgan M. Shepherd（2006); Yoo *et al.*(2016)
	MR6	I can fully express my feelings in mobile learning.	
	MR7	At present, mobile Internet provides a good learning environment for mobile learning	

Source: researchers collate.

1. Establishing Expert Validity

After the expert review, the questionnaire was collected, the researcher collected the revised opinions provided by the experts into a table. According to the statistical table, at least 75% of the experts' opinions are on the "appropriate" and "revised appropriate" items. All items are discussed and modified under the guidance of the advisor according to expert opinions, and then conducted for pre-test. The results of the review are shown in Table 3.13.

Table 3.13 Expert Review Opinions on Media Richness Scale

Construct	Original Number	Number in Revised	Code	Appropriate		Revised Appropriate		Result	
				N	%	N	%	Reserve	Delete
Media Richness	28	28	MR1	4	100	0	0	√	
	29	29	MR2	4	100	0	0	√	
	30	30	MR3	4	100	0	0	√	
	31	31	MR4	4	100	0	0	√	
	32	32	MR5	3	75	1	25	√	
	33	33	MR6	4	100	0	0	√	
	34	34	MR7	4	100	0	0	√	

Source: researchers collate.

2 .Item Analysis

According to the above criteria, the items in the Media Richness scale of this study were tested and compared. Delete MR2 in the original scale according to the principle of deleting more than three items that are not up to standard. The results are shown in Table 3.14.

Table 3.14 Item Analysis of Compatibility Scale

	Critical Ratio	Detection Correlations		Homogeneity Test			
Item	CR-value	Corrected Item-total Correlation	Corrected Item-deleted Correlation	Cronbach's Alphaif Item Deleted	Commu na lities	Factor Loading	Remarks
MR1	-14.803***	0.831**	0.866	0.932	0.516	0.628	reserve
MR2	-11.232***	0.543**	0.634	0.832	0.342	0.423	delete
MR3	-16.365***	0.873**	0.878	0.932	0.541	0.672	reserve
MR4	-15.483***	0.889**	0.858	0.930	0.584	0.663	reserve
MR5	-14.803***	0.831**	0.866	0.932	0.517	0.628	reserve
MR6	-15.450**	0.873**	0.845	0.923	0.537	0.644	reserve
MR7	-15.483***	0.889**	0.858	0.930	0.554	0.653	reserve

Source: researchers collate

3.6.8 Para-social Relationship

It is defined as the emotional affinity between people and media roles, similar to the face-to-face relationship, which is also an illusion of “face-to-face relationship”. Compared with actual interpersonal relationships, quasi-social

relationships are less immediate and intense.It has been described as a sense of friendship with fictional characters embodied in certain media environments. Previous studies (Davis, 2003; Decker, Dona, & Christenson, 2007) in educational psychology have found that the teacher-student relationship has an impact on students' academic achievement and learning motivation. In the mobile learning context, learner perception of the teacher-learner relationship may also be relevant to adoption of mobile learning. Therefore, In this study, para-social relationship is defined as a new type of teacher-student relationship in the Internet environment.

PSR was measured using an seven-item, 5-point Likert scale adapted from existing scales (Tsiotsou, 2015;Munnukka et al., 2019;N.Lee & Kwon, 2013;Lee & Watkins, 2016). Previous studies have focused on para-social relationships in online media, while this study focuses on mobile learning.Therefore, the content of the quoted scale was adjusted accordingly in this study.For example, “I would like to meet the YouTube endorser in person” in the original question is adjusted to “I would like to meet the teachers and other students behind the mobile course” according to the semantics in this study. Some items were also directly referenced, such as PSR7 “I like mobile learning in my personal space”. Based on the measurement and confirmatory factor analysis results of Tsiotsou (2015) alr model, seven items were selected from six dimensions.

The dimension include a total of 7 questions. The expert validity of the content is ensured through expert consultation and consultation with the instructor.

Through the pre-test the instrument's reliability was evaluated, and the Cronbach's α values (ranging from 0.85 to 0.95) exceeded common requirements for exploratory research, indicating a satisfactory level of reliability. The items are presented in Table 3.15 along with their sources.

Table 3.15 Mobile learning para-social relationship dimension Scale

Construct	Item	Measure	Source
Para-social Relationship	PSR1	I'm looking forward to seeing dynamic updates on mobile learning systems.	Munnukka *et al.* (2019)
	PSR2	Mobile learning makes me feel comfortable, and I feel that my teachers and classmates are friends.	Yoo *et al.* (2016) N. Lee and Kwon, (2013)
	PSR3	I want to meet the teachers and other students behind the mobile course.	Tsiotsou (2015)
	PSR4	If other learning platforms have information about the mobile course teachers or related course content, I will be interested to know.	
	PSR5	The interaction between teachers and students in the mobile learning environment is similar to that in the real world.	
	PSR6	I trust the teacher of mobile learning course, when he recommends the information beyond the course to me, I will accept it.	
	PSR7	I like mobile learning in my personal space	

Source: researchers collate.

1. Establishing Expert Validity

After the expert review, the questionnaire was collected, the researcher

collected the revised opinions provided by the experts into a table. According to the statistical table, at least 75% of the experts' opinions are on the "appropriate" and "revised appropriate" items. All items are discussed and modified under the guidance of the advisor according to expert opinions, and then conducted for pre-test. The results of the review are shown in Table 3.16.

Table 3.16 Expert Review Opinions on Para-social Relationship Scale

Construct	Original Number	Number in Revised	Code	Appropriate		Revised Appropriate		Result	
				N	%	N	%	Reserve	Delete
Para-social Relationship	35	35	PSR1	4	100	0	0	√	
	36	36	PSR2	3	75	1	25	√	
	37	37	PSR3	4	100	0	0	√	
	38	38	PSR4	4	100	0	0	√	
	39	39	PSR5	3	75	1	25	√	
	40	40	PSR6	4	100	0	0	√	
	41	41	PSR7	2	50	2	50	√	

Source: researchers collate.

2 .Item Analysis

According to the above criteria, the items in the Para-social Relationship scale of this study were tested and compared. Delete PSR4 in the original scale according to the principle of deleting more than three items that are not up to standard. Other items are reserved. The results are shown in Table 3.17.

Table 3.17 Item Analysis of Para-social Relationship Scale

Item	Critical Ratio	Detection Correlations		Homogeneity Test			Remarks
	CR-value	Corrected Item-total Correlation	Corrected Item-deleted Correlation	Cronbach's Alphaif Item Deleted (α-value)	Communalities	Factor Loading	
PSR1	-10.450**	0.513*	0.623	0.821	0.309	0.414	delete
PSR2	-15.483***	0.889**	0.858	0.930	0.384	0.663	reserve
PSR3	-14.803***	0.831**	0.866	0.932	0.516	0.628	reserve
PSR4	-10.782***	0.543**	0.634	0.832	0.342	0.417	delete
PSR5	-16.365***	0.873**	0.879	0.932	0.561	0.672	reserve
PSR6	-15.483***	0.889**	0.858	0.930	0.554	0.653	reserve
PSR7	-15.231***	0.838**	0.854	0.912	0.542	0.613	reserve

Source: researchers collate.

3.6.9 Personal Innovativeness Scale

The researches showed the success of the implementation of technology systems depends not only on other factors, but also on individual differences(Lu et al., 2003, 2005). Personal innovativeness has also been termed as innate innovativeness Hirschman (1980), or innovative predisposition Midgley and Dowling (1978). Innovativeness is “ the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system ” (Rogers, 2002, 2005). Personal innovativeness has been examined in not only innovation diffusion research (Rogers, 2002, 2005) but also information system fields

(Agarwal and Prasad, 1998). Agarwal and Prasad (1998) theorized that personal innovativeness refers to the degree to which a person believes that he/she has a positive inclination to use new technology. Lee *et al*. (2007) believed that individual innovativeness refers to an individual's inherent innovative personality for new technologies. The personal innovativeness involved in this study refers to the students' perception of innovation in the field of information technology, so it is defined as the willingness of individuals to try any new information technology in the process of mobile learning.

Personal innovativeness was measured using six items adapted from Cheng (2014), Lin and Filieri (2015). Based on the current status of mobile learning technology, the relevant items in the scale were adjusted accordingly. For example, the original "I am among the first in my circle of friends to use new Technologies" has been changed to "I am among the first in my circle of friends to use new technologies of Mobile Learning". In the original question, "I like to try new products" was divided into "I like to use mobile learning apps to complete my quizzes and exams" and "I would like to try new mobile apps". According to the characteristics of mobile learning, the semantic meaning of "I like to experiment with new ways of doing things" in the original question has been materialized and adjusted to " I am willing to try new technology of mobile Internet ".

The dimension include a total of 6 questions. The expert validity of the content is ensured through expert consultation and consultation with the instructor.

Through the pre-test the instrument's reliability was evaluated, and the Cronbach's α values (ranging from 0.86 to 0.97) exceeded common requirements for exploratory research, indicating a satisfactory level of reliability. The items are presented in Table 3.18 along with their sources.

Table3.18 Personal Innovativeness Scale

Construct	Item	Measure	Source
Personal innovativeness	PI1	I am among the first in my circle of friends to use new technologies of mobile learning.	Lu *et al*.(2005) Cheng(2014) Turan *et al.*(2015)
	PI2	I would like to use mobile learning apps to complete my quizzes and exams.	
	PI3	I'm willing to try new mobile apps.	
	PI4	I am willing to try new technology of mobile Internet.	
	PI5	I like to use mobile learning tools on mobile devices.	
	PI6	I hope to get personalized learning experience in mobile learning.	

Source: researchers collate.

1. Establishing Expert Validity

After the expert review, the questionnaire was collected, the researcher collected the revised opinions provided by the experts into a table. According to the statistical table, at least 75% of the experts' opinions are on the "appropriate" and "revised appropriate" items. All items are discussed and modified under the guidance of the advisor according to expert opinions, and then conducted for pre-test. The results of the review are shown in Table 3.19.

Table 3.19 Expert Review Opinions on Personal Innovativeness Scale

Construct	Original Number	Number in Revised	Code	Appropriate		Revised Appropriate		Result	
				N	%	N	%	Reserve	Delete
Personal innovativeness	42	42	PI1	4	100	0	0	√	
	43	43	PI2	4	100	0	0	√	
	44	44	PI3	4	100	0	0	√	
	45	45	PI4	3	75	1	25	√	
	46	46	PI5	3	75	1	25	√	
	47	47	PI6	4	100	0	0	√	

Source: researchers collate.

2 .Item Analysis

According to the above criteria, the items in the Compatibility Scale of this study were tested and compared. All items met the standard and were retained. The results are shown in Table 3.20.

Table 3.20 Item Analysis of Personal Innovativeness Scale

Item	Critical Ratio	Detection Correlations		Homogeneity Test			Remarks
	CR-value	Corrected Item-total Correlation	Corrected Item-deleted Correlation	Cronbach's Alphaif Item Deleted (α-value)	Communalities	Factor Loading	
PI1	-15.345***	0.855**	0.822	0.905	0.544	0.676	reserve
PI2	-10.434**	0.513*	0.691	0.812	0.344	0.410	delete
PI3	-16.365***	0.873**	0.878	0.932	0.541	0.672	reserve
PI4	-15.483***	0.889**	0.858	0.930	0.384	0.663	reserve
PI5	-14.823***	0.831**	0.866	0.932	0.518	0.628	reserve
PI6	-16.365***	0.873**	0.879	0.932	0.561	0.672	reserve

Source: researchers collate

3.6.10 Reliability Analysis

Cronbach's α-coefficient is to estimate internal consistency of the questionnaire. The higher the α-coefficient coefficient is, the higher the consistency of each dimension presents. According to the claims of many scholars (Cooper, 1998; DeVellis, 2003; Hair et al., 2006; Henson, 2001; Nunnally, 1978), Cronbach's alpha coefficient value above 0.70 is reliable, indicating good internal consistency of the scale. While Wu (1985) suggests that the reference range for reliability is as follows: a Cronbach alpha coefficient above 0.9 represents a high reliability value; between 0.9 and 0.7 represents very reliable; between 0.5 and 0.7 indicates confidence; between 0.4 and 0.5 means credible; between 0.3 and 0.4 is reluctant and credible; below 0.3 represents the bottom of the reliability and can not be taken.

The total reliability of the mobile learning scale in this study is 0.951, and the reliability coefficient of each factor is between 0.874 to 0.953, indicating good reliability of the scale, and the measurement results are reliable.

Table 3.21 Reliability Analysis of mobile learning factors influencing Scale

Factor	Item Quantity	Cronbach's α value
Performance Expectancy	5	0.914
Effort Expectancy	4	0.912
Perceived Credibility	5	0.903
Compatibility	4	0.928
Media richness	5	0.906

Table 3.21 (continued)

Factor	Item Quantity	Cronbach's α value
Para-social Relationship	5	0.874
Personal innovativeness	5	0.934
Intention to use	3	0.953
Total Reliability		0.951

Source: researchers collate.

3.7 Preparation of Formal Questionnaire

According to the test results of the reliability and validity in the pre-test questionnaire, the final scale of the study on the influencing factors of mobile learning for college students was prepared. This scale is divided into eight dimensions, namely performance expectancy (PE), effort expectancy (EE), perceived credibility (PC), compatibility (COM), media richness (MR), para-social relationship (PSR), personal innovativeness (PI), intention to use (ITU) ,with a total of 36 items. To ensure the semantic accuracy of the scale, we conducted a standard reverse translation of the questionnaire. The original questionnaire was prepared in English, and then three graduate students who were led by an English teacher from a "Double First-Class University" in Yunnan translated the questionnaire into Chinese. Another bilingual doctoral student translated the Chinese version of the questionnaire into English. Finally, to ensure the cross-cultural unity of translation (Sperber et al., 1994), two other Ph.D. who majored in English, also provided independent examination of the

translation, and I implanted the semantics related to the research. The scale of influencing factors of mobile learning after modification is shown in Table 3.22.

Table 3.22 The scale of influencing factors of mobile learning

Construct	Item	Measure	Source
Performance Expectancy	PE1	The diversity of mobile learning content covers my learning interests.	Chintalapati,*et al.*(2017); Davis (1989)
	PE2	Mobile learning is useful for acquiring learning-related content.	
	PE3	Mobile learning enhances my learning efficiency.	
	PE4	Mobile learning has improved my learning ability.	
	PE5	Mobile learning systems enhance learning environments and experiences	
Effort Expectancy	EE1	Mobile learning is easy for me.	Chintalapati,*et al.*(2017); Hoi(2020)
	EE2	Mobile learning makes it easy for me to access teaching resources.	
	EE3	Mobile learning with my mobile phone is simple and convenient.	
	EE4	The functional services provided in the process of mobile learning are simple and easy to operate.	
Perceived Credibility	PC1	I found that the mobile course teachers are experts in this field.	Sokolova and Kefi (2020); Munnukka *et al.* (2019)
	PC2	I find the course of mobile learning very efficient.	
	PC3	The mobile online learning course I participated in will update the teaching content regularly.	
	PC4	I think mobile learning teachers are serious and responsible.	
	PC5	The comprehensive ability of mobile course teachers is trustworthy (innovative technology use, professional knowledge update, etc.)	

Table 3.22 (continued)

Construct	Item	Measure	Source
Compati-bility	COM1	Using m-learning is compatible with most aspects of my learning.	Agarwaland Prasad (1998); Chen *et al.* (2002); Cheng,Yung-Ming(2015) Hoi(2020)
	COM2	I can quickly adapt to the learning style of mobile learning .	
	COM3	The technical support provided by the mobile learning environment is compatible with my online learning habits.	
	COM4	Many of the mobile applications I use on my mobile device are compatible with other learning methods.	
	COM5	I have the skills needed to use mobile devices for mobile learning.	
Media Richness	MR1	I think new technologies (AR,VR, short video, AI) have been effectively utilized in mobile learning.	Morgan M. Shepherd （2006）; Jahng, Jain,and Ramamurthy (2006); Yoo *et al.*(2016)
	MR2	Mobile learning allows me to learn in multiple ways simultaneously (e.g. text, audio, video, live).	
	MR3	I got personalized feedback from my teacher.	
	MR4	Mobile learning gives me a feeling of face-to-face communication.	
	MR5	At present, mobile Internet provides a good learning environment for mobile learning.	
Para-social relation-ship	PSR1	Mobile learning makes me feel comfortable, and I feel that my teachers and classmates are friends.	Munnukka *et al.* (2019); Yoo et *al.* (2016); N. Lee and Kwon (2013); Tsiotsou (2015)
	PSR2	I want to meet the teachers and other students behind the mobile course.	
	PSR3	The interaction between teachers and students in the mobile learning environment is similar to that in the real world.	
	PSR4	I trust the teacher of mobile learning course, when he recommends the information beyond the course to me, I will accept it.	
	PSR5	I like mobile learning in my personal space	

Table 3.22 (continued)

Construct	Item	Measure	Source
Personal innovative -ness	PI1	I would like to use a mobile app to download learning materials and work with students	Turan *et al.*(2015) Lu *et al.*(2005)
	PI2	I'm willing to try new mobile apps.	
	PI3	I am willing to try new technology of mobile Internet	
	PI4	I like to use mobile learning tools on mobile devices	
	PI5	I hope to get personalized learning experience in mobile learning	
Intention to use	ITU1	I will use mobile learning regularly in the future	Bhattacherjee (2001); Mathieson (1991); Roca, Chiu and Martínez (2006)
	ITU2	I will often use mobile learning in the future	
	ITU3	I will continue to use mobile learning in the future	

Source: researchers collate.

3.9 Statistical Analysis

Before we do the main analysis,In the first step, confirmatory factor analysis (CFA) was used to develop the measurement model. Afterwards, descriptive statistics and bivariate correlation analyses were conducted among variables as preliminary analyses, descriptive statistical analysis was carried out on the research data in SPSS to discover the phenomenon of data presentation on the surface of the research sample. In the second step, to explore the causal relationships among all constructs, the structural model for research model depicted in Fig. 1 was tested using SEM. The proposed model was tested using structural equation modeling (SEM) and

partial least squares (PLS) analysis. The following , the possible moderating role of personal innovativeness on the mediation was examined. In the process of testing the mediation effect, we present the PLS product-indicator approach (Chin, Marcolin, & Newsted, 2003) to detect the moderating effect of personal innovativeness as the moderator in the model. In order to further analyze the results of the moderating effect, moderated mediation analysest produced 95% bias-corrected confidence intervals (CIs) based on 10,000 resamples (Preacher & Hayes, 2008) was used. Confidence intervals that did not cross zero indicated the effects as significant. Lastly, PLS - SEM was used for Multiple group analysis of the research model

The statistical analysis software packages used to perform these processes were AMOS , SPSS , Smart PLS and PROCESS macro for SPSS .

CHAPTER 4

RESULTS

This chapter proceeds statistic analysis of the collected data from questionnaire survey which obtained from the result of the formal questionnaire (N=674) in "Questionnaire on Influencing Factors of Mobile Learning among Chinese College Students".

4.1 Confirmatory Factor Analysis of Formal Questionnaire (CFA)

AMOS is adopted in this study to perform confirmatory factor analysis on the measurement models of various scales, mainly to evaluate the reliability, validity and significance level of the observed variables and potential variables as well as the estimated parameters. According to the suggestions of Bagozzi and Yi (1988), the reliability of individual items, the component reliability of latent variables and the average variance extracted are measured to test whether the research model has sufficient reliability and validity.

4.1.1 Reliability and Validity Analysis

To ensure the discriminant and convergent validity of the sample data set,

the constructs were tested using exploratory factor analysis. Reliability is mainly adopted to test whether the measurement variables of each dimension have internal consistency. It is the test of data reliability as well as stability and consistency of test results. Three reliability analysis measurements are commonly adopted in this study, named Cronbach's α value, composite reliability (CR-value) and average variance extracted (AVE). According to the claims of many scholars (Cooper, 1998; DeVellis, 2003; Hair et al., 2006; Henson, 2001; Nunnally, 1978), Cronbach's alpha coefficient value above 0.70 is reliable, indicating good internal consistency of the scale. While Wu (1985) suggests reference range for reliability is as follows: Cronbach's α coefficient above 0.9 represents a high reliability value; between 0.9 and 0.7 represents very reliable; between 0.5 and 0.7 indicates confidence; between 0.4 and 0.5 means credible; between 0.3 and 0.4 is reluctant and credible; below 0.3 represents the bottom of the reliability and can not be taken.

Fornell and Larcker (1981) suggest CR-value be of more than 0.60 for the latent variables. The higher it is, the more potential variables could be measured. AVE mainly evaluates the average explanatory amount of the variable to its potential variable, the higher it is, the higher convergent validity of the latent variables (Fornell & Larcker, 1981). The recommended values are above 0.5 (Fornell et al., 1981), indicating that the variable has significant explanatory variation (Hair, Anderson & Black, 1998). However, according to the relationship between the sample size and factor loading proposed by Hair (1998), if sample size is more than 350, the AVE

value of 0.4 is acceptable. Fornell and Larcker (1981) also propose that AVE value between 0.36-0.5 is acceptable.

After the confirmatory factor analysis of the internal-external locus of control scale, PE4, EE3, PC3, PC4, COM3, MR2, MR6, PSR1, PSR4, PI2 are deleted due to the substandard factor loading, and other items are all reserved. Cronbach's α value in each dimension is 0.914, 0.912, 0.918, 0.949, 0.914, 0.909, 0.891, respectively. Cronbach's α-value of the Personal innovativeness construct was 0.947 with good reliability; CR-value is 0.934, 0.911, 0.918, 0.965, 0.950, 0.943, 0.956, 0.891, respectively. They all meet the standard, indicating that the combined reliability of the internal-external locus of control scale reaches a good level. The results of CFA showed that the SMC values for all items were greater than 0.5, which indicated a good reliability level (Holmes-Smith, 2001). The values of CR and AVE for all constructs exceeded the minimum acceptable values of 0.7 and 0.5 (Nunnally, 1978; Hair et al., 1998; Holmes-Smith, 2001), indicating a good reliability level and subsequently yielding very consistent results. Hence, the results of CFA demonstrated an acceptable level of reliability for all constructs. In addition, the reliability coefficients of all constructs evaluated with Cronbach's α-value exceeded the 0.7 threshold recommended by Hair *et al*.(1998).The results are shown in Table 4.1.

Table 4.1 Results of CFA, validity analysis, and reliability test

Dimension	Item	Factor Loading	SMC	Cronbach's α	C.R.	AVE
Performance Expectancy	PE1	.819	0.671	0.932	0.934	0.740
	PE2	.852	0.726			
	PE3	.901	0.812			
	PE4	.895	0.801			
	PE5	.831	0.691			
Effort Expectancy	PE5	.831	0.691	0.905	0.911	0.721
	EE1	.768	0.590			
	EE2	.841	0.707			
	EE3	.878	0.771			
	EE4	.902	0.814			
Perceived Credibility	PC1	.825	0.681	0.915	0.918	0.693
	PC2	.811	0.658			
	PC3	.833	0.694			
	PC4	.822	0.676			
	PC5	.869	0.755			
Compatibility	COM1	.883	0.780	0.948	0.949	0.788
	COM2	.879	0.773			
	COM4	.917	0.841			
	COM5	.894	0.799			
	COM6	.864	0.746			
Media Richness	MR1	.790	0.624	0.913	0.914	0.682
	MR3	.781	0.610			
	MR4	.849	0.721			
	MR5	.844	0.712			
	MR7	.861	0.741			
PSR	PSR2	.870	0.757	0.903	0.909	0.668
	PSR3	.792	0.627			
	PSR5	.875	0.766			
	PSR6	.857	0.734			
	PSR7	.675	0.456			
Intention to use	ITU1	.912	0.773	0.907	0.891	0.731
	ITU2	.936	0.689			
	ITU3	.904	0.731			

Source: researchers collate.

Furthermore, to test for discriminant validity, the procedure described by Fornell and Larcker (1981) was used in this study. The results of CFA (Tables 4.2) shows that the square roots of all the AVE values (i. e. the numbers on the diagonal)

were greater than the correlations among constructs (i. e. the off-diagonal numbers), indicating that the discriminant validity of all constructs was satisfactory. (Fornell & Larcker, 1981).

Tables 4.2 Discriminant validity for the measurement model

Construct	ITU	PSR	MR	COM	PC	EE	PE
ITU	.731						
PSR	.467	.668					
MR	.414	.506	.682				
COM	.452	.485	.442	.788			
PC	.434	.498	.453	.479	.693		
EE	.410	.416	.379	.442	.424	.721	
PE	.404	.433	.397	.411	.440	.411	.740

Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use; the italic values along the diagonal line are the AVE values for the constructs, and the other values are the squared correlations for each pair of constructs

Source: researchers collate.

4.1.2 Model Fit Test

Goodness of fit refers to the goodness of fit between the research model used to test the hypothesis and the sample data collected during the study.Previous scholars used 13 indicators in the literature on optimal fitting of structural equation models, including GFI, AGFI, CFI, NNFI, SRMR, RMSEA, etc.This study mainly

adopted the evaluation indicators recommended by most scholars :χ2/df, GFI, AGFI , CFI,TLI , NNF, RMSEA(Sivo, Fan, Witta, & Willse, 2006).

The most common rules used in performing the CFA for measurement model and testing the structural model include stipulating that the goodness-of-fit index (GFI) should be greater than 0.9, the adjusted GFI (AGFI) should be greater than 0.9, the normalized fit index (NFI) should be greater than 0.9, the Tucker-Lewis index (TLI) should be greater than 0.9, the comparative fit index (CFI) should be greater than 0.9, the root mean square error of approximation (RMSEA) should be less than 0.08 (Byrne, 2001; Hair, Black, Babin, Anderson, & Tatham, 1998).

4.2 Common method bias

When using self-reported questionnaires to collect research data, people worried about a common method bias (Malhotra, Kim, & Patil, 2006). According to the research suggestions of relevant scholars, in order to prevent the threat of deviation from the common method (Podsakoff, 2003), in this study, it would ensure that the respondents' participation and response were completely anonymous, confidential, and voluntary, they had the right to withdraw or refuse to investigate at any time. Meanwhile, they were told that there were no correct or wrong answers, and they were required to reflect their true opinions as objectively as possible.

In the CFA model test, it was confirmed that the standardized load of each

item had reached more than 0.7. In addition, a common method bias test was required. Harman's single factor test using the CFA method could evaluate common method bias. In this study, CFA was used to test the fit degree of the single factor model (all items were loaded on one factor) and the eight factor model. The results showed that the index of a suitable single factor model(χ^2=2602.423, df=405, χ^2/ df=6.426, p<0.001, goodness-of-fit index (GFI)=0.620, adjusted GFI (AGFI)=0.564, normalized fit index (NFI)=0.838, Tucker-Lewis index (TLI)=0.849, comparative fit index (CFI)=0.860, and root mean square error of approximation (RMSEA)=0.117) not as good as the fit index of the eight-factor model (χ^2=1357.308, df= 395, χ^2/ df = 3.436 , p<0.001, goodness-of-fit index (GFI)=0.727, adjusted GFI (AGFI)=0.679, normalized fit index (NFI)=0.897, Tucker-Lewis index (TLI)=0.900, comparative fit index (CFI)=0.909, root mean square error of approximation (RMSEA)=0.095). It could be seen that the fit of the single-factor model was much worse than that of the multi-factor model, which indicated that the common method bias in this study was not a problem.

4.3 Descriptive statistical analysis of formal questionnaires

The sample data of this study included Chinese undergraduates and postgraduates.The analysis unit was for Chinese college students, who had used mobile phones to participate in classroom mobile learning or had independent mobile

learning experience. Specifically, the target group of this study was the college students from three representative universities in China, who had used or were using mobile learning. The survey sample selected three universities with regional and level representation in China, namely, provincial key comprehensive universities from the central, western, and southeastern coasts, “Double First-Class” comprehensive universities directly under the Ministry of Education, and provincial key professional universities. The survey subjects ranged from first-year undergraduates to graduate students. This study adopted the convenience sampling method of non-random sampling, and selected students with mobile learning experience from college students of different grades and majors as the research objects. Questionnaires for this study were collected through mobile Internet.The questionnaire star system was used to design and collect electronic questionnaires, which were distributed to three different universities by convenient sampling method. These questionnaires are arranged and filled out online in class by professional teachers under the coordination of professional college counselors. Based on the working day of each week, the questionnaire was completed within one week. A total of 548 questionnaires were recovered, with a recovery rate of 100%. According to the questionnaire data generated by the questionnaire star, the sample data with a filling time of less than 60 seconds were removed from our final sample, and the remaining sample questionnaires were used as valid questionnaires. Finally, 524 valid samples were obtained, with the proportion of valid questionnaires being 95.6%.

The background variables of this study include gender, grade, major, mobile learning experience and the form of participation in mobile learning. Gender is divided into male and female; Grades include freshman, sophomore, junior, senior, and graduate; Majors include liberal arts, science and art; Mobile learning experience refers to the length of time the respondents have participated in mobile learning courses, which can be divided into 6 months or less, 6-12 months, 13-18 months, 19-24 months and more than 24 months. Mobile learning form refers to which kind of work interviewees prefer to use for mobile learning, including downloading app learning, WECHAT following official account or WECHAT applet, WECHAT or QQ online learning.

A total of 524 valid questionnaires were analyzed in this study. Among available survey subjects, there were 177 men (33.78%) and 347 women (66.22%). In terms of majors, 162 (30.92%) majored in liberal arts, 203 (38.74%) majored in science, and 159 (30.34%) majored in art. The distribution of levels (by grade) was as follows: 101 freshmen (19.27%), 142 sophomores (27.1%), 152 juniors (29.01%), 88 seniors (16.79%), 41 postgraduates (7.82%). In addition, the distribution of using time (the respondents' experience in mobile learning via mobile devices) was as follows: 203 less than 6 months (38.74%), 130 6-12 months (24.81%), 38 13-18 months (7.25%), 24 19-24 months (3.05%) and 137 more than 24 months (26.15%). In addition, in terms of the tendency of respondents to adopt the form of mobile learning, 350 (66.79%) download apps to learn, 77 (14.69%) use WECHAT follow public

account or WeChat miniprogram for mobile learning, and 97 (18.51%) prefer WECHAT or QQ for mobile learning. The descriptive characteristics of available respondents are shown in Table 4.3.

Table4.3 Descriptive Statistics Analysis of Formal Questionnaire

Background Variable	Category	Number	Proportion
Gender	Male	177	33.78%
	Female	374	66.22%
Grade	Freshman	101	19.27%
	Sophomore	142	27.1%
	Junior	152	29.01%
	Senior	88	16.79%
	postgraduates	41	7.82%
major	Liberal arts	162	30.92%
	Sciences	203	38.74%
	Arts	159	30.34%
Experience	Less than 6 months	203	38.74%
	6 to 12 months	130	24.81%
	13 to 18 months	38	7.25%
	19 to24 months	24	3.05%
	More than 24 months	137	26.15%
Form	APP	350	66.79%
	WECHAT Official Accounts and Mini apps	77	14.69%
	WECHAT and QQ	97	18.51%

Source: researchers collate.

4.3.1 Status Analysis of Variable

The average and standard deviation of each dimension of mobile learning influencing factor scale are presented in table 4.4. It can be seen from the table that the average score of learning motivation scale is 3.753. The average score of each

dimension is 3.675, 3.844, 3.706, 3.771, 3.690, 3.900, 3.651 and 3.783, respectively, which are all higher than the average of 3. It can be seen that college students from China have a certain considerable degree of feelings on all aspects of mobile learning influencing factor and have a certain degree of positive consensus on mobile learning.

table 4.4 Current Status of mobile learning influencing factor

Dimension	Items	Mean	SD
Performance Expectancy	5	3.675	0.605
Effort expectancy	4	3.844	0.705
Perceived Credibility	5	3.706	0.732
Compatibility	5	3.771	0.651
Media Richness	5	3.690	0.653
Para-social Relationship	5	3.900	0.744
Personal Innovativeness	5	3.651	0.654
Intention to use	3	3.783	0.714

Source: researchers collate.

4.3.2 Variance Analysis

The purpose of this section is to discuss the differences in performance expectancy, effort expectancy, compatibility, perceived credibility, media richness, para-social relationship, personal innovativeness and intention to use mobile learning among students in China's higher education through t-test or one-way Anova.

If the result of one-way Anova analysis reaches the significant level, the significant difference is further tested in post hoc test by means of Scheffé (insignificant) or Dunnett's T3 (significant), which is selected according to whether the test for homogeneity of variance research significant (Jason Hsu, 1996).

1. Gender

The analysis and comparison of the differences in mobile learning influencing factors and its various dimensions of Chinese college students with different gender are shown in Table 4.5.

Table 4.5 Differences in Mobile Learning with Different Gender

Predictor	Background Variables	N	Mean	SD	*t*-value
Total scale	Male	177	3.716	0.736	-0.842
	Female	347	3.770	0.675	
Performance Expectancy	Male	177	3.6384	0.849	-0.738
	Female	347	3.6934	0.782	
Effort expectancy	Male	177	3.8446	0.798	0.014
	Female	347	3.8437	0.733	
Perceived Credibility	Male	177	3.6655	0.758	-0.905
	Female	347	3.7268	0.719	
Compatibility	Male	177	3.7254	0.775	-1.004
	Female	347	3.7942	0.723	
Media Richness	Male	177	3.6520	0.800	-0.818
	Female	347	3.7089	0.729	
Para-social Relationship	Male	177	3.6621	0.777	-0.840
	Female	347	3.7199	0.727	
Personal Innovativeness	Male	177	3.8090	0.792	-0.921
	Female	347	3.8732	0.734	
Intention to use	Male	177	3.7363	0.871	-0.907
	Female	347	3.8069	0.783	

Source: researchers collate.

It can be seen that:

There is no significant difference in the overall perception of mobile learning among Chinese college students with different gender (t=-0.842, p=0.400).

There is no significant difference in the perception of the dimension named performance expectancy among Chinese college students with different gender (t=-0.738, p=0.461). There is no significant difference in the perception of the dimension named effort expectancy among Chinese college students with different gender (t=0.014, p=0.989). There is no significant difference in the perception of the dimension named perceived credibility among Chinese college students with different gender (t=-0.905, p=0.366). There is no significant difference in the perception of the dimension named compatibility among Chinese college students with different gender (t=-1.004, p=0.316). There is no significant difference in the perception of the dimension named media richness among Chinese college students with different gender (t=-0.818, p=0.414). There is no significant difference in the perception of the dimension named para-social relationship among Chinese college students with different gender (t=-0.840, p=0.402). There is no significant difference in the perception of the dimension named personal innovativeness among Chinese college students with different gender (t=-0.921, p=0.358). There is no significant difference in the perception of the dimension named personal innovativeness among Chinese college students with different gender (t=-0.907, p=0.365).

This result is consistent with Cheng's (1991) study that there is no difference in learning motivation between male and female students. In the studies of many scholars (Chen, 2003; Lu, 1992; Ye, 2002), students of different gender show differences in learning motivation.

2. Grade

The analysis and comparison of the differences in mobile learning influencing factors and its various dimensions of Chinese college students with different grade are shown in Table 4.6.

Table 4.6 Differences in Mobile Learning with Different Grade

Predictor	Background Variables	N	Mean	SD	*F*-value	Post hoc Test
Total scale	Freshman (A)	101	3.5570	.69417	7.856***	C>A C>B C>D E>A E>B
	Sophomore (B)	142	3.6321	.62135		
	Junior (C)	152	3.9798	.73340		
	Senior (D)	88	3.7218	.68858		
	Postgraduate(E)	41	3.8751	.58926		
Performance Expectancy	Freshman (A)	101	3.3782	.81038	9.896***	C>A C>B,C>D D>A E>A,E>B
	Sophomore (B)	142	3.5479	.80166		
	Junior (C)	152	3.9447	.80238		
	Senior (D)	88	3.6568	.72331		
	Postgraduate(E)	41	3.8829	.63871		
Effort expectancy	Freshman (A)	101	3.4733	.73850	7.794***	C>A, C>B,C>D E>A, E>B,E>D
	Sophomore (B)	142	3.6239	.64158		
	Junior (C)	152	3.9684	.76135		
	Senior (D)	88	3.6364	.72685		
	Postgraduate(E)	41	3.7415	.66067		
Perceived Credibility	Freshman (A)	101	3.5584	.75117	8.553***	C>A C>B C>D E>A
	Sophomore (B)	142	3.6690	.66356		
	Junior (C)	152	3.9921	.75918		
	Senior (D)	88	3.7364	.77165		
	Postgraduate(E)	41	3.9024	.63423		
Compatibility	Freshman (A)	101	3.5584	.75117	6.779***	C>A E>A
	Sophomore (B)	142	3.6690	.66356		
	Junior (C)	152	3.9921	.75918		
	Senior (D)	88	3.7364	.77165		
	Postgraduate(E)	41	3.9024	.63423		

Table 4.6 (continued)

Predictor	Background Variables	N	Mean	SD	*F*-value	Post hoc Test
Media Richness	Freshman (A)	101	3.5446	.77052	6.902***	C>A C>B C>D C>E
	Sophomore (B)	142	3.5662	.66736		
	Junior (C)	152	3.9500	.75931		
	Senior (D)	88	3.6341	.77502		
	Postgraduate(E)	41	3.6293	.72050		
Para-social Relationship	Freshman (A)	101	3.5545	.73804	5.515***	C>A C>B C>D C>E
	Sophomore (B)	142	3.5930	.66157		
	Junior (C)	152	3.9276	.77905		
	Senior (D)	88	3.6727	.73979		
	Postgraduate(E)	41	3.6488	.75071		
Personal Innovativeness	Freshman (A)	101	3.7267	.77238	4.078**	C>A C>B E>B
	Sophomore (B)	142	3.7225	.69603		
	Junior (C)	152	4.0171	.78359		
	Senior (D)	88	3.8455	.73827		
	Postgraduate(E)	41	4.0049	.71622		
Intention to use	Freshman (A)	101	3.6139	.79265	7.829***	C>A C>B D>B E>A E>B
	Sophomore (B)	142	3.5704	.79753		
	Junior (C)	152	4.0219	.80256		
	Senior (D)	88	3.8144	.77453		
	Postgraduate(E)	41	3.9837	.78864		

Source: researchers collate.
Note: *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

We can see from the table that:

There is significant difference in the overall perception of mobile learning among Chinese college students with different grade (F=7.856, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than Freshman (I-J=0.422, p=0.000), Sophomore (I-J=0.347, p=0.000), Senior (I-J=0.257, p=0.005); Postgraduate also have a significantly higher than Freshman (I-J=0.318, p=0.012), Sophomore (I-J=0.242, p=0.044).

There is significant difference in the dimension named performance expectancy among Chinese college students with different grade (F=9.896, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than Freshman (I-J=0.566, p=0.000), Sophomore (I-J=0.396, p=0.000), Senior (I-J=0.287, p=0.006); Senior have a significantly higher perception than Freshman (I-J=0.278, p=0.015); Postgraduate also have a significantly higher than Freshman (I-J=0.504, p=0.001), Sophomore (I-J=0.335, p=0.016).

There is significant difference in the dimension named effort expectancy among Chinese college students with different grade (F=7.794, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than Freshman (I-J=0.410, p=0.000), Sophomore (I-J=0.252, p=0.003), Senior (I-J=0.238, p=0.016); Postgraduate also have a significantly higher than Freshman (I-J=0.600, p=0.001), Sophomore (I-J=0.443, p=0.001), Senior (I-J=0.428, p=0.002).

There is significant difference in the dimension named perceived credibility among Chinese college students with different grade (F=8.553, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than Freshman (I-J=0.495, p=0.000), Sophomore (I-J=0.344, p=0.000), Senior (I-J=0.332, p=0.001); Postgraduate also have a significantly higher than Freshman (I-J=0.268, p=0.043).

There is significant difference in the dimension named compatibility among

Chinese college students with different grade (F=6.779, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than freshman (I-J=0.433, p=0.000), sophomore (I-J=0.323, p=0.000), senior (I-J=0.255, p=0.009); Postgraduate also have a significantly higher than Freshman (I-J=0.344, p=0.011).

There is significant difference in the dimension named media richness among Chinese college students with different grade (F=6.902, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than freshman (I-J=0.405, p=0.000), sophomore (I-J=0.383, p=0.000), Senior (I-J=0.315, p=0.001), and postgraduate (I-J=0.320, p=0.014).

There is significant difference in the dimension named para-social relationship among Chinese college students with different grade (F=5.515, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than freshman (I-J=0.373, p=0.000), sophomore (I-J=0.334, p=0.000),senior (I-J=0.254, p=0.010), and postgraduate (I-J=0.278, p=0.031).

There is significant difference in the dimension named Personal Innovativeness among Chinese college students with different grade (F=4.078, p=0.003). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than Freshman (I-J=0.290, p=0.003), sophomore (I-J=0.294, p=0.001); Postgraduate also have a significantly higher than sophomore (I-J=0.282, p=0.033).

There is significant difference in the dimension named Intention to use among Chinese college students with different grade (F=7.829, p=0.000). The result of Scheffé method for post hoc test shows that Junior have a significantly higher perception than freshman (I-J=0.408, p=0.000), sophomore (I-J=0.451, p=0.000); Senior have a significantly higher perception than sophomore (I-J=0.243, p=0.024); Postgraduate also have a significantly higher than freshman (I-J=0.369, p=0.012), Sophomore (I-J=0.413, p=0.003).

3. Major

The analysis and comparison of the differences in mobile learning influencing factors and its various dimensions of Chinese college students with different major are shown in Table 4.7.

Table 4.7 Differences in Mobile Learning with Different Major

Predictor	Background Variables	N	Mean	SD	F-value	Post hoc Test
Total scale	Liberal arts(A)	162	3.923	0.721	7.839***	A>B A>C
	Sciences(B)	203	3.642	0.676		
	Arts(C)	159	3.718	0.664		
Performance Expectancy	Liberal arts(A)	162	3.869	0.815	7.166***	A>B A>C
	Sciences(B)	203	3.565	0.764		
	Arts(C)	159	3.616	0.815		
Effort expectancy	Liberal arts(A)	162	4.044	0.744	10.181***	A>B A>C
	Sciences(B)	203	3.692	0.761		
	Arts(C)	159	3.833	0.716		
Perceived Credibility	Liberal arts(A)	162	3.908	0.779	10.730***	A>B A>C
	Sciences(B)	203	3.558	0.705		
	Arts(C)	159	3.688	0.671		

Table 4.7 (continued)

Predictor	Background Variables	N	Mean	S.D.	*F*-value	Post hoc Test
Compatibility	Liberal arts(A)	162	3.937	0.752	6.781**	A>B A>C
	Sciences(B)	203	3.654	0.760		
	Arts(C)	159	3.750	0.677		
Media Richness	Liberal arts(A)	162	3.843	0.788	5.738**	A>B A>C
	Sciences(B)	203	3.577	0.733		
	Arts(C)	159	3.676	0.721		
Para-social Relationship	Liberal arts(A)	162	3.830	0.805	4.748**	A>B
	Sciences(B)	203	3.591	0.711		
	Arts(C)	159	3.706	0.702		
Personal Innovativeness	Liberal arts(A)	162	4.008	0.775	5.206**	A>B A>C
	Sciences(B)	203	3.771	0.735		
	Arts(C)	159	3.793	0.736		
Intention to use	Liberal arts(A)	162	3.948	0.833	5.040**	A>B A>C
	Sciences(B)	203	3.727	0.771		
	Arts(C)	159	3.685	0.826		

Source: researchers collate.
Note: *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

We can see from the table that:

There is significant difference in the overall perception of mobile learning among Chinese college students with different major (F=7.839, p=0.000). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.281, p=0.000), arts (I-J=0.204, p=0.008).

There is significant difference in the dimension named performance expectancy among Chinese college students with different major (F=7.166, p=0.001). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.303, p=0.000), arts (I-J=0.252,

p=0.005).

There is significant difference in the dimension named effort expectancy among Chinese college students with different major (*F*=10.181, p=0.000). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.352, *p*=0.000), arts (I-J=0.211, *p*=0.011).

There is significant difference in the dimension named perceived credibility among Chinese college students with different major (*F*=10.730, p=0.000). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.350, *p*=0.000), arts (I-J=0.220, *p*=0.006).

There is significant difference in the dimension named compatibility among Chinese college students with different major (*F*=6.781, *p*=0.001). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.282, *p*=0.000), arts (I-J=0.186, *p*=0.023).

There is significant difference in the dimension named media richness among Chinese college students with different major (*F*=5.738, *p*=0.003). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.265, *p*=0.001), arts (I-J=0.166, *p*=0.046).

There is significant difference in the dimension named para-social relationship among Chinese college students with different major (*F*=4.748, *p*=0.009). The result of Scheffé method for post hoc test shows that liberal arts have a

significantly higher perception than sciences (I-J=0.239, *p*=0.002).

There is significant difference in the dimension named personal Innovativeness among Chinese college students with different major (*F*=5.206, *p*=0.006). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.237, p=0.003), arts (I-J=0.214, *p*=0.010).

There is significant difference in the dimension named intention to use among Chinese college students with different major (*F*=5.040, *p*=0.007). The result of Scheffé method for post hoc test shows that liberal arts have a significantly higher perception than sciences (I-J=0.221, *p*=0.010), arts (I-J=0.263, *p*=0.004).

It can be seen from the analysis that there is significant difference in the overall perception of mobile learning among Chinese college students with different major , and there are also significant differences at different dimensions. In the dimension of quasi-social relations, liberal arts students' perception of para-social relations is significantly higher than that of science students. In addition, the perception of liberal arts students on factors affecting mobile learning is significantly higher than that of science and art majors.

4. Experience

The analysis and comparison of the differences in mobile learning influencing factors and its various dimensions of Chinese college students with different experience are shown in Table 4.8.

Table 4.8 Differences in Mobile Learning with Different Experience

Predictor	Background Variables	N	Mean	SD	*F*-value	Post hoc Test
Total scale	Less than 6 months(A)	203	3.654	0.734	6.142***	E>A E>B E>C
	6 to 12 months(B)	130	3.649	0.652		
	13to18 months(C)	38	3.710	0.638		
	19 to24 months(D)	16	3.916	0.617		
	More than 24 months(E)	137	3.988	0.650		
Performance Expectancy	Less than 6 months(A)	203	3.549	0.818	10.647***	E>A E>B E>C
	6 to 12 months(B)	130	3.498	0.821		
	13to18 months(C)	38	3.573	0.674		
	19 to24 months(D)	16	3.875	0.664		
	More than 24 months(E)	137	4.032	0.706		
Effort expectancy	Less than 6 months(A)	203	3.681	0.803	6.831***	E>A E>B
	6 to 12 months(B)	130	3.811	0.694		
	13to18 months(C)	38	3.848	0.611		
	19 to24 months(D)	16	3.937	0.771		
	More than 24 months(E)	137	4.104	0.707		
Perceived Credibility	Less than 6 months(A)	203	3.647	0.771	2.935*	E>A E>B
	6 to 12 months(B)	130	3.620	0.695		
	13to18 months(C)	38	3.636	0.709		
	19 to24 months(D)	16	3.912	0.688		
	More than 24 months(E)	137	3.870	0.697		
Compatibility	Less than 6 months(A)	203	3.654	0.777	6.544***	E>A E>B E>C
	6 to 12 months(B)	130	3.670	0.698		
	13to18 months(C)	38	3.731	0.601		
	19 to24 months(D)	16	3.937	0.687		
	More than 24 months(E)	137	4.030	0.708		
Media Richness	Less than 6 months(A)	203	3.643	0.789	2.906*	E>A E>B
	6 to 12 months(B)	130	3.573	0.702		
	13to18 months(C)	38	3.673	0.750		
	19 to24 months(D)	16	3.962	0.537		
	More than 24 months(E)	137	3.840	0.747		
Para-social Relationship	Less than 6 months(A)	203	3.644	0.784	2.486*	E>A E>B
	6 to 12 months(B)	130	3.638	0.683		
	13to18 months(C)	38	3.584	0.729		

Table 4.8 (continued)

Predictor	Background Variables	N	Mean	SD	*F*-value	Post hoc Test
Para-social Relationship	19 to24 months(D)	16	3.925	0.627	2.486*	E>A
	More than 24 months(E)	137	3.848	0.738		E>B
Personal Innovative-ness	Less than 6 months(A)	203	3.75	0.780	5.887***	E>A
	6 to 12 months(B)	130	3.738	0.694		E>B
	13to18 months(C)	38	3.831	0.710		E>C
	19 to24 months(D)	16	3.862	0.639		
	More than 24 months(E)	137	4.110	0.740		
Intention to use	Less than 6 months(A)	203	3.663	0.842	6.721***	E>A
	6 to 12 months(B)	130	3.643	0.780		E>B
	13to18 months(C)	38	3.807	0.796		
	19 to24 months(D)	16	3.916	0.811		
	More than 24 months(E)	137	4.070	0.739		

Source: researchers collate.
Note: *** p<0.001, ** p<0.01, * p<0.05.

We can see from the table that:

There is significant difference in the overall perception of mobile learning among Chinese college students with different experience (F=6.142, p=0.000). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.334, p=0.000), 6 to 12 months (I-J=0.339, p=0.000), 13to18 months (I-J=0.277, p=0.027).

There is significant difference in the dimension named performance expectancy among Chinese college students with different experience (F=10.647, p=0.000). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.482, p=0.000), 6 to 12 months (I-J=0.533, p=0.000), 13to18 months (I-J=0.458, p=0.001).

There is significant difference in the dimension named effort expectancy among Chinese college students with different experience (F=6.831, *p*=0.000). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.422, *p*=0.000), 6 to 12 months (I-J=0.292, *p*=0.001).

There is significant difference in the dimension named perceived credibility among Chinese college students with different experience (F=6.831, *p*=0.000). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.223, *p*=0.006), 6 to 12 months (I-J=0.250, *p*=0.005).

There is significant difference in the dimension named compatibility among Chinese college students with different experience (*F*=6.544, *p*=0.000). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.376, *p*=0.000), 6 to 12 months (I-J=0.359, *p*=0.000), 13to18 months (I-J=0.299, *p*=0.025).

There is significant difference in the dimension named media richness among Chinese college students with different experience (*F*=2.906, *p*=0.021). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.197, *p*=0.017), 6 to 12 months (I-J=0.267, *p*=0.004).

There is significant difference in the dimension named para-social

relationship among Chinese college students with different experience (F=2.486, p=0.043). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.204, p=0.013), 6 to 12 months (I-J=0.210, p=0.021).

There is significant difference in the dimension named personal innovativeness among Chinese college students with different experience (F=5.887, p=0.000). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.359, p=0.000), 6 to 12 months (I-J=0.372, p=0.000), 13to18 months (I-J=0.279, p=0.040).

There is significant difference in the dimension named intention to use among Chinese college students with different experience (F=6.142, p=0.021). The result of Scheffé method for post hoc test shows that more than 24 months have a significantly higher perception than less than 6 months (I-J=0.407, p=0.000), 6 to 12 months (I-J=0.426, p=0.000).

It can be seen from the analysis that there is significant difference in the overall perception of mobile learning among Chinese college students with different experience , and there are also significant differences at different dimensions. Among them, the perception of mobile learning users with more than 24 months on factors affecting mobile learning is significantly higher than that of less than 6 months, 6 to 12 months and 13to18 months. Thus it can be seen that the richer the m-learning experience is, the stronger the perception of m-learning influencing factors will be.

5. Form

The analysis and comparison of the differences in mobile learning influencing factors and its various dimensions of Chinese college students with different learning form are shown in Table 4.9.

Table 4.9 Differences in Mobile Learning with Different learning form

Predictor	Background Variables	N	Mean	SD	*F*-value	Post hoc Test
Total scale	APP(A)	350	3.740	0.704	0.685	-
	WeChat and QQ(B)	77	3.837	0.704		
	MP(C)	97	3.727	0.662		
Performance Expectancy	APP(A)	350	3.670	0.806	0.931	-
	WeChat and QQ(B)	77	3.776	0.810		
	MP (C)	97	3.610	0.800		
Effort expectancy	APP(A)	350	3.843	0.765	0.721	-
	WeChat and QQ(B)	77	3.922	0.740		
	MP (C)	97	3.783	0.734		
Perceived Credibility	APP(A)	350	3.677	0.739	1.700	-
	WeChat and QQ(B)	77	3.846	0.720		
	MP (C)	97	3.699	0.713		
Compatibility	APP(A)	350	3.757	0.752	1.030	-
	WeChat and QQ(B)	77	3.880	0.766		
	MP (C)	97	3.732	0.680		
Media Richness	APP(A)	350	3.657	0.754	1.391	-
	WeChat and QQ(B)	77	3.813	0.798		
	MP(C)	97	3.709	0.711		
Para-social Relationship	APP(A)	350	3.681	0.749	0.579	-
	WeChat and QQ(B)	77	3.781	0.769		
	MP (C)	97	3.705	0.707		
Personal Innovativeness	APP(A)	350	3.848	0.762	0.027	-
	WeChat and QQ(B)	77	3.870	0.759		
	MP (C)	97	3.849	0.728		

Table 4.9 (continued)

Predictor	Background Variables	N	Mean	SD	*F*-value	Post hoc Test
Intention to use	APP(A)	350	3.791	0.824	0.250	-
	WeChat and QQ(B)	77	3.809	0.804		
	MP (C)	97	3.732	0.788		

Source: researchers collate.
Note: *** p<0.001, ** p<0.01, * p<0.05.

We can see from the table that:

There is no significant difference in the overall perception of mobile learning among Chinese college students with different learning form (*F*=0.685, p=0.504). There is no significant difference in the dimension named performance expectancy among Chinese college students with different learning form (*F*=0.931, *p*=0.395). There is no significant difference in the dimension named effort expectancy among Chinese college students with different learning form (*F*=0.7221, *p*=0.487). There is no significant difference in the dimension named perceived credibility among Chinese college students with different learning form (*F*=1.700, *p*=0.184). There is no significant difference in the dimension named compatibility among Chinese college students with different learning form (*F*=1.030, *p*=0.358). There is no significant difference in the dimension named media richness among Chinese college students with different learning form (*F*=1.391, *p*=0.250). There is no significant difference in the dimension named para-social relationship among Chinese college students with different learning form (*F*=0.579, *p*=0.561). There is no significant difference in the

dimension named personal Innovativeness among Chinese college students with different learning form (F=0.027, p=0.973). There is no significant difference in the dimension named intention to use among Chinese college students with different learning form (F=0.250, p=0.779).

It can be seen from the analysis that there is no significant difference in the overall perception of mobile learning among Chinese college students with different learning form , and there are also no significant differences at different dimensions.

4.4 Structural model analysis

The aim of this research is to reveal the factors that intention to use mobile learning and improve our understanding of the interaction of those factors. Through structural model analysis, this part will investigate the influence of various influencing factors on the intention to use mobile learning, as well as the mediating role of direct variables between external variables and intention to use mobile learning. The proposed model was tested using structural equation modeling (SEM) and partial least squares (PLS) analysis (CM Ringle, Wende, & Will, 2005). Because PLS is thought to be better suited to explaining complex relationships (Chin 2010). Structural equation modeling (SEM) has been widely used in recent years. SEM is a term for a large set of techniques based on the general linear model (Ullman & Bentler, 2003). This technique has become very popular in recent years for data analysis in

education, psychology, business and other disciplines (Finney & DiStefano, 2006). Partial least squares (PLS) is a form of SEM.In recent years, PLS method has been widely used in many studies in the field of education because it does not require a model to explain the covariance of all indicators, and the underlying variables of the model can be tested under non-normal conditions (Karjaluoto, Püschel, Mazzon, & Hernandez, 2010). Using partial least squares (PLS) analysis, relatively complex models can be estimated with small sample sizes (Henseler & Fassott, 2010). In this study, the software package employed was Smart PLS version 2.0. Smart PLS does not provide a fit indicator for the overall model. Instead, it determines the explanatory power of the model by determining whether the standardized path coefficient is statistically significant and a value of R^2, the higher the value, the better the model's explanatory power (Fornel & Lacker, 1981; Anderson, Tatham, & Black,1998; Medina & Chaparro, 2008; Pavlou & Fygenson, 2006).

4.4.1 Assessing formative measurement models

Formative measurement models are evaluated based on the following: convergent validity, indicator collinearity, statistical signifificance, and relevance of the indicator weights (Hair Jr, Hult, Ringle, & Sarstedt, 2016). Hair *et al*. (2017a) suggest that the correlation of the formatively measured construct with the single-item construct, measuring the same concept, should be 0.70 or higher. PLS-SEM is a nonparametric method and therefore, bootstrapping is used to determine statistical significance. Hair *et al.* (2017a) suggest using BCa bootstrap confidence intervals for

significance testing in case the bootstrap distribution of the indicator weights is skewed. When *p*-value is less than 0.05 or 95% confidence interval (based on percentile method or BCa method in the case of slanted bootstrap distribution) without zero, the statistical significance of weight is achieved(Hair, Risher, Sarstedt, & Ringle, 2019).

The variance inflflation factor (VIF) is often used to evaluate collinearity of the formative indicators (Hair et al., 2019). VIF values above 5 are indicative of probable collinearity issues among the predictor constructs, but collinearity problems can also occur at lower VIF values of 3-5 (Becker, Ringle, Sarstedt, & Völckner, 2015). Ideally, the VIF values should be close to 3 and lower.

If collinearity is not an issue, the next step is examining the R^2 value of the endogenous construct(s) (Hair et al., 2019). The R^2 measures the variance, which is explained in each of the endogenous constructs and is therefore a measure of the model's explanatory power (Shmueli & Koppius, 2011). R^2 is also known as the in sample predictive power (C Ringle, Sarstedt, & Straub, 2012). The R^2 ranges from 0 to 1, with higher values indicating a greater explanatory power. As a guideline, R^2 values of 0.75, 0.50, and 0.25 can be considered substantial, moderate and weak, R^2 values of 0.90 and higher are typical indicative of over fit (Henseler, Ringle, & Sinkovics, 2009). The R^2 is a function of the number of predictor constructs - the greater the number of predictor constructs, the higher the R^2.

Another means to assess the PLS path model's predictive accuracy is by

calculating the Q^2 value. the Q^2 is not a measure of out-of-sample prediction, but rather combines aspects of out-of-sample prediction and in-sample explanatory power (Hair Jr *et al*., 2016). Q^2 values larger than zero are meaningful, Q^2 values higher than 0, 0.25 and 0.50 depict small, medium and large predictive accuracy of the PLS path model (Hair *et al.*, 2019).

To assess the structural model, Hair *et al.* (2013) suggested looking at the R^2 , beta, and corresponding t-values via bootstrapping procedure with a resample of 5000. In addition to these basic measurements, they also suggested that researchers also need to report predictive correlations (Q^2) . First, we evaluated the relationships between the variables.

4.4.2 Path coefficient analysis

1. cognitive factors from the UTAUT (including PE and EE)

The results indicated that Performance Expectancy was positively and significantly associated with mobile learning intention to use (β = 0.246, p < .01), hypotheses 1 was supported. At the same time, Performance Expectancy was positively and significantly associated with perceived credibility (β = 0.227, p < .01), hypotheses 3 was supported. However, the relationship between effort expectancy and mobile learning intention to use was not significant (β = 0.055), hypotheses 2 was not supported. The Effort Expectancy was also positively influenced by Perceived Credibility (β = 0.297, p < .01). Thus, hypothesis 4 in this study was supported.

2. Perceived Credibility

Affective factors (including perceived credibility) were investigated in terms of the source credibility theory. The results indicated that perceived credibility was positively and significantly associated with mobile learning intention to use (β = 0.175, p < .01), hypotheses 5 was supported. The perceived credibility on mobile learning was also positively influenced by Para-social Relationship (β = 0.203, p < .01)，Media Richness (β = 0.255, p < .01)，and compatibility (β = 0.295, p < .01) . Thus, hypothesis 9b, hypothesis 6, and hypothesis 11b in this study were all supported.

3. External factors

According to the structure of the model, the three external expansion variables were analyzed. Relationships between the dimensions derived from para-social relationship theory (including PSR) and the Media Richness theory (including MR) and innovation diffusion theory (including Compatibility) dimensions were analyzed.

The results indicated that media richness (MR) was positively and significantly associated with para-social relationship (PSR) (β = 0.899, p < .01), hypotheses 7 was supported. At the same time, media richness (MR) was positively and significantly associated with compatibility (COM) (β= 0.852, p < .01), hypotheses 8 was supported. In terms of the direct effects of factors, We found that MR has a great influence on both PSR factor and compatibility factor, and the influence on PSR factor is greater than that on compatibility factor. Para-social relationship (PSR) was

positively and significantly associated with performance expectancy (PE) (β = 0.852, p < .01), hypotheses 9a was supported.

The results indicated that compatibility (COM) was positively and significantly associated with effort expectancy (EE) (β = 0.571, p < .01), hypotheses 11a was supported. At the same time, compatibility (COM) was positively and significantly associated with mobile learning intention to use (ITU) (β = 0.411, p < .01), Thus hypotheses 12 was supported.

Table 4.10 presents the causal paths, including standardized path coefficients and t values for evaluating the structural model. Hair *et al.* (2013) suggested looking at the corresponding t-values via bootstrapping procedure with a resample of 5000.

Table 4.10 Results of model effects.

	Hypothesized paths	Path coefficients	T-value
H1	PE is positively associated with ITU	0.246*	3.768
H2	EE is positively associated with ITU	0.055	0.859
H3	PE is positively associated with PC	0.227*	5.067
H4	PC is positively associated with EE	0.297**	4.500
H5	PC is positively associated with ITU	0.175*	2.593
H6	MR is positively associated with PC	0.255**	4.571

Table 4.10 (continued)

	Hypothesized paths	Path coefficients	T-value
H7	MR is positively associated with PSR	0.725***	85.294
H8	MR is positively associated with COM	0.852***	51.993
H9a	PSR is positively associated with PE	0.761***	25.844
H9b	PSR is positively associated with PC	0.203*	3.651
H11a	COM is positively associated with EE	0.571***	9.033
H11b	COM is positively associated with PC	0.295**	5.911
H12	COM is positively associated with ITU	0.411***	5.395

Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use;

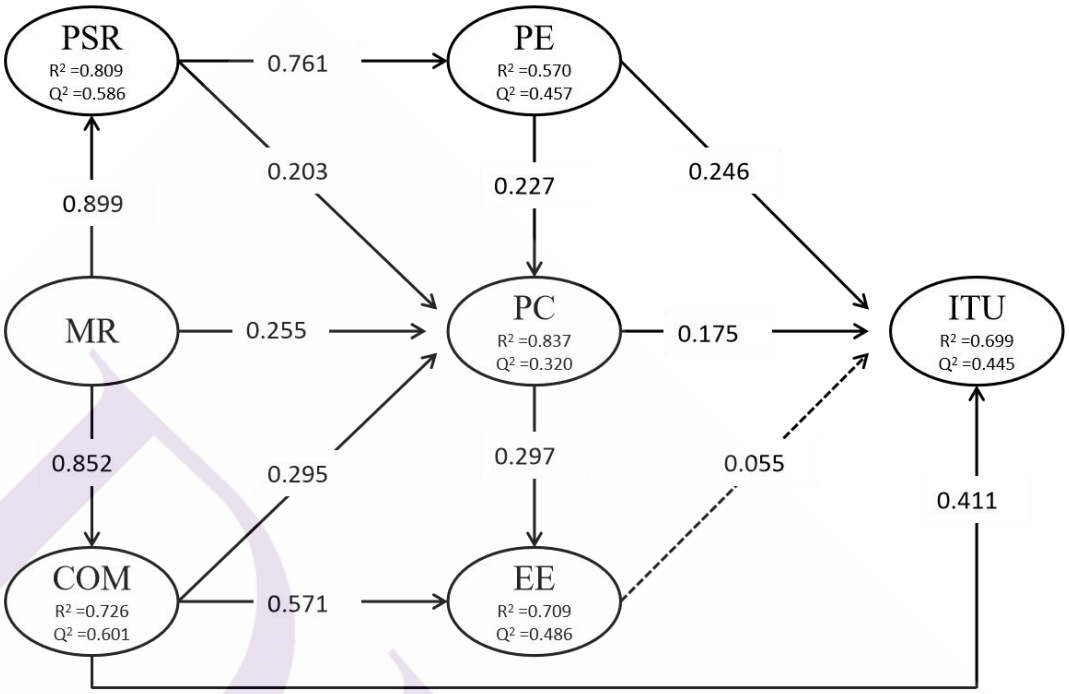
***Significant at the .01 level.
**Significant at the .05 level.
*Significant at the .10 level.

4.4.3 Explanatory power analysis of the model

In the PLS analysis, examining the structural paths helps to evaluate the explanatory power of the structural model, and examining the R2 scores of endogenous variables can evaluate the utility of the variables. Para-social relationship (PSR) explains 57.0% of variance in performance expectancy (PE) (R^2=0.570). All influencing factors explains 69.9% of variance in intention to use (R^2=0.699); Performance expectancy (PE), media richness (MR), para-social relationship (PSR)

and compatibility explains 83.7% of variance in perceived credibility (PC) (R^2=0.837). Whereas performance expectancy (PE), media richness (MR), para-social relationship (PSR), compatibility, and perceived credibility (PC) explains 70.9% of variance in effort expectancy (EE) (R^2=0.709). We used Henseler's (2009) guidelines, R^2 values of 0.75, 0.50, and 0.25 can be considered substantial, moderate and weak, R^2 values of 0.90 and higher are typical indicative of over fit. As shown in Fig. 4.1, R^2 for endogenous variables indicate acceptable explanatory power.

Based on the blindfolding procedure, Q^2 shows how well data can be reconstructed empirically using the model and the PLS parameters. For this study, Q^2 was obtained using cross-validated redundancy procedures. A Q^2 greater than 0 means that the model has predictive relevance, whereas a Q^2 less than 0 means the model lacks predictive relevance. we used Hair *et al.*(2019) guidelines, Q^2 values larger than zero are meaningful, Q^2 values higher than 0, 0.25 and 0.50 reflect the small, medium and large prediction accuracy of the PLS path model (Hair et al., 2019). As shown in Fig. 4.1, Q^2 for endogenous variables indicate acceptable predictive relevance. Table 4.10 present the properties of the causal paths, including standardized path coefficients, R^2, Q^2 to assess the structural model, and explained variance for each equation in the hypothesized model. Hair *et al.* (2013) suggested looking at the R^2 , beta, and corresponding t-values via bootstrapping procedure with a resample of 5000.



Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use.

Figure 4.1Model testing results

Source: researchers collate.

4.4.4 Mediation Analysis in the model

To understand the relevance of testing mediating effects in a PLS -SEM , it is first necessary to understand what mediating effects are. "Mediation is one way that a researcher can explain the process or mechanism by which one variable affects another " (MacKinnon, Fairchild, & Fritz, 2007). Preacher and Hayes (2008) summarized this approach as follows: Variable M is a mediator if X (Independent variable) significantly accounts for variability in M, X significantly accounts for

variability in Y(dependent variable), M significantly accounts for variability in Y when controlling for X, and the effect of X on Y decreases substantially when M is entered simultaneously with X as a predictor of Y. The path coefficient of the independent variable to the mediator variable, the path coefficient of the independent variable to the dependent variable must be significant, and the path coefficient of the intermediate variable to the dependent variable must be significant, then the mediator variable is valid (Baron & Kenny, 1986).

This research model is a complex model involving multiple mediations. However, when more than one mediating effect is present, the abovementioned differentiation between direct and indirect effects for detecting mediation relationships remain s applicable, and the above recommendations remain unchanged (MacKinnon et al., 2007). Now, the commonly used method for testing the mediating effect is the Sobel test (1982), which is the exact formula for testing the effect of the path. This test is a direct test of whether "intermediate variable → mediator variable × mediator variable → dependent variable" is significant. In other words, Sobel test is to see whether the indirect effect is significant. According to the suggestion of Preacher and Hayes (2004), Sobel test is calculated with path coefficient and estimation standard error, and when Z-value is greater than or equal to 1.96, the mediation effect is significant (Preacher & Hayes, 2004).

According to the research model, the direct and indirect effects among the variables were established respectively, and the effects among the variables were

shown in Table 4.11

Table 4.11 Results of Mediation effect test

Independent Variable (X)	Mediator Variable (M)	Dependent Variable (Y)	X-M	M-Y	Sobel Test	Results
PSR	PE	ITU	0.761	0.246	3.728***	Supported
PE	PC		0.227	0.175	2.308*	Supported
MR	PC		0.255	0.175	2.255*	Supported
COM	PC		0.295	0.175	2.375**	Supported
MR	PSR	PC	0.899	0.203	3.648***	Supported
MR	COM		0.852	0.295	5.873***	Supported
PSR	PE		0.761	0.227	4.972***	Supported
COM	PC	EE	0.295	0.297	3.580***	Supported
PE	PC		0.227	0.297	3.365***	Supported
MR	PC		0.255	0.297	3.207***	Supported
PSR	PC		0.203	0.297	2.835**	Supported

Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM -Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use;

***Significant at the .01 level.
**Significant at the .05 level.
*Significant at the .10 level.

According to the path results described above, the relationship between effort expectancy (EE) and mobile learning intention to use (ITU) was not significant (β = 0.055). Therefore, the mediation effect between these two variables does not participate in the verification at this stage. From the results of table 4.11, the criteria for building up mediation effect were fulfilled of all other mediation paths in the model.

The results indicate that performance expectancy （PE), media richness

(MR) and compatibility (COM) can indirectly make significant positive impacts on learners' usage intention of m-learning through perceived credibility, whereas para-social relationship (PSR) can also indirectly make a significant positive impact on learners' usage intention of m-learning through performance expectancy (PE). Media richness (MR) can indirectly make a significant positive impact on perceived credibility (PC) through para-social relationship (PSR) and compatibility (COM); Whereas para-social relationship (PSR) can also indirectly make a significant positive impact on perceived credibility (PC) through performance expectancy (PE). Finally, para-social relationship (PSR), media richness (MR), compatibility (COM) and performance expectancy (PE) can also indirectly make a significant positive impact on effort expectancy (EE) through perceived credibility (PC).

The results show the direct and indirect effects between the various variable structures in the model. These relationships will be discussed in detail in the next chapter in light of the current situation of mobile learning in China.

4.5 Moderating effects of personal innovativeness

This study hypothesized personal innovativeness (PI) would have a moderation effect on the relationships between performance expectancy(PE), perceived credibility (PC) and intention to use mobile learning. Moderation analysis is assessed by applying PLS product-indicator approach. As stated by Chin, Marcolin,

and Newsted (2003), PLS can give more accurate estimates of moderator effects by accounting for the error that attenuates the estimated relationships and improves the validation of theories (Henseler & Fassott, 2010). In the process of testing the mediation effect, we present the PLS product-indicator approach (Chin et al., 2003) to detect the moderating effect of personal innovativeness (PI) as the moderator in the model.

In the test analysis of the previous model, hypothesis 2 was not supported because the relationship between effort expectancy (EE) and mobile learning willingness was not significant (β = 0.055). Therefore, personal innovativeness (PI) could not moderate the relationship between effort expectancy (EE) and intention to use m-learning according to the principle of the test of moderating effect, so we reject H10c: personal innovativeness (PI) will negatively moderate the effect of effort expectancy (EE) on intention to use m-learning. In the following analysis of the moderating effect, what needs to be detected is the moderating effect of personal innovativeness (PI) on the relationship between performance expectancy (PE) and intention to use m-learning, as well as the moderating effect of personal innovativeness (PI) on the relationship between perceived credibility (PC) and intention to use m-learning.

4.5.1 The test of moderating model

To test the possibility of such effect, predictor (performance expectancy; perceived credibility) and moderator (personal innovativeness) were multiplied to

create an interaction construct (performance expectancy × personal innovativeness; perceived credibility × personal innovativeness) to predict continuance intentions (Chin et al., 2003; Henseler & Fassott, 2010). The AVE and CR of the interaction variable (performance expectancy × personal innovativeness) are respectively 0.888 and 0.995. And the AVE and CR of the interaction variable (perceived credibility × personal innovativeness) are respectively 0.876 and 0.994, which all exceed the minimum cut off value.

To test the moderating effect, we have estimated the influence of predictor on criterion variable, the direct impact of the moderating variable (personal innovativeness) on the criterion variable (intention to use m-learning) and the influence of interaction variable (performance expectancy × personal innovativeness; perceived credibility × personal innovativeness) on criterion variable (intention to use m-learning). PLS software was used to draw the moderate model diagram, and the moderating path (a, b) was shown as follows(see Fig. 4.2). Performance expectancy (PE) and perceived credibility (PC) were used as independent variables and personal innovativeness was used as the moderator variable.

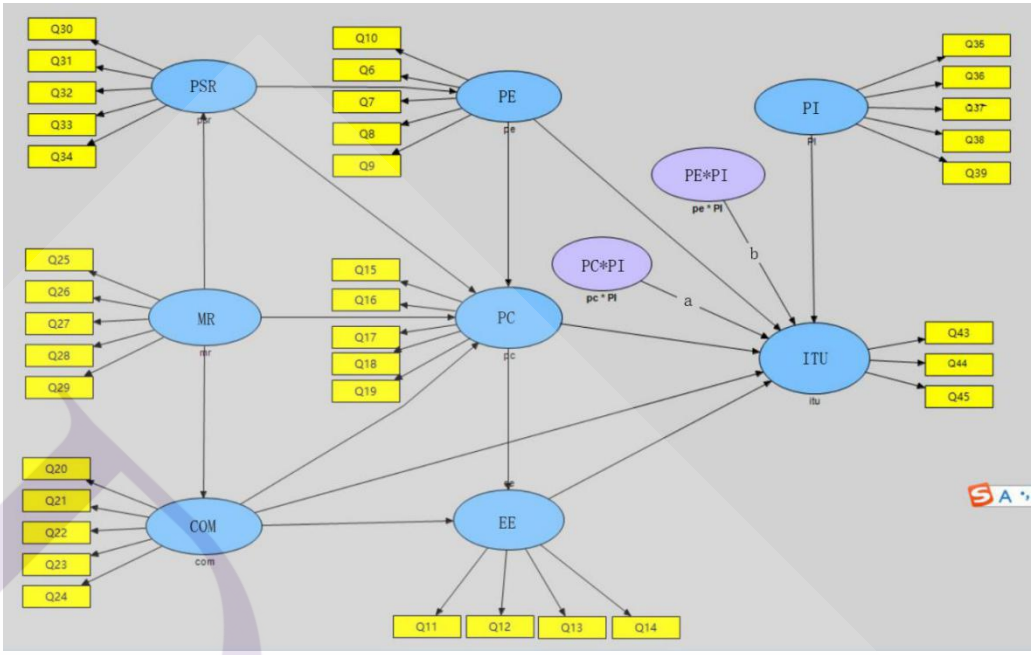
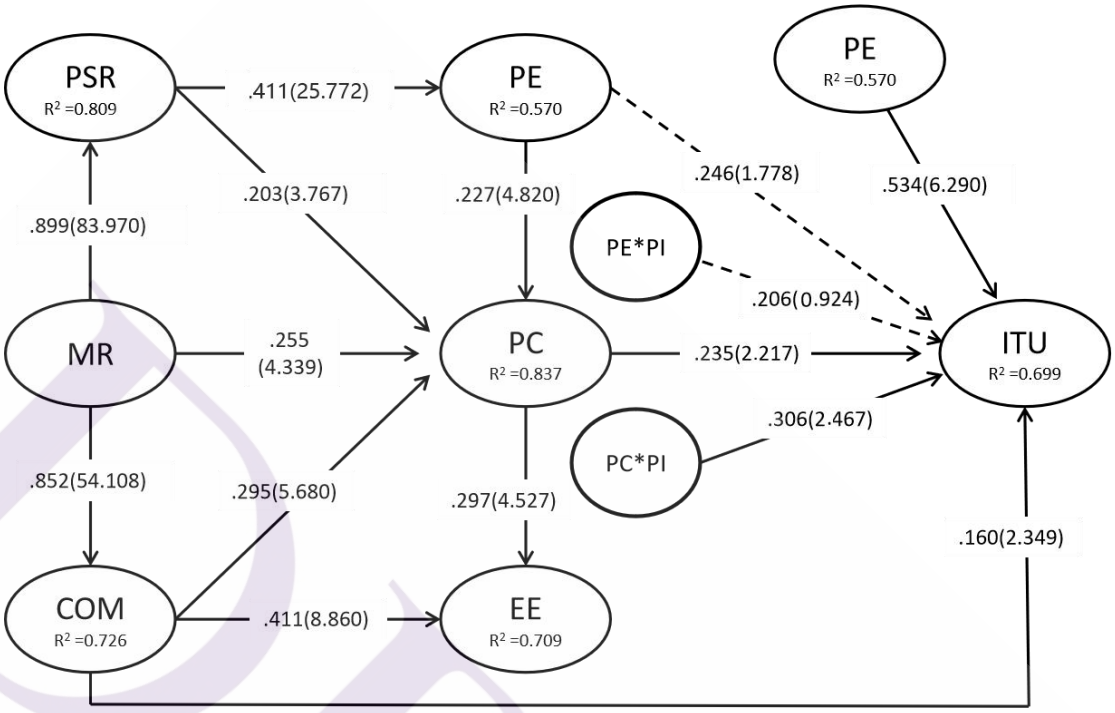


Figure. 4.2 moderating model diagram

Source: researchers collate.

The significance of a moderator can be confirmed if the interaction effect (path a and path b) is meaningful, independently of the size of the other path coefficients (Henseler & Fassott, 2010). In this case, we have estimated a standardized path coefficient of 0.306 for the interaction construct (path a), which is significant at $p < 0.05$ (t= 1.96). At the same time, we estimate that the standardized path coefficient of interaction construct (path b) is 0.206, which is not significant. The T value of path b verified by PLS bootstrapping is 0.924, less than 1.96, indicating that the moderating effect of personal innovativeness on the relationship between performance expectancy and intention to use m-learning is not tenable, while the T value of path a is 2.467, greater than 1.96, indicating that personal innovativeness has a moderating role in the relationship between PC and ITU. Figure 4.3 present the

result of the path with the interactive variables is as follows.



Significant path

Non-Significant path

The path coefficient is T

Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use; PI- Personal Innovativeness

Figure. 4.3 the result of the interaction paths

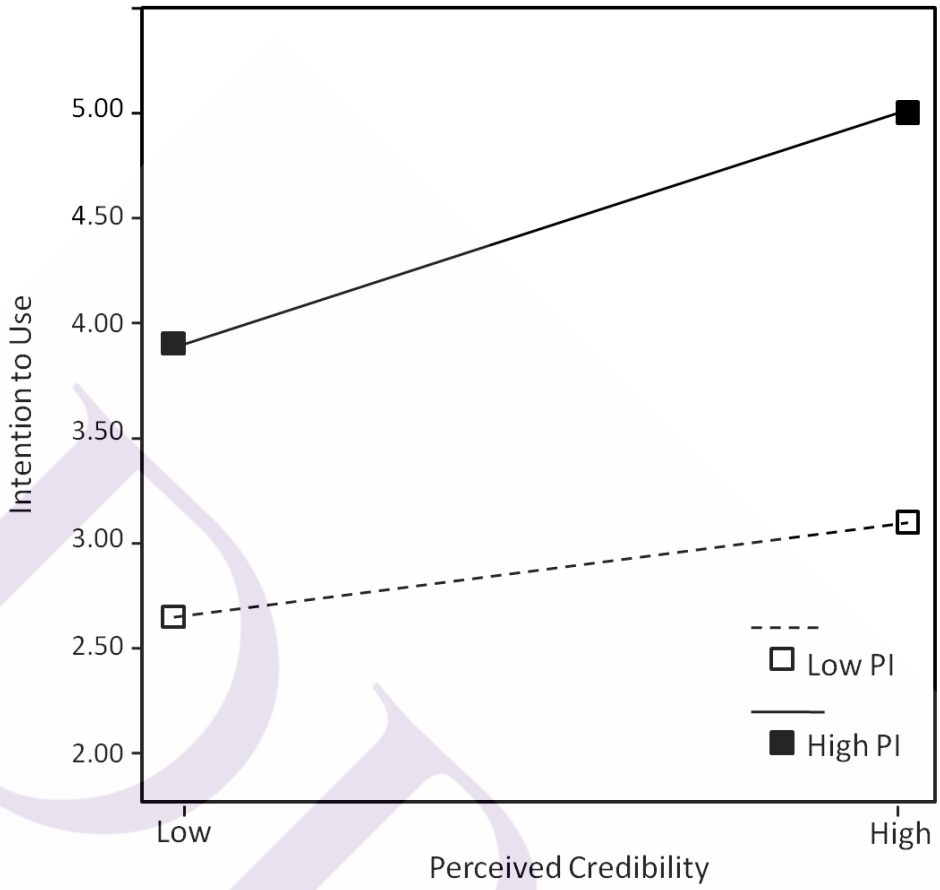
Source: researchers collate.

4.5.2 The pattern of interaction effects

Although PLS can be used to examine the existence of the moderating effects on the research model, the methods cannot allow for a plotting of the moderation relationships. Hence, to better understand the patterns of interaction effects, following the procedure suggested by Aiken and West (1991), significant interaction effects were examined by plotting two subgroup regression lines in this

study, that is, the relationship between independent variable and dependent variable at two levels (means±one standard deviation) of the moderating variable was depicted graphically in this study. The relationship between perceived credibility (PC) and intention to use at two levels (high versus low) of the personal innovativeness (PI) is shown in Figure 4.4. It reveals that the relationship between perceived credibility(PC) and intention to use is stronger among respondents with high level of personal innovativeness (PI) than among respondents with low level of personal innovativeness (PI). Specifically, at high level of perceived credibility (PC), there is a distinctly larger difference in intention to use for high and low personal innovativeness (PI) respondents.

Previous literature research results showed that the relationship between compatibility (COM), perceived usefulness (PU) and intention to use is stronger among respondents with high level of personal innovativeness (PI) than among respondents with low level of personal innovativeness (PI) (Cheng, 2014). The results have been interpreted differently in this study, which is the relationship between perceived credibility (PC) and intention to use is stronger among respondents with high level of personal innovativeness (PI) than among respondents with low level of personal innovativeness (PI). The results of this study on the moderator role of personal innovativeness (PI) enrich the research content of influencing factors of mobile learning and have certain academic value.



Note: PI – personal innovativeness

Figure. 4.4 Effects of PC by PI paths interaction on intention to use

Source: researchers collate.

4.6 Multiple group analysis

Multiple group analysis (MGA) or between-group analysis as applied using partial least squares structural equations modeling (PLS-SEM) is a means of testing predefined data groups to determine if there are significant differences in group-specific parameter estimates (Hair et al. 2014a; Henseler and Chin 2010). By applying MGA, researchers are therefore able to test for differences between two

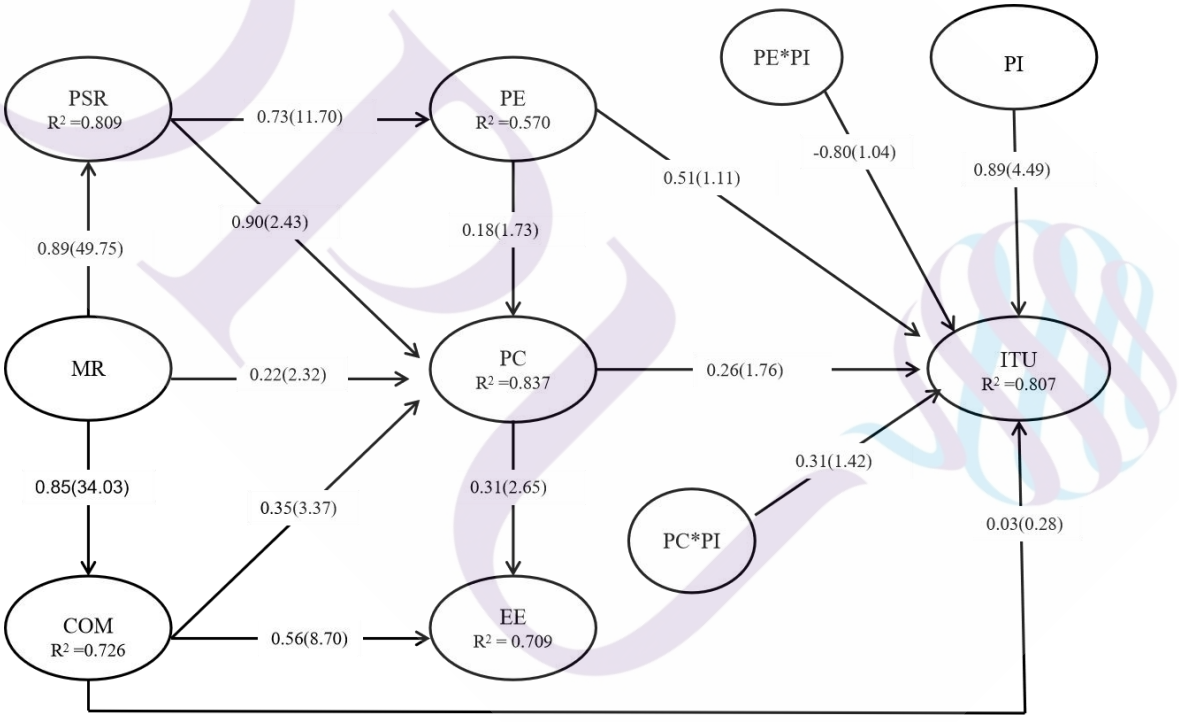
identical models for different groups. Due to the complexity of the research model, Partial Least Squares Multi-Group Analysis (PLS-MGA) was adopted in the process of MGA implementation. This method is a non-parametric significance test for the difference of group-specific results that builds on PLS-SEM bootstrapping results (Henseler et al., 2009). In this study, majors were used as grouping basis. Firstly, the original samples were divided into three data groups for multi-group analysis in SPSS software, namely liberal arts (N=162), science (N=203) and art (N=159). Then, by observing and following the guidelines, predefined data groups can be examined using PLS path modeling, and if there are meaningful and significant differences in the data, they can be reported and interpreted (Hair *et al.* 2014a, 2017b; Lohmoller 1989). There is a pervasive belief among the Management Information Systems(MIS) researchers that PLS has special abilities at small sample size (Goodhue, Lewis, & Thompson, 2006). Chin and Newsted (1999) concluded that " the PLS approach can provide information about the appropriateness of indicators at sample size as low as 20" (Chin & Newsted, 1999). According to the 10 cases/observation variables and path per indicator variable principle (Thompson, Barclay, & Higgins, 1995), there are 15 paths and 10 observation variables in the model of this study, so the sample size of each group should not be less than 150，the sample size of the three majors collected in this study met this condition. The sample number of liberal arts and science students is slightly more than that of art students, which is also in line with the current enrollment status of Chinese universities.

4.6.1 Model path coefficients of different major

For the formation of the groups, this study divided the observed variable of major in the sample into three groups: liberal arts, science and art. further, the comparison between the estimated coefficients for both groups and each pair of variables was carried out.

1. Liberal Arts Group model

Figure 4.5 lists the results of path analysis of the intention of using mobile learning and its influencing factors of liberal arts (sample number: N = 162).



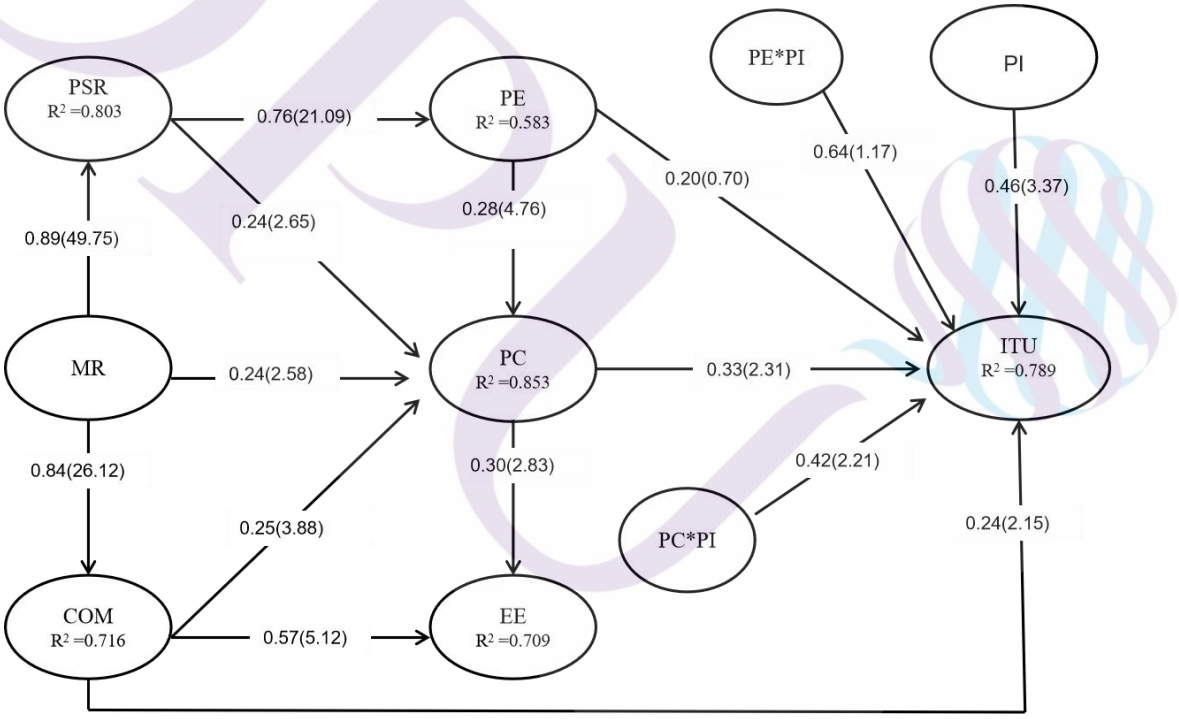
Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use; PI- Personal Innovativeness.
Figure 4.5 Path coefficients and T values in the liberal arts group model
Source: researchers collate.

It can be seen that the interaction variables (performance expectancy ×

personal innovativeness; perceived credibility × personal innovativeness) under the influence of the moderator variables, as well as the performance expectancy (PE) and perceived credibility (PC) under the influence of the interaction variables, have no significant effect on the path coefficient of intention to use. At the same time, the direct effect of compatibility (COM) on intention to use is not significant. In addition, other path coefficients are significant.

2. Science group model

Figure 4.6 lists the results of path analysis of the intention of using mobile learning of science major (sample number: N = 203).



Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use; PI- Personal Innovativeness.

Figure 4.6 Path coefficients and T values in the science group model

Source: researchers collate.

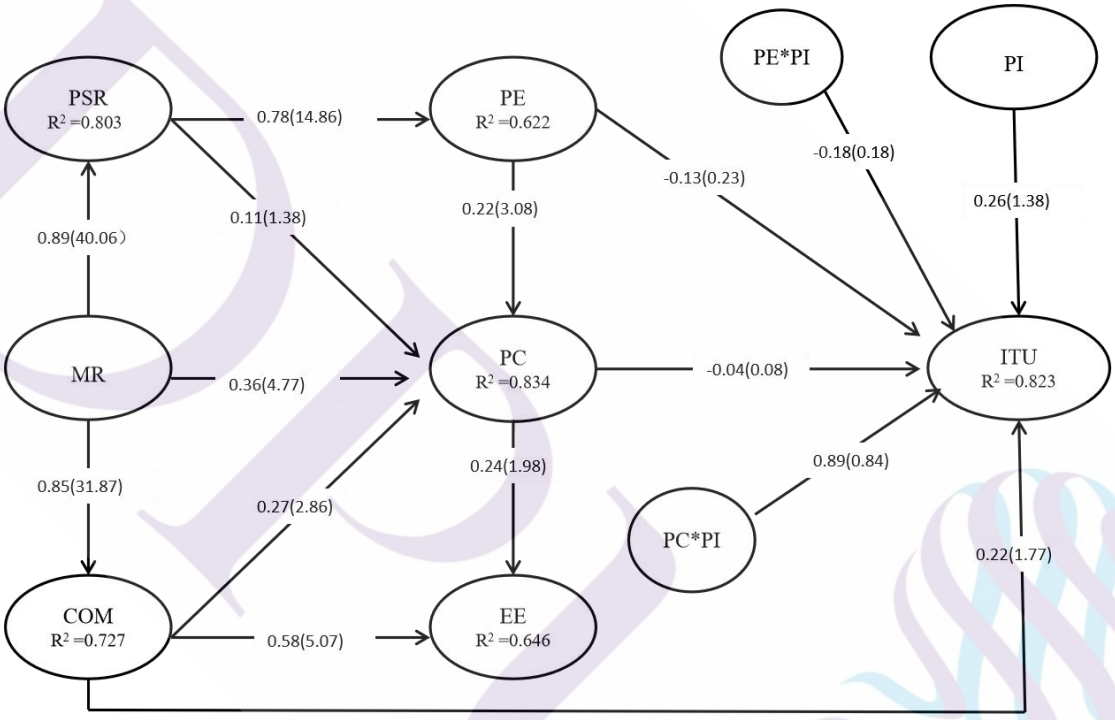
It can be seen that a standardized path coefficient of 0.42 for the interaction construct (perceived credibility × personal innovativeness to intention to use), which is significant at $p < 0.05$ (t= 1.96). the T value of this path a is 2.467, greater than 1.96, indicating that personal innovativeness has a moderating role in the relationship between PC and ITU. At the same time, we estimate that the standardized path coefficient of interaction construct (perceived expectancy × personal innovativeness to intention to use) is 0.64, which is not significant. The T value of this path verified by PLS bootstrapping is 1.17, less than 1.96, indicating that the moderating effect of personal innovativeness on the relationship between performance expectancy and intention to use m-learning is not tenable. At the same time, when the moderator variables are added into the model, the effect coefficient of efficacy expectancy on mobile learning intention to use is not significant ($\beta = 0.20$, $T = 0.70$). It can be seen that the moderating effect of personal innovativeness on perceived expectancy and intention to use is not valid in the science group model.

3. Arts Group model

Figure 4.7 lists the results of path analysis of the intention of using mobile learning of arts major (sample number: N = 159).

It can be seen that the interaction variables (performance expectancy × personal innovativeness; perceived credibility × personal innovativeness) under the influence of the moderator variables, as well as the performance expectancy (PE) and perceived credibility (PC) under the influence of the interaction variables, have no

significant effect on the path coefficient of intention to use. At the same time, the direct effect of compatibility (COM) on intention to use is not significant. In addition, other path coefficients are significant. On the whole, the results of the arts group were basically the same as those of the liberal arts group.



Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use; PI- Personal Innovativeness.

Figure 4.7 Path coefficients and T values in the arts group model

Source: researchers collate.

By comparing the results of the three groups, we found that the interaction variables under the influence of the moderator, as well as performance expectancy (PE) and perceived credibility (PC) under the influence of the interaction

variables, have significant differences in intention to use (ITU) path coefficient. At the same time, there are also differences in the path coefficient from the variable compatibility (COM) to the intention to use (ITU), only the science group model showed a significant effect on this path coefficient (β = 0.24, *t*-value=2.15). There was no significant difference in the path coefficients between the other variables. And there was no significant difference in R^2 value of each variable in the three groups of models. Of the three models, only the model in the science group (n=203) had the moderating effect of personal innovativeness (PI) on perceived credibility (PC) and intention to use (ITU) (β = 0.42, *t*-value=2.21)

4.6.2 Measurement of the differences between unstandardized coefficients

In order to verify whether there are differences between model paths of different groups, this study USES the path coefficient calculated by PLS-SEM model and the standard error value calculated by bootstrapping to compare the path correlation coefficient in pairs. Calculated the coefficient Z Score value of pair comparison through Significance of the Difference between two Slopes Calculator, so as to verified whether there is a significant difference in the path coefficient of different groups.The verification results are as follows. The analysis and comparison of the differences between the paths of different majors in the mobile learning influencing factor model are shown in Table 4.11.

Table 4.11 Comparison of the groups based on different major

Causal Relationship	Liberal Arts Group (n=162) β	Science Group (n=203) β	Art Group (n=159) β	Difference Between Liberal Arts and Science	Difference Between Liberal Arts and Arts	Difference Between Science and Arts
PI→ITU	0.896***	0.459***	0.262	0.437	0.634*	0.197*
COM→EE	0.568***	0.565***	0.584***	0.003	-0.016	-0.019
COM→ITU	0.034	0.245*	0.216	-0.211	-0.182	0.038
COM→PC	0.351***	0.254***	0.269*	0.097	0.082	-0.015
EE→ITU	0.000	-0.021	-0.128	-0.003	-0.128	-0.107
MR→COM	0.852***	0.846***	0.854***	0.006	-0.002	-0.008
MR→PC	0.185	0.214**	0.366**	-0.029	-0.181	0.152
MR→PSR	0.903***	0.895***	0.895***	0.008	0.008	0.000
PC→EE	0.315**	0.306**	0.243*	0.009	0.072	0.063
PC→ITU	0.226	0.338*	-0.042	-0.112	0.184	0.296
PC*PI→ITU	0.312	-0.420*	-0.184	-0.108	0.128	0.236
PE→ITU	0.513	-0.207	-0.133	0306	0.380	0.074
PE→PC	0.175	0.283*	0.228*	-0.108	0.007	0.055
PE*PI→ITU	-0.800	0.640	0.897	0.160	-0.097	-0.257
PSR→PC	0.264*	0.236*	0.112	0.028	0.152	0.124
PI→ITU	0.733***	0.763***	0.788***	0.030	-0.055	0.025

Notes: PE - Performance Expectancy; EE - Effort Expectancy; COM - Compatibility; PC - Perceived Credibility; MR-Media Richness; PSR - Para-social Relationship; ITU -intention to use; PI- Personal Innovativeness.

Source: researchers collate.

Notes: Significant at: *p , 0.05, **p , 0.01 and ***p , 0.001

We can see from the table that:

There is no significant difference between liberal arts majors and science majors in each path of the m-learning influencing factor model.

The results were found in the comparison between liberal arts majors and arts majors that significant differences in the unstandardized coefficients of the path between personal Innovativeness (PI) and intention to us (ITU) (*t*-value=2.310,

p<0.05). Difference between parameters is 0.634. The results indicated that in the liberal arts group (N=162), personal Innovativeness (PI) was positively and significantly associated with intention to use mobile learning (ITU) (β = 0.896, t =4.493). Meanwhile, in the art group (N=159), The path coefficient between personal Innovativeness (PI)and intention to us (ITU) is not significant (β = 0. 262, t =1.388). The coefficient of the liberal arts group on this path is significantly higher than that of the arts group. In addition to this path, there is no significant difference between liberal arts majors and art majors in the unstandardized coefficients of other paths in this model. As can be seen, the relationship between personal innovativeness (PI) and intention to use was stronger among liberal arts students than among art students. In other words, compared with art students, liberal arts students believe that personal innovativeness has a stronger influence on the intention to use mobile learning.

In the comparison of science major and art major, it was found that significant differences in the unstandardized coefficients of the path between personal innovativeness (PI) and intention to use (ITU) (t-value=2.117, p<0.05). Difference between parameters is 0.197. The results indicated that in the science group (N=203), personal Innovativeness (PI) was positively and significantly associated with intention to use mobile learning (ITU) (β = 0.459, t =3.370). Meanwhile, in the art group (N=159), The path coefficient between personal innovativeness (PI) and intention to use (ITU) is not significant (β = 0. 262, t =1.388). The coefficient of the science group on this path is significantly higher than that of the arts group. In addition to these

three paths, there is no significant difference between science majors and art majors in the unstandardized coefficients of other paths in this model. As can be seen, the relationship between personal innovativeness and intention to use was stronger among science students than among art students. In other words, compared with art students, science students believe that personal innovativeness has a stronger influence on the intention to use mobile learning.

4.7 Summary of Hypothesis Verification

The research hypotheses proposed in this study are analyzed and verified one by one through status analysis, difference analysis, structural equation modeling (SEM) and partial least squares (PLS) analysis， moderating effect verification and multiple group analysis. The results of the research hypothesis are sorted out and presented in Table 4.14.

Table 4.14 Summary of Hypothesis Verification

	Hypothesized paths	Results of analysis
H1	The performance expectancy of students in mobile learning has a significant positive impact on intention to use m-learning.	Supported
H2	The effort expectancy of students in mobile learning has a significant positive impact on intention to use m-learning.	N.S.
H3	The performance expectancy of students in mobile learning has a significant positive impact on perceived credibility.	Supported

Table 4.14 (continued)

	Hypothesized paths	Results of analysis
H4	The perceived credibility of students in mobile learning has a significant positive impact on effort expectancy.	Supported
H5	The perceived credibility of students in mobile learning has a significant positive impact on intention to use m-learning.	Supported
H6	The perceived media richness of students in mobile learning has a significant positive impact on perceived credibility.	Supported
H7	The perceived media richness of students in mobile learning has a significant positive impact on para-social relationship.	Supported
H8	The perceived media richness of students in mobile learning has a significant positive impact on compatibility.	Supported
H9a	The para-social relationship of students in mobile learning has a significant positive impact on performance expectancy.	Supported
H9b	The para-social relationship of students in mobile learning has a significant positive impact on perceived credibility.	Supported
H10a	Personal innovativeness will positively moderate the effect of performance expectancy on intention to use m-learning.	N.S.
H10b	Personal innovativeness will positively moderate the effect of PC (Perceived Credibility) on intention to use m-learning.	Supported
H10c	Personal innovativeness will negatively moderate the effect of EE (effort expectancy) on intention to use m-learning.	N.S.
H11a	The compatibility of students in mobile learning has a significant positive impact on effort expectancy .	Supported
H11b	The compatibility of students in mobile learning has a significant positive impact on perceived credibility.	Supported
H12	The compatibility of students in mobile learning has a significant positive impact on intention to use m-learning.	Supported
H13	There are significant differences in the influencing factors of mobile learning among students of different majors.	N.S.

Source: researchers collate

CHAPTER 5

DISCUSSIONS

Based on the relevant theories and literature in the past, this chapter shows the discussions of the results in Chapter 4.

This study took the college students from three representative universities in China as participant (target population), and focused on the current status ,difference, correlation of influencing factors of mobile learning, as well as the relationships among them. In the current situation analysis, the average and standard deviation are described by descriptive statistics for the overall variable and the dimensions of performance expectancy, effort expectancy, perceived credibility, Compatibility, media richness and para-social relationship .

And then, t-test, one-way ANOVA and post-hoc test are adopted, so as to understand differences in performance expectancy, effort expectancy, perceived credibility, Compatibility, media richness and para-social relationship of college students in China. Furthermore, the overall and various dimensions of the variables are explored by means of correlation analysis.

And then, the proposed model was tested using structural equation modeling (SEM) and partial least squares (PLS) analysis. At last, PLS software was

used to draw the moderate model diagram, which verified the moderating effect of personal innovativeness as a moderator. In this section, the research results are summarized,and the following discussion is made by combining the previous literature and theories.

5.1 Current Status of Participants

This study took students in China's higher education institutions as participants (target population). And the number of valid participants is 524 among which 177 are male (33.78%), and 347 are female (66.22%). The proportion of female students is significantly higher than that of male students. For a long time, the proportion of female college students in China is generally high. As early as 2012, according to relevant statistics, female students accounted for 51.35% of college students nationwide, surpassing male students for the first time. In 2013, the proportion of female students was 51.74%; In 2018, the proportion of female students peaked at 57.74 percent, and the proportion of female students gradually increased. We can also find from the data released by the New Media Alliance of Chinese Universities that 367 of the 719 universities surveyed have more female students than male students, accounting for more than half, and the overall proportion of female students exceeds that of male students. The gender distribution in this research also conforms to the current situation that the proportion of female college students in

general colleges and universities in China is generally higher than that of male students.

In terms of grade distribution, there are 152 junior students, accounting for 29.01%; 142 sophomore students accounting for 27.1%; 101 freshmen accounting for19.27%. Most of the senior students practice outside the home. Due to the pressure of employment and further study, the number of students participating in mobile learning in this grade is relatively small, resulting in a small sample size. In terms of the proportion of graduate students, all grades are similar, which is also consistent with the actual situation.

In terms of majors, 162 (30.92%) majored in liberal arts, 203 (38.74%) majored in science, and 159 (30.34%) majored in art. In the three majors, except the number of science majors is slightly more points, in proportion are relatively close, in line with the actual situation.

In terms of using time (the respondents' experience in mobile learning via mobile devices) , 203 students less than 6 months, accounting for 38.74%; 137 students with more than 24 months 6 to 12 months' mobile learning experience, accounting for 26.15%. These two types of students account for more than half of the participants. As for other types, there are 130 students (24.81%) with 6 to 12 months' mobile learning experience, 38 students (7.25%) with 13 to18 months and 24 students (3.05%) with 19 to 24 months. It can be seen that the mobile learning experience of Chinese college students is polarized. It can be inferred that Chinese university

students will be affected by mobile learning experience in the process of accepting mobile learning.

In terms of the tendency of respondents to adopt the form of mobile learning, 350 (66.79%) download apps to learn, 77 (14.69%) use WeChat follow public account or WECHAT miniprogram for mobile learning, and 97 (18.51%) prefer WECHAT or QQ for mobile learning. Relevant research results have shown that WECHAT is a leading mobile foreign language learning platform in China (Antropova, Vlasov, & Kasyanenko, 2019). WECHAT has a good cross-platform feature. It does not need to consider the mobile phone system users use. It has low cultivation cost, high timeliness, easy dissemination and low development cost.However, it also has obvious disadvantages, such as being unable to learn offline and opening any course requires online network, which is not secure enough to be compared with APP. Moreover, due to the limited interface provided by WeChat, learning records cannot be tracked comprehensively, personalized requirements are difficult to achieve, and management background has limitations. The advantages of APP are that it is easy to expand, can meet the personalized needs of enterprises, high security, and supports offline learning. Because mobile APP provides powerful cloud platform support, rich course resources and more professional management for mobile learning, it has become the most important learning method for mobile learning in Chinese colleges and universities.

5.2 Difference of Background Variables in Influencing Factors

Five background variables are adopted in this research: gender, grade, major, experience and form of college students from China. In this part, the researcher analyzes and discusses the results of the differences in performance expectancy, effort expectancy, compatibility, perceived credibility, media richness, para-social relationship, personal innovativeness and intention to use mobile learning of college students in China with different background variables.

1. Difference of Gender

It can be found from the analysis in chapter four that there is no significant difference in the the dimensions of influencing factors of mobile learning among college students from China with different gender. Perhaps because the subjects were all Chinese students, this result was consistent with the research results of Snell and Snell-Siddle (2013), that is, there was no statistically significant difference between the genders, indicating that male students and female students in Chinese university environment had similar perception of mobile learning.(Snell & Snell-Siddle, 2013). This result is also consistent with Al-Emran (2016) study that there was no statistically significant differences among the students' attitudes towards the use of M-learning with regard to their gender(Al-Emran et al., 2016). In the studies of many scholars (Bao, Xiong, Hu, & Kibelloh, 2013; Y. S. Wang, Wu, & Wang, 2009), students of different gender show differences in influencing factors of mobile learning.

the results indicate that there exist some significant gender and age differences in terms of the effects of the determinants on behavioural intention(Y. S. Wang et al., 2009). Such different results may be caused by different characteristics of student groups or different age composition, and the exact reasons need to be further analyzed and demonstrated.

2. Difference of Grade

In this study, students of different grades have different perceptions of the overall influencing factors of mobile learning. The result shows that Junior have a significantly higher perception than Freshman, Sophomore and Senior; Graduate also have a significantly higher than Freshman, Sophomore.

It can be seen from the results that freshmen and sophomores have limited learning experience in participating in mobile learning courses, and they do not have enough understanding of mobile learning system and environment, so their cognition of influencing factors of mobile learning is not as strong as that of Juniors. Postgraduate students have a full understanding of the course online learning system after the complete undergraduate study, and their cognition of the influencing factors of mobile learning is also better than that of freshmen and sophomores. Graduate students probably have a stronger need for conducting research, they seem to acknowledge online information more so than do their undergraduate counterparts(Chou, Wu, & Chen, 2011). As senior students are facing graduation, most of their energy is devoted to internship and entrance examination, and their

learning time is reduced. Therefore, they naturally have a lower perception of factors affecting mobile learning than junior students. College students, long prior to entering college, can very well have been using the Internet as an entertainment device, as a cyber-representation of the self (Chou, Yu, Chen, & Wu, 2009) , and as a communication channel (Chou & Peng, 2007); therefore, while moving up to the position of senior on campus, these students would not be changing their related attitudes, so there was no significant difference between freshmen and sophomores

In many studies, some scholars (Chou, 2011; Uzunboylu, 2009) also draw the conclusion that grade level made a significant difference in some Internet attitude dimensions of mobile learning. According to the test results of researcher Chou *et al*. (2011) revealed that graduate students' mean scores were higher than freshmen/sophomore students' mean scores in the dimensions of Intention to use, Trade, and Media Information, and higher than junior/senior students' mean scores in the dimensions of Trade and Treasure of information (Chou *et al.,* 2011). According to the test results of researcher Uzunboylu *et al.* (2009) revealed that second-year undergraduate students recorded significantly higher post project scores than third-year or fourth-year students. Thus, attitudes toward the influencing factors of mobile learning are seems related to grade or age. Reasons for ranking the importance of these topics, however, remain unknown (Uzunboylu, Cavus, & Ercag, 2009). As reported in previous study(W. Lin, 2017), Students in different grades have different network learning self-efficacy, the higher the grade, the higher the network learning

ability. This result is also presented in the mobile learning of college students.

It can be seen from the above analysis that different grades have different effects on the influencing factors of mobile learning of Chinese college students.

3. Difference of Major

The results of this study show that there are significant difference in each dimension of influencing factors of mobile learning among Chinese college students with different major. In addition to the influence factors of para-social relationship, the test results of all other dimensions consistently showed that liberal arts have a significantly higher perception than sciences and arts. In the dimension of para-social relationship, the results showed that liberal arts have a significantly higher perception than sciences.

Compared with other majors in liberal arts and sciences, art majors had certain particularity, and required higher requirements for their professional capabilities. The proportion of practical teaching in the curriculum setting was significant, there were many extended courses. Apart from relying on formal classroom teaching, these courses needed to rely on independent learning in an informal environment as an effective supplement to enhance professional ability. Current ICT technologies are insufficient to support the development of practical teaching of art majors in mobile learning environments. Therefore, art majors are lower than other majors in terms of their perception of mobile learning. Ng & Wong (2020) indicates that it was interesting to note that the sciences students rated online

discussion as high as the arts students. This study also confirmed that there is no significant difference between science and art students in terms of para-social relationship.

In many studies, some scholars (Ng & Wong , 2020; Al-Emran *et al.*, 2016) also draw the conclusion that major made a significant difference in some Internet attitude dimensions of mobile learning. Ng & Wong (2020) indicates that the arts students on average gave the highest overall average on mobile learning activities, followed by the sciences students, the engineering students, and the art students. The arts students consistently rated the mobile learning activities the highest, the sciences students consistently rated the mobile activities the second highest, and the business students consistently rated the mobile activities the lowest(Ng & Wong, 2020). Ng & Wong's (2020) study showed that a significant difference was found for only four of the 19 mobile activities despite the different ratings given by the students from the different majors. It can be seen that not all mobile learning activities have significant differences in terms of majors(Al-Emran *et al.*, 2016). Likewise, Taleb and Sohrabi (2012) has revealed that there was no significant difference among the students' attitudes towards the use of M-learning in terms of their academic majors. According to the different research results, it is speculated that the reason may be related to the particularity and region of the research object group, which need further research and analysis.

4. Difference of Experience

The results of this study show that there are significant difference in each dimension of influencing factors of mobile learning among Chinese college students with different experience. the test results of all other dimensions consistently showed that more than 24 months have a significantly higher perception than less than 6 months , 6 to 12 months, 13to18 months. Thus it can be seen that the richer the m-learning experience is, the stronger the perception of m-learning influencing factors will be.

Chunmei Gan *et al.* (2017) study showed that user perceptions among experienced and inexperienced samples are different in mobile learning. It was found that students' cognition of the characteristics of mobile learning technology in their previous use experience will help to establish a stronger attitude and willingness to use mobile learning. Pramana (2018) study showed that mobile learning experience does not have any significant effect on any of the nine direct effects on Behavioral Intention(Pramana, 2018). According to the different research results, it is speculated that the reason may be related to the particularity and region of the research object group, which need further research and analysis.

5. Difference of Form

The results of this study show that there is no significant difference in the overall perception of mobile learning among Chinese college students with different learning form, and there are also no significant differences at different dimensions. this result is also consistent with Ng and Wong (2020) study that the operating system

had much impact on the students' m-learning activities(Ng & Wong, 2020).

However, it can be seen from the data that the scores of all dimensions of the influencing factors of APP are comparable to WECHAT , QQ and MP. The results of this study show that different learning styles have little influence on the adoption of mobile learning. From the scores of various dimensions, it can be found that college students are more likely to adapt to mobile learning using APPS. The research scope of this study includes formal learning and informal learning. In informal mobile learning, WECHAT has become the main mobile learning tool due to its convenience of real-time interaction and its feature of having a large number of apps.However, due to the limitation of WECHAT, the interface provided in the formal learning environment is limited, so the learning record cannot be tracked comprehensively, and it is difficult to realize personalized requirements. The advantages of the APP are that it is easy to expand, can meet the personalized needs of different schools, high security, and supports offline learning. At present, the mobile learning system used in the formal education environment of Chinese colleges and universities must have the function of routine teaching management. Therefore, mobile apps have become the most frequently used learning tool in the mobile learning of Chinese colleges and universities.

5.3 Analysis of structural model results

This part mainly discusses the Structural model analysis results presented by the structural equation modeling (SEM) and partial least squares (PLS) analysis in Chapter 4. The results present the properties of the causal paths, including standardized path coefficients, t-statistics, Sobel test, Bootstrapping technology and explained variance for each equation in the hypothesized model.

The purpose of this study was to identify factors that affect Chinese college students' behavioral intention to use m-learning. The research model presented in this paper is unique in its integration of performance expectancy, effort expectancy, perceived credibility, compatibility, media richness, para-social relationships and intention to use into the UTAUT model to evaluate the determinants of students' behavioral toward m-learning. The research model explained 69.9% of the variance in intention to use m-learning.

5.3.1 Perceived performance factors

Performance expectancy (PE) and effort expectancy (EE) were tested as two major cognitive factors common to technology adaptation theories. According to the discussion in the second chapters, many scholars (Venkatesh *et al.*, 2003; Šumak and Šorgo, 2016; Hoque and Sorwar, 2017; Khalilzadeh *et al.*, 2017; Šumak *et al.*, 2017) draw consistent conclusion that performance expectancy (PE) and effort expectancy (EE) can significantly affect behavioral intention (BI). Many scholars (Oliveira and Thomas, 2014; Gupta Kriti *et al.*, 2019) draw consistent conclusion that performance expectancy (PE) is a significant predictor of perceived credibility (PC) .

Many scholars (Koufaris and Hampton-Sosa, 2004; DeLone and McLean, 2016; Kabra et al., 2017) were also unanimously confirmed that perceived credibility (PC) has a significant positive effect on users' behavioral intention to adopt Internet products.

Based on the above theoretical and empirical studies, combined with the influence coefficient of the performance expectancy in this study on the intention to use mobile learning (β = 0.246, p < .01), it can be concluded that performance expectancy had the strongest direct impact on intention to adopt mobile learning; this was in accordance with the findings of other studies (Šumak and Šorgo, 2016; Yoo *et al.*, 2016; Hoque and Sorwar, 2017; Khalilzadeh *et al.*, 2017; Šumak *et al.*, 2017; Chao,2019). The effect of performance expectancy on intention to use was consistent with the findings of previous technology adoption studies (Koufaris, 2002; Venkatesh et al., 2003; Venkatesh *et al.*, 2012). Second was perceived credibility (β = 0.175, p < .01). This was consistent with the findings of another study (Koufaris and Hampton-Sosa, 2004; DeLone and McLean, 2016; Kabra *et al.*, 2017; Chao,2019). Therefore, perceived credibility is crucial predictors of individuals' intention to adopt mobile learning. By visible, the hypothesis H1 and hypothesis H5 in this study is supported. However, no direct impact of effort expectancy (EE) was found (β = 0.055). Therefore, the hypothesis H2 in this study is not supported. Likewise, Taleb and Sohrabi (2012) has revealed the direct effects of performance expectancy (PE) on intention to adopt robot-assisted learning were significant, although those of effort

expectancy (EE) were not. The same result was obtained in the study of Yoo *et al.*, (2016). This finding is different from the findings of many previous UTAUT models (DeLone and McLean, 2016; Kabra et al., 2017; Chao,2019).

It can be seen from the above analysis that performance expectancy (PE) and perceived credibility (PC) are important perceived performance factors that affect the intention to use mobile learning. Moreover, performance expectancy (PE) had an indirect influence on intention to adopt mobile learning systems through perceived credibility (PC). Therefore, performance expectancy (PE) and perceived credibility (PC) are directly crucial predictors of students' behavioral intention to use m-learning. Based on the findings of this study, mobile learning is an increasingly important learning method for students. When students discover that mobile learning can improve their academic performance and learning results, their intention to use mobile learning are enhanced. With the development and popularization of ICT technology, college students have been equipped with a good information technology foundation and the ability to adapt to technological changes since they enter the university. Many students have been fully aware of the advantages of e-learning and mobile learning, which has imperceptibly enhanced their perception of trust in mobile learning. It can be seen that the higher the students' perceived credibility in mobile learning, the stronger their willingness to participate in mobile learning. Therefore, perceived credibility was proved to be an important external extension variable in the UTAUT model. Effort expectancy (EE) was a critical moderating variable for m-learning

usage in our extended UTAUT model. However, effort expectancy (EE) has no direct impact on the intention to use mobile learning. According to this finding, if college students think mobile learning is easy to use, their effort expectation will be relatively low, so there will be no fundamental impact on their willingness to participate in mobile learning.

5.3.2 External factors

Para-social relationship, media richness and compatibility were tested as the three external influencing factors in this research model. According to the discussion in the second chapters, many scholars (Venkatesh *et al.*, 2003; Šumak and Šorgo, 2016; Hoque and Sorwar, 2017; Khalilzadeh *et al.*, 2017; Šumak *et al.*, 2017) have confirmed that the teacher–student relationship was found to affect student performance in terms of academic achievement and establishment of learning motivation. The teacher–student relationship perspective was linked to para-social interaction theory to improve our understanding of the learner's psychological process in deciding to adopt mobile learning systems(Yoo et al., 2016). Many scholars (Cho *et al.*, 2009; López-Nicolás *et al.*, 2008) draw consistent conclusion that the media richness is a significant predictor of perceived credibility. Media richness also have significant effects on perceived usefulness (ZhangYan-Zhi, 2009). Yoo *et al.*, (2016) have confirmed that media richness is positively affect the development of para-social relationships between users and robot-assisted learning systems. Previous studies have proved that compatibility is an important factor that determines whether an individual

is willing to adopt innovations (Al-Jabri, 2015; Hanafizadeh, Behboudi, Koshksaray, & Tabar, 2014; Kleijnen et al., 2007; Lai & Chang, 2011; Lin, 2011; Lin & Lu, 2015; Moore & Benbasat, 1991; Rogers, 1983). Thaneshan *et al.*, (2020) have confirmed that media richness and compatibility combine to make mobile content more accessible. Many scholars (Tung and Chang, 2008; Cheng, 2015) found that compatibility directly affects perceived usefulness and willingness to use.

Based on the above theoretical and empirical studies, combined the results of the influence coefficients of each path in the research model, the para-social relationship of m-learning positively predicted performance expectancy (β = 0.41). Likewise, Yoo *et al.*, (2016) has revealed the significant effect of the para-social relationship on and performance expectancy, it highlights the importance of human similarity in machine learning. And then, the results showed that the para-social relationship of m-learning positively predicted perceived credibility (β = 0.20). The same result was obtained in the study of Lee, (2013). Therefore, the hypothesis H9a and hypothesis H9b in this study is supported. The compatibility of m-learning positively predicted effort expectancy (β = 0.41) and perceived credibility (β = 0.29). Therefore, the hypothesis H11a and hypothesis H11b in this study is supported. Hence, compatibility can have direct and indirect effects on learners' intention to use m-learning. The finding is also consistent with the views of previous studies (Wu & Wang, 2005; Wu *et al.*, 2007; Xue *et al.*, 2012; Cheng, 2015) that show compatibility is an important determinant for usage intention of the mobile technology. The media

richness of m-learning positively predicted perceived credibility ($\beta = 0.25$). Therefore, the hypothesis H6 in this study is supported. This is in line with prior research that suggests a positive correlation between media richness and trust (e.g. Burgoon *et al.*, 2002; Cho *et al.*, 2009; López-Nicolás *et al.*, 2008). Moreover, media richness of m-learning was positive predictors of para-social relationship ($\beta = 0.33$) and compatibility ($\beta = 0.50$). The same result was obtained in the study of Yoo *et al.*, (2016). Therefore, the hypothesis H7 and hypothesis H8 in this study is supported.

It can be seen from the above analysis that para-social relationship (PSR) , media richness (MR) and compatibility (COM) are important external influencing factors that affect the perceived credibility (PC). At the same time, para-social relationship (PSR) is important external influencing factors that affect the perceived performance expectancy (PE), compatibility (COM) is important external influencing factors that affect the effort expectancy (EE). Moreover, media richness (MR) had an indirect influence on perceived credibility (PC) through para-social relationship (PSR) and compatibility (COM). The direct role of PSR and the indirect effect of media richness on user perceived credibility were comparable with that of performance expectancy. This result highlights the importance of taking social-relational factors into account to explain the success of mobile learning.

Based on the findings of this study, it could be seen that the Chinese college students perceived rich media functions during the mobile learning process, which would bring them a stronger perception of para-social relations. In other words,

the media richness characteristics given by the current mobile learning system provided teachers and students with simpler and more direct social interaction functions, which made it easier for students to perceive the existence of para-social relationships. And then we found that the perceived credibility in the content of mobile courses and teachers' professionalism as a source of information had a positive effect on students' perception of the effectiveness of participating in mobile learning. Especially in the teaching field of practical training was an important part of curriculum teaching, with practical orientation and strong practicality, teachers' professional ability and project execution would become direct judgment of the students' participation in course learning. Compared with other e-learning systems, the current mobile learning system using innovative ICT technology provides stronger face-to-face interaction through search engine, audio and video interaction, direct instant feedback, cloud storage, virtual reality, augmented reality, haptic Internet and other functions. These rich media functions make students realize that it is easier to obtain information and knowledge through mobile learning. At the same time, it also provided compatibility guarantee for students with different habits to participate in mobile learning, so that students' perception and trust of mobile learning would be enhanced.

5.4 Analysis of Moderating effects

This part mainly discusses the moderating effects analysis results presented by the structural equation modeling (SEM) and partial least squares (PLS) analysis in Chapter 4. The results present the properties of the causal paths, including standardized path coefficients, t-statistics, Bootstrapping technology and explained variance for each equation in the hypothesized model.

Most related studies (Sánchez-Prieto et al., 2016; Chang et al.,2017; Tsai et al., 2018) have argued that the individual's ability to innovate is considered a prerequisite for the technology acceptance process. According to the discussion in the second chapter, many scholars (Sultan and Winer, 1993; Rogers, 1995; Faiers et al.,2007; Faiers *et al.*, 2007; Cheng, 2014) draw consistent conclusion that people who with a high innovative personality are more likely to participate in or be interested in the new IT, realize the comparative advantages of the new IT, and thus more receptive to innovation. As shown in the results of Chapter 4, the estimated standardized path coefficients for the effect of the moderator on the intention to use (β=0.406; *T*-value=0.924) was not significant. This indicates that personal innovativeness in mobile learning no moderating effect on the relationships between performance expectancy and intention to use m-learning. Hence, H10a was not accepted. This finding differs from that obtained by Cheng (2014).

In the test analysis of the previous model, Hypothesis 2 is not valid, because the relationship between effort expectation (EE) and intention to use m-learning is not significant (β= 0.055). According to the principle of moderating

effect test, we reject H10c.

However, to our knowledge, no studies have investigated personal innovativeness (PI) would have a moderation effect on the relationships between perceived credibility (PC) and intention to use mobile learning; thus, a theoretical foundation is yet to be built. The findings of this study demonstrated that personal innovativeness (PI) significantly and positively moderated the relationship between perceived credibility (PC) and intention to use mobile learning. As shown in the results of Chapter 4, the estimated standardized path coefficients for the effect of the moderator on the intention to use (β=0.306; T-value=2.467). Hence, H10b was accepted. This significant relationship indicated that personal innovativeness as a moderating variable provided a robust basis for our hypotheses of influencing factors in mobile learning, and personal innovativeness was a critical moderating variable for m-learning usage in our extended UTAUT model.

With regard to the moderating effects of personal innovativeness, the relationship between perceived credibility and intention to use mobile learning is more sensitive among learners with high level of personal innovativeness regarding the influencing factors than among low personal innovativeness learners (Fig. 4.4). It reveals that in comparison to those with low innovativeness, high personal innovativeness learners have distinctly higher intention to use m-learning when they have high level of perceived credibility of m-learning; however, high personal innovativeness learners have slightly higher intention to use m-learning when they

have low level of perceived credibility of m-learning. The result implicates that learners with high level of personal innovativeness pay more attention to perceived credibility in the process of using m-learning. Based on the findings of this study, it could be seen that In the process of mobile learning in formal education of Chinese colleges and universities, it is necessary to strengthen the cultivation of students' innovation ability. By improving students' innovation and creativity in the learning process, students' perception and trust of mobile learning content and learning environment can be enhanced, so as to more effectively strengthen students' willingness to use mobile learning.

5.5 Analysis of differences between majors

In previous studies, many scholars (Al-Emran, 2016； Taleb & Sohrabi, 2012；Al-Emran *et al.*, 2016；Ng & Wong , 2020) compared the differences between different majors in mobile learning mainly focused on students' attitudes and learning styles towards mobile learning. In the previous studies on UTAUT model of mobile learning, major was only discussed and studied as a moderating variable, and most of the results showed that its moderating effect was not significant (Shufeng-Wen , 2019; Qiongzhen-Huang , 2018).

By comparing the results of three models of different majors, we found that the interaction variables under the influence of the moderator, perceived

credibility (PC) under the influence of the interaction variables, as well as compatibility (COM) have significant differences in intention to use (ITU) path coefficient. Of the three models, only the model in the science group (n=203) had the moderating effect of personal innovativeness (PI) on perceived credibility (PC) and intention to use (ITU) (β = -0.42, t-value=2.21). Moreover, the effect of compatibility (COM) on intention to use (ITU) was only significant in the science group (β = 0.24, *t*-value=2.15).

By comparing the significant difference of path coefficient with the result of coefficient Z score, we found that the unstandardized coefficient of personal innovation (PI) and willingness to use (ITU) in the art group was significantly different from that in the liberal arts group and the science group, the differences between the parameters are 0.634 and 0.197, respectively. As can be seen, the relationship between personal innovativeness and intention to use was stronger among science students and liberal arts students than among art students. In other words, compared with art students, liberal arts students and science students believe that personal innovativeness has a stronger influence on the intention to use mobile learning. Ng and Wong (2020) found in their research that students majoring in science seem to be more active in participating in mobile learning activities than students majoring in art and business. At the same time, science majors have more information technology skills than liberal arts and arts students, and more experience in online education than liberal arts and arts students (Ng & Wong, 2020). Combined

with the research results of this study, it can be found that in terms of behavioral intention to accept mobile learning, science majors have higher requirements on compatibility and trust of content and system than other majors.

Compared with science majors, art majors and some liberal arts majors have certain particularity and higher requirements on professional ability.In the curriculum setting of liberal arts and art majors, the proportion of practical teaching is significant, and there are more extended courses. Based on the current situation of mobile education in China, most of the online teaching management and live teaching rely on the unified mobile education platform of schools, and the conditions for assisting practical teaching are limited to a certain extent.Therefore, the results of this study are in line with the current situation of mobile education in China, and are representative to the comprehensive research on the influencing factors of mobile education.

CHAPTER 6

CONCLUSIONS

Based on the results and discussions in Chapter 4 and 5, the conclusions of this research are sorted out in this chapter.

This study developed an extended integrated model to explain the main factors influencing the use of mobile learning among Chinese college students. Based on the UTAUT model, this well-validated model was extended by including five additional predictors (i.e., perceived credibility, media richness, para-social relationships, compatibility, and personal innovativeness). Data were collected from 524 students with mobile learning experience from three universities in China. The results showed that the model has high internal consistency and reliability, which indicates that the model has strong explanatory power. This study found that perceived credibility and performance expectancy were important factors affecting college students' participation in mobile learning. In addition, para-social relationship , media richness and compatibility were important external factors affecting perceived credibility. Students will perceive rich media functions in the process of mobile learning, which will bring them stronger perception of para-social relations; Students' perceived credibility of mobile course content and teachers' expertise as information sources have a positive impact on students' participation in mobile learning. At the same time, providing compatibility guarantee for students with different habits to

participate in mobile learning can improve students' perception and trust of mobile learning, so as to improve students' participation in mobile learning. The results of moderating effect showed that compared with learners with low innovation ability, learners with high personal innovation ability were significantly more willing to use mobile learning when their perceived credibility was high. Finally, in the results of multiple group analysis, we found that the relationship between personal innovation ability and willingness to use was stronger for science and liberal arts students than for art students. The results of this study have certain reference value for decision makers, students and teachers in educational institutions.

This chapter is divided into three sections. The first part is the theoretical and practical significance.The second part is the suggestion to the college education practice;The third part is the limitation of the research and the suggestion of the follow-up research.

6.1 Theoretical and Practical Significance

In this study, a theoretical model of the influencing factors of mobile learning was developed and tested empirically. The research framework was created based on Daft and Lengel's (1986) media richness theory, Rogers's (2003) Innovation diffusion theory and Venkatesh's (2003) a unified theory of the acceptance and use of

technology model. Although there have been a lot of previous studies on the factors affecting the use of mobile learning (Cochrane & Rhodes, 2013;Arpaci, 2015;Serillano-Garcia & Vazquezcano, 2015). They concluded that the most important factor was to ensure that there was a model designed to ensure the integration of mobile learning as a new way of understanding teaching and learning. Since mobile learning did not appear in a vacuum, it is important to understand the factors and variables that influence its use and effectiveness for successful implementation.The results of such studies can help add to this knowledge base. Mobile learning has advanced recently due to developments in e-learning and ICT technologies. Based on the theory of media richness, this study breaks the previous research background restrictions of formal education, combines formal and informal education, social media and education system, collects survey data from general college students, conducts empirical test on the data obtained, gives the test results and analyzes them.

In the proposed model, constructs derived from studies with a social-relational perspective, namely the para-social relationship, successfully illustrated the concept of new teacher-student relationship in mobile learning in the context of network media and integrated it with the theory of technology acceptance. The significant effect of this process was verified through empirical analysis. With the research on the compatibility, media richness and para-social relationships of mobile learning, the face-to-face interaction function and the compatibility of mobile learning

was found to be significant to learners' perceptions of mobile learning systems as educationally effective. These factors also had significant influence on user perceived credibility. These results suggest that interaction similar to real teaching activities must be considered in the application of mobile learning.

The research model explained 69.9% of the variance in intention to use m-learning. The most crucial factors that influenced intention to use were performance expectancy, effort expectancy, perceived credibility, compatibility, media richness, and para-social relationships. perceived credibility and performance expectancy had direct effects on intention to use m-learning. In addition, the effect of perceived credibility on intention to adopt mobile learning was examined based on source credibility theory. The combination of this theory and UTAUT model is an innovation in the process of constructing the theoretical model in this study. It was found that performance expectancy and perceived credibility are crucial predictors of students' intention to adopt mobile learning. However, no direct impact of effort expectancy was found.

6.2 Suggestions to Education Practice

Based on the summary and analysis of the above research conclusions, this section, from the perspective of educational practice, puts forward suggestions

and suggestions to the administrative departments of higher education, teachers and students. In this study, the objects of practical suggestions were divided into three parts: educational management departments and colleges, teachers and students. It is stated as follows.

1. Suggestions to Educational Management Departments and Colleges

The results of this study show that perceived credibility had direct effects on intention to use m-learning. This was in accordance with the findings of other studies (Almaiah & Al Mulhem, 2019; Liew, Tan, & Ismail, 2017). Moreover, para-social relationships, media richness, and compatibility have been shown to have indirect effects on intention to use m-learning through the mediating role of perceive credibility. It can be seen that the higher the degree of trust of students on mobile learning, the higher their willingness to use it. In order to improve students' trust in mobile learning system and content, colleges and universities should first provide an effective mobile learning support platform. According to the survey data of PISA (2019), on average, only half of school principals in OECD countries reported that "their school has an effective online learning support platform". This shows that China currently has a very big challenge in providing usable digital equipment and mobile learning-related infrastructure in universities. A stable network environment is the basic guarantee of mobile learning. Therefore, how to ensure the school Internet bandwidth and speed, access to adequate digital teaching resources, etc., has become the primary problem to be urgently solved for schools with digital infrastructure

shortage to carry out mobile education. And then, with the continuous development of technology, many students have realized the advantages of e - learning and mobile learning, they will take the initiative to formal education courses in the use of mobile learning content and the way comparing with other mobile learning system and content, therefore, in the process of moving the education development of colleges and universities need to continuously optimize the teaching system and teaching content, develop and improve the function of mobile learning system.

The results of this study showed that there are significant differences in various dimensions of influencing factors of mobile learning among Chinese college students of different majors. At the same time, the study found that in terms of behavioral intention to accept mobile learning, science students have higher requirements on compatibility and trust of content and system than other majors. Therefore, different majors need to be treated differently in the process of developing mobile education. At present, public mobile learning systems in colleges and universities are not compatible enough and lack of interactive functions, which cannot simultaneously meet the needs of the construction of different professional courses. Therefore, it is suggested that colleges and universities should delegate authority to the secondary departments in the construction of online courses, and institutes should carry out differentiated construction according to their own professional development needs.

2. Suggestions for teachers

The results of this study show that para-social relationship, media richness and compatibility are important external influencing factors that affect the perceived credibility. At the same time, para-social relationship is important external influencing factors that affect the performance expectancy. Moreover, media richness had an indirect influence on perceived credibility through para-social relationship. It is found that the richness of media endowed by the current mobile learning system provides a simpler and more direct social interaction function for teachers and students, and makes it easier for students to perceive the existence of para-social relationships. The higher the degree of para-social relationships students perceived in mobile learning, the higher their perceived credibility and performance expectation for mobile learning.

It is found that teachers' professional competence and project execution will be the direct judgment of students' participation in mobile course learning. Due to many teachers don't know about online teaching instructional design mode specific teaching activities of the organization, and the advantages of online teaching, making them the traditional teaching style teaching completely copy in mobile platforms, can easily lead to a drop in the quality of teaching, therefore, how to innovate the teaching design, become teachers to conduct teaching one of the biggest challenges faced by mobile. In fact, mobile teaching is completely different from traditional classroom teaching, which requires teachers to have a high level of ICT ability and skilled use of digital equipment online teaching platform, etc. Moreover, it puts forward higher

requirements for teachers' innovative teaching design. Teachers need to fully understand the teaching situation and learning situation in mobile teaching, and effectively use the mobile network space situation and online platform to design teaching activities suitable for mobile learning, so as to effectively achieve the teaching and learning objectives. Through the mobile teaching platform to establish a harmonious and trusted new relationship between teachers and students. Hereby, the following specific suggestions are put forward.

First of all, teachers should strengthen their sense of responsibility according to the change of teaching environment and further improve their leadership. In this process, teachers should fully understand students' ICT - related technical support issues and give help according to students' actual situation and learning needs. In addition, it is necessary to pay continuous attention to the emotions of all students and give relevant feedback in time to provide necessary emotional support for students. Constantly strengthen their own comprehensive ability, in the minds of students to establish a positive influence. In addition, teachers should actively carry out deep professional cooperation. In cooperation, teachers can share each other's practical and teaching experiences through social platforms. At the same time, they can also upload a large number of online teaching resources for everyone to learn from each other. Finally, it is suggested that teachers should explore the best teaching methods suitable for students and guide students to conduct independent learning through mobile learning on the basis of full understanding of students' learning habits,

learning foundation and learning interest.

3. Suggestions for Students

First, students need to change their learning model. At present, students cannot fully adapt to the environment and learning mode of mobile learning, and are faced with the test of self-learning management ability in the learning process. Therefore, how to establish a deep and efficient interpersonal cooperation relationship in mobile learning is a major challenge for college students. Students have greater autonomy in mobile learning, so how to make efficient learning plans, choose appropriate learning contents and allocate reasonable time is the focus of college students' attention. Next, students need to adjust their mindset in mobile learning. The development of ICT technology has put forward higher requirements for mobile learning, and there are certain differences in students' ability to accept technology, which also has a certain impact on students' psychological or emotional state. A long time of online learning is likely to further promote their anxiety, irritability, depression and other emotions. For students with poor self-regulation ability, they cannot quickly adapt to the new online teaching mode, and thus have anxiety about their learning ability and learning quality. Therefore, how to conduct emotional management more scientifically and effectively is a practical problem faced by many students.

6.3 Limitations and future research

This study took Chinese college students as the research object. However, due to personnel, material and time constraints, samples were collected from only three universities in southwest, central and eastern China through a convenient sampling method, all of which had conducted mobile learning courses and students had mobile learning experience in either formal or informal learning. However, some of these students do not have much experience in mobile learning.

From this perspective, the participants in this study are somewhat under-represented. Therefore, it is suggested that in future studies, the researchers can expand the scope of the study to more different types of universities, such as professional colleges and private colleges, for more detailed studies. Postgraduate and doctoral students can also be participants in the follow-up research, and even university graduates with mobile learning experience in China can be participants in the follow-up research, not just college students. This will make the whole study more complete and incisive.

In the process of studying the influencing factors of mobile learning, this study focuses on discussing the relationship between these variables. Quantitative research is used in data analysis, but qualitative research and discussion are few. In order to improve the effect and recovery rate of the questionnaire, the teachers' organizations of the Youth League Committee and the Student Affairs Office of

various colleges and universities are specially entrusted to give unified explanations to students and help distribute and collect the questionnaire.

In the research of mobile education, UTAUT model is used as a basic model to verify the adoption of students' behaviors, and its conclusions tend to be mature and stable.In the process of verifying the mediating and moderating effects, this study found that the basic model constructed has a good fit. Therefore, it is recommended to consider adding different variables to the model in future studies to find more relationships between the variables and try to test their effects. There is another suggestion for researchers with interest that try to put the para-social relationship variables and the perceived credibility variables into different research domains to verify whether they still present mediating or moderating effect in different fields.

This study also has several limitations in terms of research content, which can be resolved in future research. First of all, this study is a cross-sectional study with a short duration. With the accumulation of new knowledge and experience, students' perceptions of performance expectancy, effort expectancy, perceived credibility, media richness, para-social relationship and intention to use in mobile learning will change over time. Therefore, future studies could use longitudinal designs to obtain more accurate results from specific populations. Secondly, the research on the content of para-social relationship and perceived credibility needs to be further expanded. According to the results of our investigation, the students in

addition to the research of mobile learning outside, have a basic understanding of the influence factors for mobile learning in other potential problems have certain understanding, (such as formal education system problems, the network relationship between teachers and students, using online BBS, etc.), special mention of privacy and security issues of mobile learning system need to be more and more attention. All of these factors can reduce students' para-social relations in mobile learning, thus affecting students' perceived trust.It is worth noting that when using mobile learning, students will worry about problems that may hinder their learning, thus increasing students' distrust in mobile learning and reducing their willingness to use it. Therefore, schools and system developers should establish a feedback mechanism, so that students can know whether their work has been successfully uploaded to the system, to ensure that teachers and students can receive corresponding feedback in the first place;This measure can enhance teachers' and students' trust in the mobile learning system and thus increase their willingness to use it. Then, this study regarded personal innovativeness as a moderator, but variables such as para-social relationship, perceived credibility, and system compatibility could also regulate the relationships among other variables in the UTAUT model. Therefore, in future studies, these variables should be regarded as moderating variables for further study. Finally, this study used the self-report questionnaire as the research tool. In the questionnaire survey, the interviewees may not express their true opinions when answering the questions, which may lead to errors in the results. This should be approached with

caution when interpreting the data. In addition, the mobile learning system included in this study is the mainstream mobile learning system in China at present.

Therefore, the results of this study should not be generalized to all mobile learning systems used in formal or informal educational settings. Other factors, such as mobile learning content or learning system, may also be important factors affecting mobile learning adoption.However, we did not include these factors in our research model, and future studies may wish to examine them in their corresponding specific context.

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A APPENDICES

Appendix I

Expert and Scholar Opinion on Questionnaire

Dear Prof._____ ,

Now I am doing my doctoral research with the title Empirical Research on Mobile Learning Diffusion Factor Based on MRT Theory and Internet Interaction Characteristics. This study developed a novel integrative model to explain the determinants of university students intention to using m-learning at an individual level. In order to understand and establish the expert validity of the research measurements, I sincerely hope that you can provide me with your insights.

This study explored the behavioral intention to use m-learning from the perspective of college students by applying the extended unified theory of acceptance and use of technology (UTAUT) model with the addition of perceived credibility, media richness, compatibility, para-social relationships, and personal innovativeness moderators. In this model, cognitive factors external factors are conceptualized as a combination of performance expectancy, effort expectancy and perceived credibility; External factors are conceptualized as a combination of media richness, compatibility and para-social relationships ; Personal innovativeness as Moderator. This study aims to propose a new theoretical model to explain the influencing factors of mobile learning in the context of higher education in China.

I would like to express my heartfelt thanks to you for your assistance during your busy schedule.

Dhurakij Pundit University
Advisor: Dr. Zhang Ren-Cheng
From PhD student: Wei Meng
E-mail: mengwei54321@gmail.com

Notes: This questionnaire contains five parts: the first part is personal basic information with 5 items; the second part is Cognitive factors from the UTAUT (including PE and EE) questionnaire with 13 items; the third part is Perceived credibility questionnaire with 7 items; the fourth part is compatibility questionnaire with 6 items; the fifth part is the questionnaire of media richness with 7 items; the six part is the questionnaire of para-social relationship with 7 items. he six part is the questionnaire of personal innovativeness with 6 items. Please provide your valuable insights on the applicability of each topic and dimension, and kindly provide your comments as an important reference for the questionnaire revision. And thank you for your assistance!

I. Personal Basic Information

Item Number	Description of Items	Options
1	Gender	☐Male ☐Female
2	Grade	☐Freshman ☐Sophomore ☐Junior ☐Senior ☐postgraduates
3	Major	☐Liberal arts ☐Sciences ☐Arts
4	Experiences of engaging in mobile learning through mobile devices.	☐Less than 6 months ☐6 to 12 months ☐13 to 18 months ☐19 to24 months ☐More than 24 months
5	Which of the following form do you prefer for mobile learning?	☐APP ☐WECHAT Official Accounts and Mini Apps ☐WECHAT and QQ

II. Compilation Illustration of Cognitive Factors Scale

Performance expectancy are the extent to which a person believes that using a mobile learning system will help him or her gain in learning and performance at work. Effort expectancy is the extent of convenience perceived for using system. Similar constructs in other models and theories from semantic viewpoints are: perceived ease of use (technology acceptance model).

The researchers combined the TAM model scale compiled by Davis (1989) and the Modified UTAUT Survey items compiled by Chintalapati *et al.*(2017), Hio (2020) as the basic measurement methods of UTAUT2 in this study. These two dimensions include a total of 13 questions, including 6 questions on performance expectations and 7 questions on effort expectations.

Likert 5-point scale is adopted for scoring, 1 point means strongly disagree and 5 points means strongly agree.

Cognitive factors from the UTAUT (including PE and EE) scale

Construct	Item	Measure	Applicable	Applicable after Modification	Not Applicable	Revise opinion
Performance Expectancy	1	The diversity of mobile learning content covers my learning interests.				
	2	Mobile learning is useful for acquiring learning-related content.				
	3	Mobile learning enhances my learning efficiency.				
	4	Mobile learning improves the quality of my study.				
	5	Mobile learning has improved my learning ability.				
	6	Mobile learning systems enhance learning environments and experiences.				
	7	Using m-learning gives me greater control over learning.				
Effort Expectancy	1	Mobile learning is easy for me.				
	2	Mobile learning makes it easy for me to access teaching resources.				
	3	Mobile learning makes it easy for me to search the learning content by my interests.				
	4	It is easy for me to learn to use a mobile device.				
	5	The functional services provided in the process of mobile learning are simple and easy to operate.				
	6	I find it convenient to use mobile devices for course practice.				

III. Compilation Illustration of Perceived Credibility Dimension Scale

Perceived credibility in mobile learning content is closely related to the influence of media richness. It is believed that the operation of credibility is divided into two parts: trust and ability.

The construct, we adapted the measurement of Mc Croskey and Teven (1999). At the same time, according to the scale compiled by Munnukka *et al*. (2019) and Sokolova and Kefi (2020), audiences' perceived credibility in online media has been modified accordingly.

The dimension include a total of 7 questions. According to the characteristics of China Mobile learning environment, the contents of the original scale items have been modified.

Likert 5-point scale is adopted for scoring, 1 point means strongly disagree and 5 points means strongly agree.

Mobile Learning Perceived Credibility Dimension Scale

Construct	Item	Measure	Applicable	Applicable after Modification	Not Applicable	Revise opinion
Perceived Credibility	1	I found that the mobile course teachers are experts in this field.				
	2	I find the course of mobile learning very efficient.				
	3	I think mobile learning programs are trustworthy.				
	4	I think mobile teachers understand the needs of students.				
	5	The mobile online learning course I participated in will update the teaching content regularly.				
	6	I think mobile learning teachers are serious and responsible.				
	7	The comprehensive ability of mobile course teachers is trust worthy(innovative technology use, professional knowledge update, etc.)				

IV. Compilation Illustration of Compatibility Scale

Compatibility is described as the intensity with which innovations are perceived to align with the current needs, values, and prior experiences of their probable adopters (Rogers, 1995).

This scale is prepared by referring to the Innovation diffusion theory (IDT) of Rogers (2003). At the same time, this scale also refers to the content of compatibility scale in the research of Chen (2015) regarding technical characteristics and compatibility as influencing factors of mobile learning, and the content of compatibility scale used by Agarwaland Prasad (1998) in the research of personal innovation.Since the research objects of the scale in the references are all mobile learning, the contents of the items are directly quoted.

The dimension include a total of 6 questions.

Likert 5-point scale is adopted for scoring, 1 point means strongly disagree and 5 points means strongly agree.

Mobile Learning Compatibility Dimension Scale

Construct	Item	Measure	Applicable	Applicable after Modification	Not Applicable	Revise opinion
Compatibility	1	Using mobile learning is compatible with most aspects of my learning.				
	2	I can quickly adapt to the learning style of mobile learning.				
	3	Using mobile learning fits my learning style.				
	4	The technical support provided by the mobile learning environment is compatible with my online learning habits.				
	5	Many of the mobile applications I use on my mobile device are compatible with other learning methods.				
	6	I have the skills needed to use mobile devices for mobile learning.				

V. Compilation Illustration of Media Richness Scale

MR (media richness) is the ability to process rich information. In this study, the concept of technology richness refers to a new richness discovered with the development of new ICT technology. The main focus of this paper is not to determine which specific media are more likely to be adopted and used in mobile education, but to determine the characteristics of different media.

This scale is prepared by referring to the media richness theory of Daft & Lengel(1986). Meanwhile, the contents of the MR scale in the study on media enrichment theory and distance education environment by Morgan M. Shepherd (2006) were also referred. Meanwhile, the contents of the MR scale in the study on media enrichment theory and distance education environment by Morgan M. Shepherd (2006) were also referred.In addition, according to the study semantics, the content of MR scale in Hio (2016) study on robot learning was modified.

The dimension include a total of 7 questions. According to the characteristics of China Mobile learning environment, the contents of the original scale items have been modified.

Likert 5-point scale is adopted for scoring, 1 point means strongly disagree and 5 points means strongly agree.

Mobile Learning Media Richness Dimension Scale

Construct	Item	Measure	Applicable	Applicable after Modification	Not Applicable	Revise opinion
Media Richness	1	I think new technologies (AR,VR, short video, AI) have been effectively utilized in mobile learning.				
	2	The interaction with teachers and other students in mobile learning is what I expect.				
	3	Mobile learning allows me to learn in multiple ways simultaneously (e.g. text, audio, video, live).				
	4	I got personalized feedback from my teacher.				
	5	Mobile learning gives me a feeling of face-to-face communication.				
	6	I can fully express my feelings in mobile learning.				
	7	At present, mobile Internet provides a good learning environment for mobile learning.				

Ⅵ. Compilation Illustration of Para-social Relationship Scale

It is defined as the emotional affinity between people and media roles, similar to the face-to-face relationship, which is also an illusion of "face-to-face relationship".In this study, para-social relationship is defined as a new type of teacher-student relationship in the Internet environment.

The scale was measured using an seven-item, 5-point Likert scale adapted from existing scales (Tsiotsou, 2015;Munnukka et al., 2019;N.Lee & Kwon, 2013;Lee & Watkins, 2016). Previous studies have focused on para-social relationships in online media, while this study focuses on mobile learning.Therefore, the content of the quoted scale was adjusted accordingly in this study. Some items were also directly referenced, such as PSR7"I like mobile learning in my personal space". Based on the measurement and confirmatory factor analysis results of Tsiotsou (2015) alr model, seven items were selected from six dimensions.

The dimension include a total of 7 questions. According to the characteristics of China Mobile learning environment, the contents of the original scale items have been modified.

Likert 5-point scale is adopted for scoring, 1 point means strongly disagree and 5 points means strongly agree.

Mobile Learning Para-social Relationship Dimension Scale

Construct	Item	Measure	Applicable	Applicable after Modification	Not Applicable	Revise opinion
Para-Social Relationship	1	I'm looking forward to seeing dynamic updates on mobile learning systems.				
	2	Mobile learning makes me feel comfortable, and I feel that my teachers and classmates are friends.				
	3	I want to meet the teachers and other students behind the mobile course.				
	4	If other learning platforms have information about the mobile course teachers or related course content, I will be interested to know.				
	5	The interaction between teachers and students in the mobile learning environment is similar to that in the real world.				
	6	I trust the teacher of mobile learning course, when he recommends the information beyond the course to me, I will accept it.				
	7	I like mobile learning in my personal space				

Ⅶ. Compilation Illustration of Personal Innovativeness Scale

The Innovativeness involved in this study refers to the innovation in the field of information technology, so it is defined as the willingness of individuals to try any new information technology.

Personal innovativeness was measured using six items adapted from Cheng (2014), Lin and Filieri (2015). Based on the current status of mobile learning technology, the relevant items in the scale were adjusted accordingly.For example, the original "I am among the first in my circle of friends to use new Technologies" has been changed to "I am among the first in my circle of friends to use new technologies of Mobile Learning". In the original question, "I like to try new products" was divided into "I like to use mobile learning apps to complete my quizzes and exams" and "I would like to try new mobile apps". According to the characteristics of mobile learning, the semantic meaning of "I like to experiment with new ways of doing things" in the original question has been materialized and adjusted to "I am willing to try new technology of mobile Internet".

The dimension include a total of 6 questions. According to the characteristics of China Mobile learning environment, the contents of the original scale items have been modified.

Likert 5-point scale is adopted for scoring, 1 point means strongly disagree and 5 points means strongly agree.

Personal Innovativeness Scale

Construct	Item	Measure	Applicable	Applicable after Modification	Not Applicable	Revise opinion
Personal Innovativeness	1	I am among the first in my circle of friends to use new technologies of mobile learning.				
	2	I would like to use mobile learning apps to complete my quizzes and exams.				
	3	I'm willing to try new mobile apps.				
	4	I am willing to try new technology of mobile Internet.				
	5	I like to use mobile learning tools on mobile devices.				
	6	I hope to get personalized learning experience in mobile learning.				

Thank you again for your assistance in your busy schedule!
My deepest thanks!

Appendix II

Formal Questionnaire

The Scale of Influencing Factors of Mobile Learning

Construct	Item	Measure	Source
Performance Expectancy	PE1	The diversity of mobile learning content covers my learning interests.	Chintalapati,*et al.*(2017); Davis (1989)
	PE2	Mobile learning is useful for acquiring learning-related content.	
	PE3	Mobile learning enhances my learning efficiency.	
	PE4	Mobile learning has improved my learning ability.	
	PE5	Mobile learning systems enhance learning environments and experiences	
Effort Expectancy	EE1	Mobile learning is easy for me.	Chintalapati,*et al.*(2017); Hoi(2020)
	EE2	Mobile learning makes it easy for me to access teaching resources.	
	EE3	Mobile learning with my mobile phone is simple and convenient.	
	EE4	The functional services provided in the process of mobile learning are simple and easy to operate.	
Perceived Credibility	PC1	I found that the mobile course teachers are experts in this field.	Sokolova and Kefi (2020); Munnukka *et al.* (2019)
	PC2	I find the course of mobile learning very efficient.	
	PC3	The mobile online learning course I participated in will update the teaching content regularly.	
	PC4	I think mobile learning teachers are serious and responsible.	
	PC5	The comprehensive ability of mobile course teachers is trustworthy (innovative technology use, professional knowledge update, etc.)	

Construct	Item	Measure	Source
Compati-bility	COM1	Using m-learning is compatible with most aspects of my learning.	Agarwaland Prasad (1998); Chen *et al.* (2002); Cheng,Yung-Ming(2015) Hoi(2020)
	COM2	I can quickly adapt to the learning style of mobile learning .	
	COM3	The technical support provided by the mobile learning environment is compatible with my online learning habits.	
	COM4	Many of the mobile applications I use on my mobile device are compatible with other learning methods.	
	COM5	I have the skills needed to use mobile devices for mobile learning.	
Media Richness	MR1	I think new technologies (AR,VR, short video, AI) have been effectively utilized in mobile learning.	Morgan M. Shepherd （2006）; Jahng, Jain,and Ramamurthy (2006); Yoo *et al.*(2016)
	MR2	Mobile learning allows me to learn in multiple ways simultaneously (e.g. text, audio, video, live).	
	MR3	I got personalized feedback from my teacher.	
	MR4	Mobile learning gives me a feeling of face-to-face communication.	
	MR5	At present, mobile Internet provides a good learning environment for mobile learning.	
Para-social relation-ship	PSR1	Mobile learning makes me feel comfortable, and I feel that my teachers and classmates are friends.	Munnukka *et al.* (2019); Yoo et *al.* (2016); N. Lee and Kwon (2013); Tsiotsou (2015)
	PSR2	I want to meet the teachers and other students behind the mobile course.	
	PSR3	The interaction between teachers and students in the mobile learning environment is similar to that in the real world.	
	PSR4	I trust the teacher of mobile learning course, when he recommends the information beyond the course to me, I will accept it.	
	PSR5	I like mobile learning in my personal space	

Construct	Item	Measure	Source
Personal innovative -ness	PI1	I would like to use a mobile app to download learning materials and work with students	Turan *et al.*(2015) Lu *et al.*(2005)
	PI2	I'm willing to try new mobile apps.	
	PI3	I am willing to try new technology of mobile Internet	
	PI4	I like to use mobile learning tools on mobile devices	
	PI5	I hope to get personalized learning experience in mobile learning	
Intention to use	ITU1	I will use mobile learning regularly in the future	Bhattacherjee (2001); Mathieson (1991); Roca, Chiu and Martínez (2006)
	ITU2		
	ITU3	I will often use mobile learning in the future	
		I will continue to use mobile learning in the future	