A FRAMEWORK FOR IMPLEMENTING MOBILE INTERACTIVE LECTURE INFORMATION SYSTEMS IN HIGHER LEARNING INSTITUTIONS

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FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
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ABSTRACT

The basis for conducting this research is the potential of mobile technology to aid and increase interactions between students and lecturers in higher education. The determination of key predictors of mobile technology adoption, and its effects on student-lecturer interactions, defined the overall direction of this research. The Interactive Mobile Messaging Acceptance framework was established with system quality, information quality, perceived usefulness, perceived ease of use, enjoyment, self-efficacy, and uncertainty avoidance as the independent variables (predictors), and adoption intention of mobile technology to aid student-lecturer interactions as the dependent variable. Therefore, this research attempts to investigate the impact of the predictors on the adoption intention of mobile technology.

A mix method approach was undertaken in this research. Findings from observations of large lecture classes confirmed the negative effects of large classes on student-lecturer interactions. Semi-structured interviews with academics of higher education using non-probability quota sampling method was conducted. Thematic analysis was applied to the qualitative data collected from the interviews. Overall, lack of interactions was perceived as the norm of large classes. Perceptions on the potential of mobile technology to aid interactions with their students were favourable, however, reservations relating to the suitability of using mobile technology in the classrooms were also expressed.

The research then commenced to the quantitative phase. A non-probability convenience sampling was used to collect data from tertiary students in Malaysia. Exploratory factor analysis was applied, and the underlying structure of the framework was confirmed. Partial least squares path modelling was applied to assess the reliability and validity of the framework, and to test the hypotheses. Lastly, importance-performance matrix analysis was applied to extend the findings. Findings supported the significance

of system quality, information quality, enjoyment, and uncertainty avoidance construct, pointing to the relevance of mobile technology's features, and feelings of satisfaction or pleasure when using the technology. Lower uncertainty level has a small effect on adoption intention of mobile technology. Findings failed to support the significance of perceived ease of use, perceived usefulness, and self-efficacy.

Next, the Interactive Mobile Messaging Application (IMMAP) was developed using the framework as a guide. A pretest-posttest experimental procedure was undertaken to assess IMMAP's feasibility to aid student-lecturer interactions. Significant differences were detected for the enjoyment (lower), uncertainty avoidance (lower) and system quality (higher) of IMMAP, as well as overall intentions to use IMMAP in future classes (higher). Therefore, functional features that can increase user enjoyment when using IMMAP must be given careful considerations in future enhancements.

This research makes several theoretical and practical contributions, and provides further insights on mobile technology acceptance in higher education to support student-lecturer interactions. Theoretical, methodological, and educational implications were discussed, and several suggestions for future research were identified and recommended. In short, this research helped to further the understanding on the educational use of mobile technology in higher education.

ABSTRAK

Asas bagi menjalankan kajian ini adalah potensi teknologi mudah alih untuk membantu dan meningkatkan interaksi antara pelajar dan pensyarah dalam pendidikan tinggi. Penentuan peramal utama penggunaan teknologi mudah alih, dan kesannya terhadap interaksi pelajar-pensyarah, menentukan hala tuju keseluruhan kajian ini. Rangka kerja telah ditubuhkan dengan menggunakan sistem kualiti, kualiti maklumat, persepsi penggunaan, persepsi kemudahan penggunaan, keseronokan, keyakinan diri, dan pengelakan ketidakpastian sebagai peramal, dan niat penggunaan teknologi mudah alih untuk membantu interaksi pelajar-pensyarah sebagai pembolehubah bersandar. Oleh itu, kajian ini bertujuan untuk menyelidik kesan peramal hasrat terhadap niat untuk menggunakan teknologi mudah alih .

Pendekatan kaedah campuran telah dijalankan dalam kajian ini. Hasil daripada pemerhatian kelas kuliah besar mengesahkan kesan negatif daripada kelas yang besar terhadap interaksi pelajar-pensyarah. Temu bual separa berstruktur dengan ahli akademik pengajian tinggi menggunakan kaedah bukan kebarangkalian persampelan kuota telah dijalankan. Analisis tematik telah digunakan untuk data kualitatif yang diperoleh daripada temu bual. Secara keseluruhan, kekurangan interaksi dianggap sebagai kebiasaan kelas besar. Persepsi mengenai potensi teknologi mudah alih untuk membantu interaksi dengan para pelajar mereka adalah menggalakkan, bagaimanapun, kebimbangan yang berkaitan dengan kesesuaian penggunaan teknologi mudah alih di bilik darjah juga telah dinyatakan.

Seterusnya adalah fasa kuantitatif. Persampelan mudah tidak berkebarangkalian telah digunakan untuk mengumpul data daripada pelajar pengajian tinggi di Malaysia . Analisis faktor penerokaan telah digunakan, dan struktur asas rangka kerja telah disahkan. “Partial least squares path modelling” telah digunakan untuk menilai kebolehpercayaan dan

kesahihan rangka kerja, dan untuk menguji hipotesis. Akhir sekali, “importance-performance map analysis” telah digunakan untuk meningkatkan hasil kajian. Hasil kajian menyokong kepentingan kualiti sistem, kualiti maklumat, kenikmatan, dan pengelakan ketidakpastian yang merupakan ciri-ciri teknologi mudah alih, dan perasaan kepuasan atau keseronokan apabila menggunakan teknologi. Tahap pengelakan ketidakpastian yang lebih rendah mempunyai kesan yang kecil kepada niat penggunaan teknologi mudah alih. Penemuan gagal menyokong kepentingan persepsi penggunaan, persepsi kemudahan penggunaan, dan keyakinan diri.

Seterusnya, aplikasi pesanan mudah alih telah dicipta dengan menggunakan rangka kerja sebagai panduan. Prosedur eksperimen pretest-posttest telah dijalankan untuk menilai kemungkinan IMMAP untuk membantu interaksi pelajar-pensyarah. Perbezaan yang signifikan telah dikesan untuk kesoronokan (lebih rendah), pengelakan ketidakpastian (lebih rendah) dan kualiti sistem (lebih tinggi) untuk applikasi pesanan, serta niat keseluruhan untuk menggunakan applikasi pesanan dalam kelas dia masa depan (lebih tinggi). Oleh itu , ciri-ciri fungsi yang boleh meningkatkan keseronokan pengguna apabila menggunakan applikasi pesanan perlu diberi pertimbangan di masa hadapan .

Kajian ini membuat beberapa sumbangan teori dan praktikal, dan memberi maklumat lanjut di dalam bidang penerimaan teknologi mudah alih dalam pendidikan tinggi untuk menyokong interaksi pelajar-pensyarah. Implikasi teori, metodologi, dan pendidikan telah dibincangkan dan beberapa cadangan untuk kajian akan datang telah dikenal pasti dan disyorkan. Pendek kata, kajian ini membantu untuk melanjutkan pemahaman mengenai penggunaan pendidikan teknologi mudah alih dalam pendidikan tinggi.

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LIST OF SYMBOLS AND ABBREVIATIONS

CB-SEM	:	Covariance-Based SEM
CFA	:	Confirmation Factor Analysis
DOI	:	Diffusion of Innovation
EFA	:	Exploratory Factory Analysis
IMMA	:	Interactive Mobile Messaging Acceptance
IMMAP	:	Interactive Mobile Messaging Application
IS	:	Information System
IT	:	Information Technology
PLS-SEM	:	Partial Least Squares SEM
SCT	:	Social Cognitive Theory
SEM	:	Structural Equation Modelling
TAM	:	Technology Acceptance Model
TPB	:	Theory of Planned Behaviour
TRA	:	Theory of Reasoned Action
UTAUT	:	United Theory of Acceptance and Use of Technology

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CHAPTER 1: INTRODUCTION

Mobile technology is a collective term for technology that is portable and used for cellular communication (Daichendt, 2015). The 21st century has seen the unprecedented advancements of mobile technology sophistication. Pagers and mobile phones have evolved to smartphones, tablets, netbooks, GPS navigation devices, handheld game consoles, and Internet devices for surfing the web. At the forefront of the rapid growth is the adoption of mobile technology by the masses, particularly among millennials (i.e. born between the year of 1977 and 2000). A study by Mashable Inc., an online news portal on emerging computing trends found that millennials prefer to use mobile devices for communication purposes and to conduct online transactions (Mashable, 2015). In Malaysia, approximately 66 percent of the population are active Internet users, 47 percent of them own more than one mobile phones, and more than ten million of them are 3G subscribers (Teller, 2014).

Studies examining user behavioural adoption intention and use of mobile technology across a wide range of areas pervade the literature. In higher education, mobile technology has made its impact. Learning platforms enabled by computing technology, such as online learning, mobile learning, and distance education are evidences of the Internet and mobile technology influences. Recent years have seen the integration of computing technology to enhance the teaching and learning experiences of higher education lecturers and students, for instance conducting group-based collaborative activities in large lecture classes using online collaborative workspaces. The availability of Web 2.0 applications developed specifically for use in the classrooms to aid different aspects of the teaching and learning processes, coupled with the convenience of installing these applications on mobile devices have given rise to a new wave of technology-assisted tools for education.

Such approaches, known as blended learning enable students and lecturers to engage and communicate in ways not usually possible in traditional face to face classes.

The advent of mobile messaging applications, for instance WhatsApp and Facebook Messenger have greatly eased communication. As conventional face to face lecture classes are still an integral part of higher education, and given the constraints often faced by lecturers in classes with large number of students, such messaging applications can ease interactions between students and lecturers beyond those attainable in face to face classes. As such, the main proposition of this research is the efficacy and feasibility of using mobile technology, specifically mobile messaging applications for aiding and increasing student-lecturer interactions in the classrooms, in particular large classes. However, using mobile technology in the classrooms of higher education is not without its challenges and drawbacks. In addition, insufficient understanding of mobile technology requirements from the users' perspectives could have adverse effects on the willingness of both students and lecturers to use mobile technology in the classrooms for interaction.

Therefore, a critical part of mobile technology adoption is to determine the requirements of students and lecturers alike through the identification of significant factors for predicting adoption of mobile technology in the classrooms of higher education to aid student-lecturer interactions. It is the determination of the key predictors of mobile technology adoption, and its effects on promoting student-lecturer interactions that define the overall direction of this research.

1.1 Background of Research

The use of mobile technology for learning among higher education students is becoming increasingly prevalent (Hwang, Lai, & Wang, 2015; Seilhamer, Chen, & Sugar, 2013). With an Internet and mobile penetration of 66 percent and 140 percent of the population in Malaysia (approximately 47% own more than one mobile phone) (On Device Research, 2014), the convenience, flexibility and interactivity advantages of mobile devices and applications are expected to play key roles in changing the higher education learning environments. Numerous studies on mobile technology enhanced learning conducted in recent years have yielded positive results for changing the delivery of higher education. For instance, Bernard et al. (2014) examined the correlation of students' online interactions and their achievements within an online and distance learning context, and results pointed to an increase of students' academic achievements when given the platform for active interactions with one another. Implementation of blended learning practices in higher education have also met with varying degree of successes (Albrecht, 2006; Torrisi-Steele & Drew, 2013). Deperlioglu and Kose (2013) studied the effects of integrating face to face classroom instructions with online learning for a computer programming subject, and students' perceptions were found to be favourable with evidences of an increase of students' level of satisfaction with the new pedagogical approach and improvements of academic achievements. Similar findings were revealed by Bernard et al. (2014) where blended learning practices yielded better students' achievements compared to face-to-face classroom instructions.

Widespread adoption of popular technologies such as social media and mobile messaging applications have greatly eased communication and information sharing, incurring minimal cost for mobile users. Growing literature of studies have documented the effects of using mobile technology in the classrooms for easing student-lecturer interactions, as well as enabling collaborations among the students (Blasco-Arcas et al., 2013; Chen & Lan, 2013; Oigara & Keengwe, 2013). For instance, students were observed to be self-directed in using their iPads inside and outside the classrooms for learning purposes (Mueller et al., 2012), and students' reading comprehension improved through the implementation of a personalized mobile learning approach in an English reading course (Hsu, Hwang, & Chang, 2013). Gikas and Grant (2013) examined students' perceptions relating to the use of mobile technology for learning, and findings demonstrated that mobile technology and Web 2.0 tools raised the students' level of engagement and interactions in group-based projects and assignments.

Background studies within the context of technology adoption in higher education are therefore essential for providing an overview of recent researches conducted, as well as providing key insights and issues of user behavioural intention pertaining to technology acceptance. The following section briefly discusses key theoretical technology acceptance models and theories, recent works relating to use of information technology in higher education, and issues pertaining to adoption.

1.1.1 Information System Adoption and Use

Information System (IS) researchers have demonstrated strong interests in understanding users' perceptions and behavioural adoption intentions, and factors driving actual adoption. As a result, IS researchers have applied one or a combination of several research approaches. The first approach involves the conceptualization and validation of technology acceptance theories, for instance Diffusion of Innovation (DOI) theory (Rogers, 1995) and Technology Acceptance Model (TAM) (Davis, 1989). Rogers's (1995) DOI theory originated from the field of social science and seeks to explain how new innovations "diffuses" across a targeted population or social system. The application of the DOI model in IS and computing technology adoption studies permeates the literature, evidence of the significance of the DOI theory to predict technology and system acceptances (Al-Jabri & Sohail, 2012; Doyle, Garrett, & Currie, 2014; Lee, Hsieh, & Hsu, 2011; Ward, 2013). Davis's (1989) TAM on the other hand, put forth two crucial factors to predict technology and IS acceptance: perceived usefulness and perceive ease of use. Numerous studies have validated the significance of perceive ease of use and perceived usefulness as predictors of technology and IS acceptance (Hess, McNab, & Basoglu, 2014; Huang et al., 2012; Joo, Lim, & Kim, 2011).

The second approach involves the examination of IS adoption from a social psychology perspective via the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975) and Theory of Planned Behaviour (TPB) (Ajzen, 1991). TRA posits a distinction between user attitude, subjective norm, behavioural intention and actual behaviour, and the relationships between these variables (Fishbein & Ajzen, 1975). TPB further extended TRA by proposing that attitude, subjective norm and perceived behavioural control contribute to intention and actual behaviour (Ajzen, 1991). The fundamental principle of these different models and theories are the relationships between users' perceptions and intentions to actual use of the system (Venkatesh et al., 2003).

Studies from the literature of IS acceptance also provided evidences of pivotal role of intrinsic motivational factor in the form of computer self-efficacy, i.e. the belief in one's own capability to competently use computing technology as a crucial determinant of technology adoption (Compeau & Higgins, 1995). Vallerand's (1997) motivational model emphasizes the importance of both extrinsic and intrinsic motivations. Extrinsic motivations differ from intrinsic motivations, with the former espousing the main motivation for performing a set of tasks is to obtain external rewards, while intrinsic motivations drive people to do something because they enjoy doing it. In IS studies, extrinsic motivations are often conceptualized as perceived usefulness, performance expectancy, or social influence (Venkatesh et al., 2003; Lee, Cheung, & Chen, 2005), whilst intrinsic motivations are often represented as enjoyment, satisfaction, or playfulness constructs (Ryan & Deci, 2000; Venkatesh & Davis, 2000). Yoo, Han, and Huang (2012) examined the difference between these two motivation groups, and intrinsic motivators (i.e. effort expectancy, attitudes, and anxiety) were found to be more significant in predicting employees' intention to use e-learning in the workplace than the extrinsic motivators (performance expectancy, social influence, and facilitating conditions).

Unifying these different approaches that links users' perceptions and adoption intentions to the actual use of IS is the United Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003). The model combined earlier IS acceptance models and theories, namely DOI, TRA, TPB, TAM, and motivational factors. The UTAUT model aims to explain behavioural intention and usage behaviour and has four main constructs posited as predictors - performance expectancy, effort expectancy, social influence are posited as determinants of behavioural intention, whilst facilitating condition and behavioural intention are posited as determinants of actual user behaviour.

DeLone and McLean (1992) merged elements of organizational and user influences in their IS success model, with system quality and information quality posited as the main predictors of system use and subsequent user satisfaction. Numerous studies have validated the causal relationships of the constructs in the IS success model, as well as the significance of the system quality and information quality constructs (Hsu et al., 2014; Lin & Wang, 2012; Tsai et al., 2012). DeLone and McLean (2002) then modified their IS success model and included service quality, focusing on attributes not directly related to the IS but rather on services such as maintenance and end-user support. DeLone and McLean (2002) emphasized the importance of the service quality for measuring the overall success of the IS throughout an organization.

These alternative views on technology acceptances firmly emphasize that factors influencing technology and system acceptances are multifaceted, encapsulating different aspects of internal and external factors. On the other hand, mobile devices' embedded operating systems and applications are constrained in terms of available resources, for instance processor speed, memory capacity, power consumption and physical size. Mobile applications tend to be used for shorter sessions, and qualities such as quick start-up time, responsiveness, limited but useful set of functionalities are often prioritized and implemented by developers (Hayes, 2014). Therefore, the differences between mobile applications and IS running on desktops or servers merit a more in-depth investigation among researchers of mobile technology adoption intention and use among users today.

1.1.2 Mobile Technology in Higher Education

The use of mobile technology in the classrooms is at an emerging stage. Prior to the surge of mobile technology popularity and adoption, traditional lectures eschewed the use of computing technology in the lecture classes. Computing technology are often exclusively used in laboratory settings. Reeves (2006), and Erickson and Siau (2003) emphasized the importance of allowing students to query freely and receive prompt feedback or encouragements from their peers and teachers. Face to face lecture classes remain an integral part of higher education as they provide opportunities for students and lecturers to engage in discussions in order to foster critical thinking skills.

Large lecture classes are common occurrences in all higher education institutions. There are no agreed upon definitions in the literature as to what constitute large classes in higher education. In this research, large lecture classes are defined as classes where the number of students exceeded the limit where the lecturers are unable to provide adequate attention or elicit feedback from their students, conduct active face to face discussions or collaborative activities with their students. Paladino (2008) and Spence and McKenzie (2014) defined interactivity in the context of learning as fostering an environment that encourages active feedback and discussions among students, and with their lecturers. Fostering active interactions in the classrooms, whether among the students, or between students and the lecturers are crucial. To combat the negative effects of large lecture classes on students and lecturers interactions, blended learning approaches have taken off in recent years. Using Web 2.0 tools such as Twitter to gather students' feedback (Elavsky, Mislan, & Elavsky, 2011), and Clickers - instructional technologies that enable lecturers and teachers to obtain structured or semi-structured responses from all the students (Blasco-Arcas et al., 2013) were successful in facilitating interactions, improving attendances and learning in large classes. Rehman, Afzal and Kamran (2013) reported both students and lecturers concurring on the importance of active interactivity in the classrooms to aid students' understanding of the subject content. Comparative research to ascertain students' preferences for lecture sessions that encourage interactivity and traditional lecture classes by Chilwant (2012) revealed a strong preference by students for lectures that encourages them to actively voice their opinions and field questions. Frequent interactions, coupled with concise delivery of the syllabus' learning objectives, and summary of key points with the aid of multimedia content were deemed supportive of students' learning efforts (Roopa et al., 2013; Sarwar, Razzaq, & Saeed, 2014).

Newer tools such as microblog with its interactive micro-messaging feature was also shown to enhance interactions in large lecture classrooms (Ledford et al., 2015). Other benefits observed were the convenience mobile technology provided for students to copy notes at a faster rate using their laptops, and easing both individual and collaborative academic tasks in the classrooms (Kay & Lauricella, 2011).

The use of mobile technology in the classroom as instructional tools in higher education is not without its challenges though. Clear drawbacks observed were disruptions and loss of concentration among the students (Kay & Lauricella, 2011; Scornavacca, Huff, & Marshall, 2009). Another study pertaining to the use of mobile technology in the classrooms were inconclusive with neither benefits nor drawbacks observed (Chen & Lan, 2013). Oigara and Keengwe (2013) reported mixed results in their study of mobile technology use in the classrooms, whereby students' satisfactions regarding use of mobile technology as an instructional tool in the classrooms increased, but their level of motivation to study remained the same. Therefore, proper selection and implementation of suitable mobile tools, coupled with adequate knowledge and maturity among the students are key success factors of mobile technology integration in the classrooms to promote student-lecturer interactions (Alzaza & Yaakub, 2011; Mahat, Ayub, & Luan, 2012).

1.2 Problem Statement

It is undeniable that mobile technology is an important aspect of our everyday lives, being our primary tool for communication, access and dissemination of information. Today's students are tech-savvy, and are already using their mobile devices in the classrooms for various reasons, for instance accessing the learning materials and capturing the notes written by their lecturers using their mobile devices' built-in cameras (Zakaria, Watson, & Edwards, 2010).

Lecture classes are the mainstream approach to teaching and learning in higher education, and are considered an effective platform for teaching and learning activities. Typical lecture classes are an hour to two in Malaysia, during which lecturers are required to cover the required syllabus, conduct discussions with their students or in-class exercises to gauge their students' understanding. Tertiary institutions' courses are often delivered in large lecture classes, i.e. classes that may have hundreds of students and situated in big halls. Large classes are prevalent in universities due to notable reasons, such as being a convenient strategy for universities with budget and scheduling constraints, as well as other constraints such as lack of teaching staff (Cuseo, 2007).

The negative effects of large, impersonal classes for the teaching and learning of tertiary students are well documented. Reviews of literature have unearthed sound arguments against large lecture classes and the negative consequences for both students and educators alike, backed with empirical evidences. For instance, the difficulties faced by lecturers in meeting the academic excellence standards pertaining to students' achievements in large classes with a diversity of cultural backgrounds (Biggs, 2012). Consequently, Pollock, Hamann, and Wilson (2011) compared students' perceptions of small-group classes versus large-group classes, and their findings revealed the students' clear preference for small-group classes for conducting discussions. Furthermore, their findings revealed a more equal and balanced participation of students from different ethnic backgrounds in small-group classes. There are also evidences of the effects of large classes toward students' academic achievements. Johnson (2010), and Yoder and Hochevar (2005) provided crucial empirical evidence that by increasing the size of classes, a significant negative effect on students' grades across all disciplinary areas was observed, and recommended that class sizes should be reduced to increase students' academic performances.

This research will attempt to summarize two main consequences associated with large lecture classes, and their implications on the teaching and learning of higher education students and educators. They are (i) reduction of quality student-lecturer interactions, and (ii) prevalence of teacher-centered approach to learning.

1.2.1 Reduction of Quality Student-Lecturer Interactions

With lecturing still being the prevailing instructional method in large classes, a comprehensive review of literature revealed crucial drawbacks and challenges in teaching large classes, namely lack of interactions with their students, inability to provide adequate attention to all the students, and unresponsive students who tend to sit at the back of the classrooms (Bachman & Bachman, 2011; Lane & Harris, 2015; Owston, Lupshenyuk, & Wideman, 2011). Large and long lecture classes often result in students losing interest and attention as communication are often uni-directional from the lecturers to their student, and students have limited opportunities to feedback or query their lecturers (Kotzé & Mole, 2015).

Moulding (2010) proved that large classes hinder interactions between educators and their students, and interactions when they do occur are often at lower cognitive levels. Exeter et al. (2010) further asserted that increasing class sizes makes it difficult for educators to promote active learning and encourage students' engagement, whilst conducting discussions in small sized classes elicited the highest level of satisfaction from the students. Similar results were reported by Hamann, Pollock, and Wilson (2012) whereby students surveyed demonstrated a higher level of satisfaction for small sized classes compared to large sized classes. Time constraint, language barrier, rigid layout of big lecture halls or classrooms, and students' personalities and cultural backgrounds contribute towards the difficulties faced by lecturers in engaging students in the learning process (Ragan et al., 2014; Smith & Cardaciotto, 2012).

Encouraging students to engage in discussions in the classrooms can be time consuming. The pressure to complete the syllabus within the academic trimester before the examination commences often hinders lecturers from conducting frequent discussions or hands-on activities in the classrooms (Draper & Brown, 2004). The time constraint therefore results in limited opportunities for active discourses to be initiated by lecturers who wish to do so (Trees & Jackson, 2007). Another reason for the lack of student-lecturer interactions is the big lecture halls or classrooms of many public universities (Geske, 1992). These massive halls are typically designed to accommodate large number of students. When courses are conducted in such halls, especially when the courses are registered by hundreds of students, the big space distances the students from their lecturers. The lecturers often position themselves in front, and students sitting at the far end of these big halls makes it difficult for the lecturers to maintain eye contact and to conduct discussions. The seating arrangements in typical lecture halls reinforces the lecturers' roles as the speaker and students' roles as the listener, thus presenting an invisible barrier that may limit students from initiating discussions during lectures.

Mayer et al. (2009) points to a growing concern among lecturers regarding students being passive or non-responsive to their queries or encouragements to provide feedback. Students in large classes may hesitate to voice their opinions or query their lecturers due to numerous intrinsic factors, such as being reluctant to disrupt the lecturer, fear of public embarrassment, introversion, shyness, poor language proficiency, and existing culture of learning that reinforces the expectation of passive behaviours in the classrooms (Caldwell, 2007; Davidson, Gillies, & Pelletier, 2015; Murberg, 2010).

1.2.2 Prevalence of Teacher-Centered Approach to Learning

In teacher-centered education, the students' focus and attention are expected to rest solely on the teacher. In other words, barring class activities, a traditional face to face lecture classes are classes where the students exclusively listen whilst lecturers "lectures" (Cotner et al., 2008).

There are documented evidences for and against teacher-centered approaches in higher education. There are notable advantages of teacher-centred approaches, for instance students are able to listen attentively without disruptions from their peers, and focus wholly on the instructor's directives, therefore the instructors do not have to worry that their students will miss out on important topics delivered in the classrooms (Classroom Resources, 2012; Kain, 2003). However, the modern day students are typically characterised as possessing shorter attention span, greater reliance of mobile technology in many aspects of their lives, prefer digital content as their source of learning materials in the form of webinars, instructional videos and simulations, favour fast and easy communication platforms, and the need for instant gratifications (Spence & McKenzie, 2014). Cherney (2008) concurs that traditional teacher-centred approach results in passivity among students, and subsequently lowers students' memory retention of the subject content. Smith and Cardaciotto (2012) reiterated the same argument that traditional teacher-centred approach of one-way communication in the classrooms reinforces students' passivity in the classrooms and reduces the quality of their learning experiences. Lack of students' participation and involvement in the learning process may result in serious consequences, for instance lack of understanding about the subjects may lead to poor academic achievements (Mayer et al., 2009). Therefore, it can be argued that using the teacher-centered approach solely are no longer effective, particularly among today's students as the lack of interaction opportunities impede their ability to feedback or query their instructors on academic matters.

In contrast, student-centered pedagogies focus on the students and are derived from the constructivism learning theory whereby learning, acquiring and the sharing of knowledge are achieved through active students' engagement, participation, and collaborative activities (Huba, & Freed, 2000; Wright, 2011). Researchers in the field of education have long argued for the replacement of teacher-centered with learner-centered pedagogies, i.e. instructional designs that place the students front and center in their learning undertakings (Frambach et al., 2014; Hansen & Stephens 2000; Polly & Hannafin, 2011; Rubin & Herbert 1998). Moulding (2010) reported higher students' satisfaction and better grades when student-centered approaches were utilised compared with traditional lecture-based instruction. A large scale study of tertiary students produced results that supported the proposition that learner-centered education can positively influence students' engagement, and that students' perceptions of their engagement level were higher compared to the usual lecture-based classes (Hallinger & Lu, 2013). Catalano and Catalano (1999) identified several key initiatives that educators should implement to transition from teacher-centered to student-centered paradigms. One of the key initiatives is to “provide a no-risk student feedback channel for information”.

However, higher education penchant for large classes makes it difficult for lecturers to encourage discussions and collaborative activities during classes. Coupled with the other constraints faced by lecturers handling large number of students in a single class, classrooms can get rather noisy and chaotic (Classroom Resources, 2012). Moreover, students’ who are naturally introvert or shy may find such learning environments overwhelming. As such, computing technology, in particular mobile technology can play a huge role in large lecture classes. It is posited that proper implementation and use of mobile technology in the classrooms, especially for large lecture classes, can foster student-lecturer interactions by providing a platform for students to feedback on important academic issues, thus allowing them not only to express themselves, but also to query their lecturers immediately when the need arises. Lecturers on the other hand have the opportunity to read their students’ feedback or queries on their mobile screens, and verbally address their queries in the classroom during intermittent breaks, or reply after the class ended.

To sum up, advocates of learner-centred approach affirms the importance of active learning, an instructional methodology that emphasizes active students’ participations and engagement (Soler-Dominguez et al., 2014). Kuh, Laird and Umbach (2004) highlighted that increasing students and lecturers’ interactions, as well as enabling prompt feedback are critical strategies for effective learning. Recent studies on using mobile technology in the classrooms to improve students’ engagement and providing an avenue for students to feedback have met with considerable success (Blackburn, 2015; Blasco-Arcas, Buil, Hernandez-Ortega, & Sese, 2013; Elavsky, Mislan, & Elavsky, 2011; Ledford et al., 2015).

Recent years have seen lecturers in higher education experimenting with the use of technology, notably Clickers to aid and increase interactions with their students via structured and semi-structured queries and answers (Blasco-Arcas et al., 2013; Green et al., 2015; Sevian & Robinson, 2011; Stowell, Oldham, & Bennett, 2010). Students' responses are analysed and their overall results are then produced for the lecturers. The results enable the lecturers to generally gauge students' level of understanding. However, such technologies are limited to close-ended questions, and for large groups of students, it can be time consuming for the lecturers to wait for their students to input their responses and ensure that everyone is participating (Nicol & Boyle, 2003). Moreover, students are also constrained in regards to the type of feedback they can provide other than the set of questions prepared by the lecturers. Therefore, mobile technology in place of Clickers are increasingly being utilised to obtain students' responses (Stowell, 2015). Chapter two will discuss the use of other forms mobile technology in classrooms of higher education.

1.3 Research Questions

The increasing popularity and use of mobile technologies for learning purposes among tertiary students is undeniable. Despite this, literature reveals that little is known about students' perceptions towards mobile technology for aiding student-lecturer interactions from different dimensions of technology adoption.

Based on the research identified, the research therefore intends to answer the following research questions:

1. What are the key factors that are relevant and pivotal for the adoption and use of mobile technology in the classrooms of higher education to increase student-lecturer interactions?
2. How likely will tertiary students adopt mobile technology to interact with their lecturers in the context of a mobile app developed based on the identified significant factors?

The aforementioned gap and research questions thus lead to the following research aim and objectives.

1.4 Research Objectives

Consequently, the aim of this research is to narrow the research gap by examining the roles of generalized system perceptions, extrinsic and intrinsic motivations, system traits, and cultural influences on tertiary students' adoption of mobile technology to interact with their lecturers.

The objectives below have been set out in order to achieve the above aim:

1. To develop the Interactive Mobile Messaging Acceptance (IMMA) theoretical framework for analysing the significance of factors predicting adoption intention of mobile technology for increasing student-lecturer interactions.
2. To empirically determine significant factors predicting the adoption intention of mobile technology for increasing student-lecturer interactions.
3. To develop a mobile messaging application prototype using the IMMA framework as a guide in order to ascertain tertiary students' behavioural intention to use mobile technology to interact with their lecturers.

Figure 1.1 correlates the research questions to the research objectives.

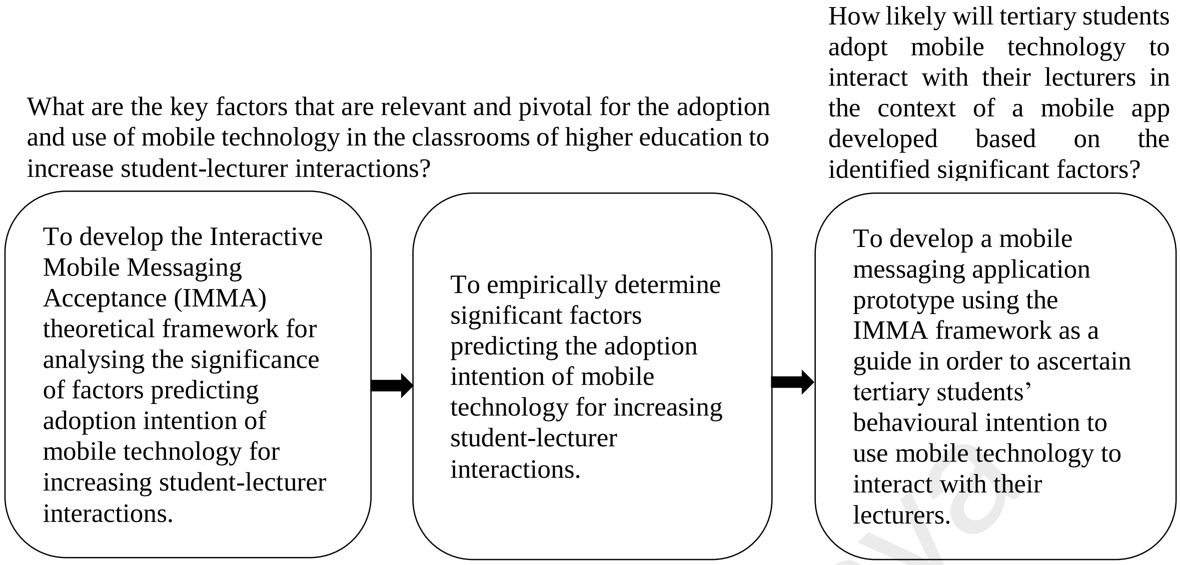

Figure 1.1: Correlation of the research questions and research objectives

1.5 Significance of Study

From the researcher and practitioner point of view, this research is needed given the pervasive use of mobile technology today in higher education. Issues regarding student-lecturer interactions, for example the constraints caused by large lecture classes and how mobile technology can be utilised effectively for aiding student-lecturer interactions must be uncovered. By doing so, the potential benefits of using mobile technology in the classrooms for interaction purposes can be discovered, and educators can thus embrace and benefit from the use of this technology in order to remain relevant. The popularity of mobile messaging applications in particular present an opportunity for students to utilize these platforms beyond merely texting their friends to actually using such applications to interact with their lecturers for educational purposes.

The arguments for supporting the significance of this research are thus explained from the theoretical and practical points of views.

1.5.1 Theoretical Contribution

Mobile technologies are used differently by different users for a multitude of purposes. Each group of users have their own sets of needs, and the benefits of mobile technology varies. In addition, the younger generation are known to multitask and may use their smartphones with their desktops or tablets simultaneously for communication, entertainment and work purposes. In higher education, students are often seen holding their smartphones and checking their mobile screens intermittently, thus causing considerable challenges for educators to maintain students' attention during face to face classes.

Therefore, existing technology acceptance models and theories need to be re-examined in the context of mobile technology use for educational purposes. In particular, the needs of tertiary students, as well as educators could be better understood in order to balance the perspectives of both groups. Generalisation of existing IS acceptance models and their respective factors may not be relevant, or the significance of the models' factors may differ when it comes to predicting mobile technology adoption in higher education to promote interactions between students and their lecturers. In addition, the hardware and technology sophistication of mobile devices differ greatly from those of desktops and servers. Coupled with the other challenges of ensuring students' attention and engagement when it comes to technology use in the classrooms, the theoretical necessity of the research is established. The research fulfils the need for mobile technology adoption to be evaluated from the view point of students and educators in order to focus on aspects that matters to them. In sum, it is hoped that this research will contribute to the body of knowledge in the area of mobile technology adoption in higher education, focusing on the effects of large lecture classes on student-lecturer interactions and how mobile technology can be utilised to aid student-lecturer interactions.

In pursuant to this, this research attempts to build and validate a mobile technology acceptance framework to investigate the adoption intention of tertiary students. The combination of technology acceptance models, and motivational theories would allow the behavioural adoption intention of the students to be examined from the mobile technology and non-technology point of views. In addition, reviews of literature regarding significant factors of IS successful implementation, i.e. information quality and system quality have not been thoroughly examined in mobile technology adoption studies. Influences of users' cultural backgrounds as determinants of technology acceptances are also gaining recognition and merits further investigation in the context of this research. It is believed that the research represents a novel research area on mobile technology use in the classrooms for facilitating student-lecturer interactions, and the multidimensional integration of mobile technology adoption, and its wider contribution to the literature of blended learning practices in higher education can be established.

To sum up, this research sets out to examine the perceptions of Malaysia's higher education students and lecturers in relation to mobile technology to increase the interactions between students and lecturers. A set of factors (independent variables) believed to affect adoption intention (dependent variable) of mobile technology adoption for promoting student-lecturer interactions were identified. Subsequently, the IMMA framework was conceptualized from the relationships among the independent and dependent variables. Qualitative (semi-structured interviews with lecturers) and quantitative (survey distributed to students) data were gathered and analysed in order to refine and re-evaluate the variables identified, and for determining the significance of the variables' relationships (hypotheses).

1.5.2 Practical Contribution

The research also designed and developed a mobile messaging application prototype named Interactive Mobile Messenger Application (IMMAP), based on the significant variables identified in the IMMA framework. The purpose of developing IMMAP is to facilitate student-lecturer interactions, with the intention of encouraging students who face difficulties during classes to send queries relating to the syllabus using the app. To ascertain students' views and intentions to use IMMAP for this purpose, a posttest and pretest experimental research was conducted. Surveys were distributed prior to the experiment to ascertain general views of mobile technology (pretest), and after the experiment concluded to ascertain views of IMMAP in aiding student-lecturer interactions (posttest).

Using a mainstream mobile messaging applications such as WhatsApp is not appropriate for the experimental research for a number of reasons. In general, students' existing use or partiality for the specific messaging application can affect their posttest survey answers. Furthermore, popular messaging applications are designed with features meant for casual conversations and are thus unsuitable for supporting teaching and learning endeavours. Lecturers on the other hand will also be burdened with the tasks of saving their students' mobile numbers, and group chats for courses taught using the messaging app.

Therefore, from a practical perspective, the IMMAP experiment results obtained might be of value for mobile application developers, particularly when developing mobile applications for educational purposes by taking into consideration the key significant factors deemed crucial for determining behavioural adoption intentions of the students and lecturers alike. Higher education institutions will undoubtedly benefit from gaining a deeper understanding on how mobile technology can be successfully used in the classrooms to promote students' engagement and interactions.

1.6 Research Methodology

This section briefly explains the research methods undertaken in this research, and the statistical analyses conducted. Detailed description of the research methodology is discussed in chapter three. Figure 1.2 depicts the overall research design undertaken in this research.

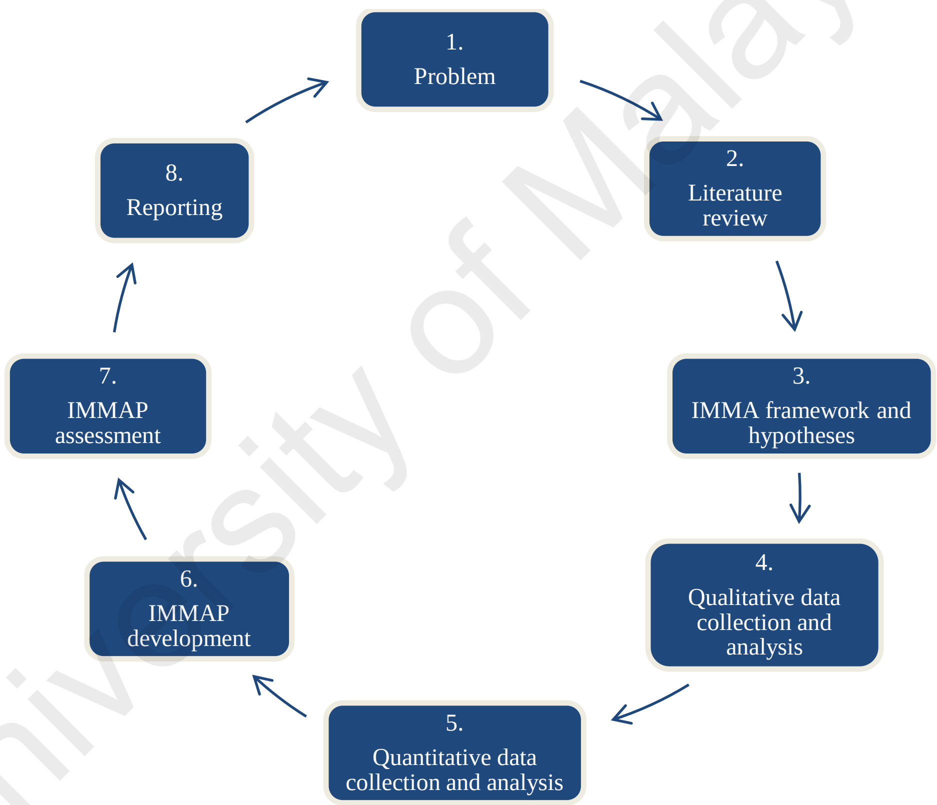

Figure 1.2: Main stages of the research process

The research problem statement, research questions and objectives, and its theoretical and practical contributions are first identified. Reviews of literature on technology adoption studies, success factors, motivational and cultural theories lead to the development of the IMMA theoretical framework, and justifications for the hypotheses in this research.

The research data analysis methodology in this research is a sequential mixed-method approach and consisted of three stages. Stage one was conducted over a period of eleven months (November 2012 till September 2013). Non-participatory observations of four large lecture classes (three science subjects and one non-science subject) were conducted to ascertain constraints caused by large lecture classes on student-lecturer interactions. Semi-structured face to face and telephone interviews with 22 lectures from five institutions in Malaysia across a range of academic disciplines were conducted to further confirm the research problem and identified gaps in the literature. Most importantly, findings from thematic analysis on the data collected from the semi-structured interviews were used to refine the factors (i.e. independent variables) identified in the proposed theoretical framework, and subsequently finalising the research's hypotheses.

Stage two commenced on October 2013 through October 2014, over a period of approximately a year. A self-administered online survey was sent to six higher education institutions. A total of 396 responses were gathered, and the data were subjected to statistical data examination and analysis. To empirically analyse the quantitative data, IBM SPSS Statistics 21 software was used to examine the preliminary data to detect the presence of outliers, to assess the normality of the data, and to generate the descriptive statistics. The software was also used to discover evidence of common method bias using exploratory factory analysis, and to confirm the reliability of the survey's scale items based on the results of item-to-total correlations and inter-item correlations. SmartPLS Version 2.0.M3 was used to run confirmatory factor analysis (CFA) and structural equation modelling (SEM) to verify the IMMA framework's internal consistency, reliability and validity. Most importantly, SEM was used to estimate the structural research model and to confirm the research's proposed hypotheses. SmartPLS Version 2.0.M3 was also used to estimate the moderating effects of the students' education backgrounds in relation to their intention to use mobile technology in the classrooms for aiding student-lecturer interactions.

Stage three took a total of approximately six months (December 2014 till May 2015). The IMMA framework factors were subsequently used for the design and development of IMMAP. A pretest-posttest research design approach was used for the assessment of IMMAP. A pretest survey was distributed to gauge students' perceptions on current use of mobile technology prior to the experiment. Another posttest survey was then administered to gauge students' perceptions of IMMAP after the experiment was concluded. IBM SPSS Statistics 21 was used for data analysis to derive the descriptive statistics of the experiment. Data gathered from the pretest and posttest evaluations of IMMAP were subjected to paired sample *t*-test analysis to determine whether there are significant differences between the significant factors prior to using IMMAP (pretest survey) and after using IMMAP (posttest survey).

1.7 Organization of Thesis

This thesis is divided into seven chapters. This chapter introduces the research, and explains the overall direction and rational for conducting the research. It also explains the gaps identified in the literature. The research's research questions, objectives, and significance, research methods, and the overall structure of this thesis are presented next in this chapter.

Chapter two reviews the relevant literature in order to determine the theoretical justifications of this research, and identifies the research gaps that provided the rational for undertaking this research. Thorough literature reviews of DOI, TRA, TPB, TAM, TAM2 and TAM3, UTAUT, UTAUT2, motivational model, and social cognitive theory for learning are presented. These are the underlying theories that form the theoretical foundation of this research. Emerging important issues in context of mobile technology, for instance adoption barriers of mobile technology are discussed. Significant factors in mobile technology adoption are also discussed, with the aim of understanding the advantages and disadvantages of each factor in recent mobile studies, and its effects toward determining adoption intention. The reviews of the relevant theories helped to identify the gaps in the literature, and provided crucial insights during the development of the IMMA framework and hypotheses for this research.

Chapter three deals with the hypotheses development and research methodology of the research. These includes the conceptualization of the IMMA framework leading to the development of the causal relationships (hypotheses) in the research model. The chapter also detailed the research methods used for data collection, which is fundamentally a mix methods approach employing qualitative research (non-participatory observations and semi-structured interviews), quantitative research (self-administered survey), and pretest-postttest research. Sampling methods, and justifications of the analysis methods of the qualitative, quantitative, and experimental research are presented.

Chapter four presents and discusses the results of the qualitative and quantitative data analyses results using IBM SPSS Statistics 21 and SmartPLS Version 2.0.M3. Data examination analyses and descriptive analysis results were first presented, followed by results from SEM for verifying the internal consistency and reliability of the IMMA framework and hypotheses testing. The results from the statistical analyses are then organized and presented according to the specific objectives of the research and its corresponding hypotheses.

Chapter five discusses the design and development of IMMAP to ascertain behavioural adoption intention via the pretest-posttest experimental approach, along with the justifications of the experimental design and quantitative analysis undertaken. The final part of the chapter presents and discusses the results of the experimental assessment of IMMAP.

The final chapter presents the implications, conclusion and recommendations of the research. The implications of the findings are first discussed, followed by the limitations encountered in this research. Recommendations are presented next, followed by the research's conclusion.

1.8 Summary

The benefits of using technology in the classrooms of higher education are well documented. For instance, allowing students to use their mobile devices in the classrooms inculcates in them a sense of responsibility by equipping them with the skill set required to use their mobile devices for educational purposes (Kay & Lauricella, 2011). Furthermore, with cheaper alternatives of e-books, students have the option of purchasing and accessing e-books on their mobile devices at great convenience and flexibility. Opportunities for learning outside the classrooms are made possible with mobile devices, such as collaboration opportunities on social media platforms, access of webinars or instructional videos uploaded online, etc. With lecture classes being an integral part of the higher education structure, it is therefore imperative to find ways to engage students in the learning process.

Lecture classes with large number of students limit the opportunities for lecturers to engage their students in meaningful academic dialogues or discussions. In addition, large classes typically exhibit a teacher-centered approach to teaching and learning in the classrooms. In a typical teacher-centered education, lecturers mainly teach and direct all classroom related activities. Students are expected to listen attentively and adhere to the instructions given, leading to the prevalence of rote learning and a lack of student-lecturer interactions. To evolve from a teacher-centered to a student-centered, self-directed approach to learning, students must be given the opportunities to express themselves as well as to interact with their peers and lecturers

Therefore, the aim of this research is to gain an understanding regarding the adoption of mobile technology to aid student-lecturer interactions in the classrooms. In pursuant of this aim, two major components in the development of scientific knowledge, i.e. theory formulation and theory application were undertaken (Portides, 2006). Theory formulation was undertaken first where vast related literature of studies were reviewed, resulting in the identification of the research gaps and subsequent conceptualization of the IMMA theoretical framework. The proposed IMMA framework integrates the theories of technological acceptance (Davis, 1989; Venkatesh, et al., 2003), social psychology (Ajzen, 1991; Fishbein & Ajzen, 1975; Rogers, 1995), motivation (Giesbers et al., 2013; Park, Nam, & Cha, 2012; Turel, Serenko, & Giles, 2011; Yoo et al., 2012), cultural (Hofstede, Hofstede, & Minkov, 2010; Hwang & Lee, 2012; Yoo & Huang, 2011), and IS success (DeLone & McLean, 2003; Detlor et al., 2013; Lin & Wang, 2012. The aim was to combine important factors from these differing theories into a single model in an attempt to fill the research gap and examine mobile technology from a multidimensional point of views.

The IMMA framework variables (factors) were subjected to rigorous statistical analyses for hypotheses testing. Theory application was undertaken in the form of the development of IMMAP, a mobile messaging app designed based on significant variables from the IMMA framework for enabling student-lecturer interactions pertaining to the syllabus of the students' registered subjects in the current trimester. An experimental approach was undertaken to determine the efficacy of IMMAP for aiding interactions between students and lecturers, and students' perceptions were obtained for assessing IMMAP.

To conclude, use of mobile technology in the classrooms of higher education for aiding the teaching and learning endeavours of students and lecturers does comes with its challenges. However, given the mobility of the technology and when utilised effectively, the educational benefits are numerous and significant for both students and lecturers. Though adoption of mobile technology by students are pervasive, understanding the nature and requirements of the current generation of students pertaining to use of the technology for aiding their learning efforts are paramount. To keep abreast and remain relevant, educators have to take on different approaches to their teaching pedagogy, shifting from traditional teacher-centered approach to an approach that focuses on encouraging students' engagement, interactions, and collaborative activities. An essential component of the student-centered approach is enabling student-lecturer interactions. This allows students the ability to feedback their opinions or academic queries anytime, and anywhere, including during lecture classes. Current mainstream mobile messaging applications such as WhatsApp are deemed unsuitable in this research by reasons which will be discussed in chapter seven of this thesis. A mobile messaging application designed for exclusive use in higher education environments to aid student-lecturer interactions can not only promote interactions between students and their lecturers, but subsequently encourages students to be self-directed, proactive and accountable towards their own learning process.

CHAPTER 2: LITERATURE REVIEW

Chapter one presented the study's background information, the research problems, research questions, research objectives, and theoretical and practical contributions of this research. Studies relating to technology acceptances pervade the literature, in particular studies that attempted to unravel factors affecting users' acceptance. The researchers in this field primarily aim to elicit users' perceptions of new technologies, what are the factors that may lead to favourable or unfavourable views about the technology. The existing body of knowledge affirms that numerous factors affect users' perceptions of the technology, and subsequent acceptance and usage. As a consequence, a large number of theories and models have been conceptualized and empirically verified.

This chapter presents a comprehensive review of literature on technology acceptances' models and theories. Due to the numerous studies unearthed, this research will attempt to narrow down and present the most relevant and prominent models related to technology acceptances. Technology acceptances are also reviewed from the context of IS success, motivational and cultural influences. The purpose of the thorough reviews of the literature is to lay the groundwork for the discovery of pivotal factors affecting the adoption of mobile technology adoption to aid student-lecturer interactions. The factors identified form the basis for the conceptualization of the theoretical framework of this research – the IMMA framework. Detailed reviews of each hypothesized independent and dependent variables are drawn from recent literatures in order to justify the inclusion of the variables.

In sum, reviews of the literature provided a context and justification for conducting this research, as well as illustrate how similar studies have been researched previously. Flaws highlighted in previous studies outlined gaps in the existing body of knowledge, and show how this research can add to the understanding and knowledge in the field of mobile technology acceptances.

2.1 Modelling Information Technology Acceptance

Researchers of information technology (IT) acceptance have developed prominent models and theories relating to understanding users' perceptions of IT and information systems. Among the numerous models, the most well-known and important models are Diffusion of Innovations (DOI) (Rogers, 1976, 1995), Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), Theory of Planned Behaviour (TPB) (Ajzen, 1991), Technology Acceptance Model (TAM) (Davis, 1989), and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). These models have been used, replicated, and enhanced by many researchers of technology acceptances over the past 20 years (Kim & Malhotra, 2005). The following sections summarize the theoretical and practical implications of each model.

2.1.1 Diffusion of Innovations

DOI is a theory that seeks to explain how, why and at what rate innovations spread through cultures (Rogers, 1976, 1995). Everett Rogers promoted this theory in his book titled *Diffusion of Innovations,* published in 1962. Rogers (1995) argues that an innovation is a novel idea, product, practice or technology perceived by the society, and diffusion is the "process by which an innovation is communicated through certain channels over a period of time among the members of a social system". Research on diffusion centres on the circumstances that increase or decrease the probability that a new invention will be adopted by members of a society. Rogers (1995) posits that innovation diffusion are influenced by five key factors – (i) The invention itself, (ii) communication channels (ways to transfer and share information), (iii) passage of time, (iv) the social system (external influences such as mass media, organizational or governmental mandates, and internal influences such as social relationships), and (v) the adopters (individuals, organizations, clusters of social networks or countries).

The success of an innovation depends on its adoption by the masses. It must be widely adopted to the point where it reaches critical mass, i.e. adequate number of adopters in a society where the rate of adoption becomes self-sustaining and creates further growth (Rogers, 1995). As such, studies relating to how innovation occurs often centre on the characteristics of the adopters. Rogers (1995) classify adopters into five categories:

(1) innovators – have the highest social status and financial ability, possess high risk tolerance that may see them adopting innovations or new technologies that may fail.
(2) early adopters – have high social status and financial ability, highly opinionated, and are more careful in their adoption choices.
(3) early majority – have above average social status and financial ability, and tend to adopt an innovation after a varying degree of time.
(4) late majority – have below average social status and financial ability, highly sceptical of any new innovations, and tend to adopt an innovation after the majority of the society have adopted the innovation.
(5) laggards – have the lowest social status and financial ability, generally the oldest in age, highly averse to innovations, and the last group to adopt.

The adoption rate of these five adopter categories typically follows a standard deviation curve, with innovators adopting the innovations in the beginning (2.5%), followed shortly by early adopters (13.5%), with the early majority (34%) and the late majority (34%) adopting after some time, and finally the laggards (16%) (Rogers, 1995).

Recent DOI based studies on technology adoption are diverse in nature, and primarily seeks to unravel variables that influence how and why users adopt an innovation, such as mobile banking (Al-Jabri & Sohail, 2012) and social media (Chang, 2010). Older DOI based studies were primarily focused on the factors contributing to the rate of technology adoption (Mahajan, Muller, & Srivastava, 1990; Mustonen-Ollila & Lyytinen, 2003; Parker, 1994). These researches typically gather the data on the adoption time frame of the adopters, and observed the cumulative rate of adoption (Meade & Islam, 2006). Since the DOI theory was first introduced, it has been used countless times in diverse fields over time (Prescott & Conger, 1995), such as healthcare (Crystal, Sambamoorthi, & Merzel, 1995; Greer, 1977), and e-commerce (Eastin, 2002), to recent studies in the fields of mobile banking (Van der Boor, Oliveira, & Veloso, 2014), social media (Archibald & Clark, 2014; Neo & Calvert, 2012), and education (Doyle, Garrett, & Currie, 2014; Sargent, 2015).

2.1.2 Theory of Reasoned Action

TRA was proposed by Martin Fishbein and Icek Ajzen in 1967, and is rooted in the field of social psychology to explain an individual's behavioural motivations to perform an action. The theory attempts to "organize and integrate research in the attitude area within the framework of a systematic theoretical orientation (Fishbein & Ajzen, 1975). TRA posits that an individual intention to perform an action (known as behavioural intention), a belief that performing the action will result in specific outcomes, is an important determinant of actual behaviour. In other words, the theory conjectured that stronger behavioural intention increases the probability for the behaviour to be performed. The TRA model suggests two factors preceding behavioural intention: (i) attitude (a person's opinions about the behaviour), and (ii) subjective norm (perceived social pressure a person feels when deciding whether to perform or not to perform the behaviour). Together, they form a model for predicting specific sets of behaviours.

Madden, Ellen, and Ajzen (1992) laid down three conditions that may affect the association of behavioural intention and behaviour. The first condition is that in order to predict a behaviour, an individual must be clear and precise about his or her level of behavioural intention. The second condition is that an individual's intention should generally remain relatively constant from the time it is measured until the time the behaviour is performed. Lastly, the individuals should have the autonomy to perform or not to perform the behaviour.

TRA based studies are numerous and multi-disciplinary, in particular in fields of predicting consumers' behaviours (Bagozzi et al., 2014; Bang et al., 2000; Shimp & Kavas, 1984). Notably, studies relating to information technology acceptances to confirm the suitability of the TRA model to predict users' behavioural intentions also pervade literature of past years (Liker & Sindi, 1997; Nor, Shanab, & Pearson, 2008; Wu, 2003; Ramayah et al., 2009). However, there is a scarcity of studies using TRA exclusively to examine users' behavioural intention for predicting actual behaviour in recent years. Researchers are integrating TRA with other newer models and theories in order to improve the predictive accuracy of their studies (Kim, Kim, & Goh, 2011; Ryu & Jang, 2006).

2.1.3 Theory of Planned Behaviour

TPB by Ajzen (1991) further extended the TRA model. Unlike TRA, TPB postulates that an individual behaviour may not be voluntary, and added perceived behavioural control (PBC), together with subjective norm and attitude from TRA to determine intention prior to actual behaviour. An individual PBC is his or her perceived ease or difficulty associated with performing a particular behaviour (Ajzen, 1991). PBC is important as it allows researchers to predict behaviours under circumstances where the individuals do not have complete autonomy or when constraints exist, thus rendering attitude and subjective norm insufficient to predict intention (Armitage & Conner, 2001). TPB also hypothesized that both intention and PBC determine actual behaviour.

The TRA model does not distinguish individuals' beliefs, while TPB does. TPB categorizes three types of beliefs – (i) behavioural beliefs (perceived consequences from performing the behaviour) that produce favourable or unfavourable attitudes toward the behaviour; (ii) normative beliefs (what other people who are important to the individual, for instance family and close friends, think whether he or she should or should not perform the behaviour) that affect subjective norm; and lastly (iii) control beliefs (perceived factors that may aid or obstruct effectiveness when performing the behaviour) that affect an individual' PBC level. These concepts lead to the development of the TPB model by Ajzen (1991).

The early years since the inception of the TPB model have seen numerous researchers successfully confirming the efficacy and predictive capability of the model, in particular the significant association of control beliefs and PBC (Ajzen & Madden, 1986; Sparks, Hedderly, & Shepherd, 1992). For instance, Ajzen and Driver's (1992) utilization of TPB to predict tertiary students' outdoor recreational activities choices, and Godin and Kok's (2000) review of the applications of TPB in the domain of healthcare and the model's effectiveness to predict health-related behaviours, Flannery and May's (2000) application of TPB together with Jones's (1991) moral intensity construct for predicting environmental ethical decisions, and Bamberg's (2006) use of TPB for predicting travel behaviour, to name a few.

Despite the years, TPB remains popular among researchers and a search of recent literature confirms the startling wide applicability of the model in various fields, such as healthcare (Ajzen, 2011; McEachan et al., 2011), social networking (Baker & White, 2010), educational technology (Lee, Cerreto, & Lee, 2010), and the environment (Nigbur, Lyons, & Uzzell, 2010). TPB was also integrated with TAM (Davis, 1989) for predicting e-procurement adoption (Gamal Aboelmaged, 2010), and Internet banking (Nasri & Charfeddine, 2012).

2.1.4 Technology Acceptance Model

TAM by Davis (1989) is widely known and popular for its simplicity and predictive accuracy in the field of technology acceptances. TAM was conceptualized based on the psychological model of TRA (Fishbein & Ajzen, 1975), and proposes two crucial factors for understanding and determining behavioural intention - perceived usefulness and perceived ease of use. Perceived usefulness is the degree to which an individual believes that using technology will improve his or her productivity, whereas perceived ease of use is the degree to which an individual believes that using technology is free of cognitive effort (Davis, 1989). Similar to both TRA and Ajzen's (1991) TPB, behavioural intention is hypothesized as the determinant of actual system use. Unlike TRA's predictors of behavioural intention, TAM's perceived ease of use is postulated to affect perceived usefulness.

To verify the model, Davis (1989) conducted two studies involving a total of 152 users and four computer application programs to test the reliability and validity of the perceived ease of use and perceived usefulness's scale items. Both variables significantly correlated to self-reported current usage and self-predicted future usage. Perceived usefulness had a higher correlation with usage behaviour than perceived ease of use, and thus points to perceived ease as a causal determinant of perceived usefulness as opposed to being a direct determinant of system usage. Davis, Bagozzi, and Warshaw (1989) compared the TAM and TRA model, and TAM was found to be superior in predicting acceptance of computing technology. Mathieson (1991) subsequently compared the TPB model with TAM to predict users' intentions to use an information system, and found both models predicted intention to use considerably well, with TAM having a slightly higher predictive power.

TAM has also been applied and replicated in subsequent studies of system acceptances in the following years, such as messaging technology (voice and email) (Adams, Nelson, & Todd, 1992), database and spreadsheet applications (Hendrickson, Massey, & Cronan, 1993), and voice mail and dial-up system (Subramanian, 1994). Davis and Venkatesh (1996) conducted three experiments involving two systems to address the presence of measurement biases due to TAM's grouping of the multiple items measuring each variable that might falsely increase the variable's reliability and validity results. Results of the study revealed no significant differences as to whether the variables' scale items were grouped together or intermixed with other variables' scale items, therefore validating TAM's original grouped format. Unlike TRA or TPB which have been applied in fields of study other than technology acceptance, TAM is widely used for predicting various perspectives of technology acceptances, from mobile learning (Park et al., 2012), e-learning (Cheung & Vogel, 2013), healthcare information systems (Pai & Huang, 2011), e-government (Lin, Fofanah, & Liang, 2011), and smart-grid technology (Toft, Schuitema, & Thøgersen, 2014).

The following years after TAM was introduced have seen researchers recommending modifications to enhance the model. As the original Davis's (1989) TAM only has four variables, and four casual relationships, new determinants for perceived ease of use and perceived usefulness have been proposed (Karahanna & Straub, 1999; Ramayah; 2006; Saadé, & Bahli, 2005; Venkatesh & Davis, 1996). A notable extension of the original TAM was proposed by Venkatesh and Davis (2000), and included social influence elements (subjective norm, voluntariness, and image), cognitive instrumental processes (job relevance, output quality, and result demonstrability) and experience to explain perceived usefulness and usage intention. The modified model developed by Venkatesh and Davis (2000) is known as TAM2. Venkatesh and Davis (2000) tested the appropriateness of TAM2 for technology prediction, and results obtained strongly supported the extended model's social influence and cognitive instrumental processes together with perceived ease of use to influence user acceptance.

TAM2 mainly explored further perceived usefulness and usage intention, and no new antecedents were proposed for perceived ease of use. Venkatesh (2000) explored the perceived ease of use variable by proposing two main groups of antecedents, i.e. anchors (self-efficacy, facilitating conditions, computer playfulness, and computer anxiety) and adjustments (system usability and system-specific perceived enjoyment) for perceived ease of use. Empirical evidence obtained strongly supported the anchors and adjustments' antecedents of perceived ease of use at all points of measurement (Venkatesh, 2000).

Due to TAM2's emphasis on perceived usefulness and usage intention, and the extended TAM's (Venkatesh, 2000) emphasis on perceived ease of use, Venkatesh and Bala (2008) integrated TAM2 and Venkatesh's (2000) extended TAM, and proposed another extended model of TAM, known as TAM3. Literature concerning determinants of perceived usefulness and perceived ease of use were reviewed and a comprehensive integrated model of both variables' antecedents were proposed and empirically tested. Though TAM3 combined the antecedents of both perceived ease of use by Venkatesh (2000) and perceived usefulness by Venkatesh and Davis (2000) into a single model, three new relationships were introduced, i.e. experience will moderate the relationships between (i) perceived ease of use and perceived usefulness; (ii) computer anxiety and perceived ease of use; and (iii) perceived ease of use and behavioural intention. Results obtained were generally consistent with those obtained by Venkatesh and Davis (2000), and Venkatesh (2000). Most importantly, none of the determinants of perceived ease of use had a significant effect on perceived usefulness at any point in time, and vice versa, and lastly, perceived usefulness emerged as the stronger predictor of behavioural intention (Venkatesh & Bala, 2008).

2.1.5 Unified Theory of Acceptance and Use of Technology

UTAUT (Venkatesh et al., 2003) is another prominent model of technology cceptance. Similar to earlier acceptance models discussed above, it seeks to explain user intention to use information systems and further explain system usage behaviour. The model posits three constructs, i.e. performance expectancy, effort expectancy, and social influence to directly influence behavioural intention. In turn, facilitating conditions together with behavioural intention are posited to influence usage behaviour. The model has four moderators: gender, age, experience and voluntariness of use.

Venkatesh et al. (2003) have tested and verified the effectiveness of the model for understanding user intention and usage behaviour of technology across six industries – entertainment, telecommunication services, banking, public administration, financial services, and retail electronic services. Subsequent years have seen researchers subjecting the model to analyse its capability to predict adoption in other areas, for instance wireless Local Area Network (LAN) (Anderson & Schwager, 2004), Internet banking (AbuShanab & Pearson, 2007; Foon & Fah, 2011), e-commerce (Uzoka, 2008), IT adoption in healthcare (Kijsanayotin, Pannarunothai, & Speedie, 2009), and technology adoption in higher education (Birch & Irvine, 2009).

Recently, Venkatesh, Thong, and Yu (2012) modified the UTAUT model where three new constructs were proposed – (i) hedonic motivation (fun or pleasure derived from technology use) as the antecedent of behavioural intention, (ii) price (associated with the cost that users usually have to bear pertaining to technology use) as the antecedent of behavioural intention, and (iii) habit (prior technology usage experience) as the antecedent of behavioural intention and use behaviour. Venkatesh et al. (2003) included hedonic motivation as it has been shown to be essential for determining technology adoption in prior studies (Childers et al., 2002; Brown & Venkatesh, 2005; Thong, Hong, & Tam, 2006; Van der Heijden, 2004). Price value was included in UTAUT2 due to evidence of its significance for predicting technology acceptance, such as short messaging services (SMS) (Chan et al., 2008). Particularly for the inclusion of habit, prior studies such as those by Ajzen and Fishbein (2005), De Guinea and Markus (2009), Limayem and Hirt (2003), and Limayem, Hirt, and Cheung (2007) have noted that feedback from prior experiences does influence users' beliefs and future performance of the said behaviour.

The extensions proposed in UTAUT2 showed substantial improvements in the variances explained in behavioural intention and technology use. In particular, empirical results obtained by Venkatesh et al. (2003) point to the importance of hedonic motivation, price and habit as important drivers for predicting continued use of technology.

2.1.6 Limitations of Technology Acceptance Models

The sections above discussed prominent models proposed for examining users' acceptances and usage of computing technologies. Each model differs from one another based on the variables and their respective antecedents for determining users' intentions and actual use. Older models such as TRA, TPB, and TAM have fewer numbers of variables and thus, researchers are able to easily replicate the models in various contexts to study users' perceptions and behaviours. However, there are limitations associated with these older models. For instance, the TRA model presumes that users have autonomy over their behaviours, therefore circumstances where users have no control when it comes to performing a set of behaviours cannot be explained by this model (Ajzen & Fishbein, 1980; Ajzen, Timko, & White, 1982). Furthermore, TRA does not take into consideration intrinsic factors or user beliefs, such as self-efficacy, effort expectancy, and enjoyment to predict technology acceptances.

TPB addresses the main limitations of TRA through the inclusion of PBC (perceived ease or difficulty associated with a particular behaviour) as the third antecedent of intention. In addition, behavioural beliefs, normative beliefs, and control beliefs are proposed as antecedents of attitude, subjective norm, and PBC respectively. Though user beliefs are included, other potential factors such as users' demographics are not considered.

On the other hand, the DOI theory proposed by Rogers (1962, 1995) suffers from empirical deficiency due to its limited applicability to studies of technology adoption, in particular to understand users' perceptions (Agarwal & Prasad, 1998; MacVaugh & Schiavone, 2010). Furthermore, classifying users into the categories of innovators, early adopters, early majority, late majority, and laggards may not be appropriate for users of mobile technologies. For instance, users may have the financial means (characteristic of early adopters), but can be highly averse to new mobile technology and are the last to adopt such new innovations (characteristics of laggards) due to unfavourable views of the technology and its negative effects on their lifestyle quality.

TAM on the other hand has no discernible limitations. The model's applicability in various disciplines or areas of technology studies, and the significance of the variables of perceived ease of use and perceived usefulness as determinants of behavioural intention are well supported and documented in many studies. However, although TAM is one of the most prominent and robust model for examining user acceptance of technology, it fails to take into consideration the intrinsic factors that may play a huge role. Positive intrinsic factors such as enjoyment or negative sentiments such as anxiety or uncertainty are not included in the model. As the sophistication of technology evolve over time, particularly mobile technology, and the needs of the user increases in complexities. Various intrinsic factors and the users' cultural backgrounds (Sathapornvajana & Papasratorn, 2013; Zhang, Zhu, & Liu, 2012), and positive feelings such as enjoyment when using the technology have been noted to be vital (Antón, Camarero, & Rodríguez, 2013; Yang, 2012a). Due to these limitations, extended versions of TAM2 (Venkatesh & Davis, 2000) that explored further the role of perceived usefulness, and Venkatesh's (2000) extended TAM that further investigate the perceived ease of use variables were proposed. Venkatesh and Bala (2008) eventually integrated both extended versions of TAM, known as TAM3, and is widely regarded as a comprehensive assessment of technology adoption from multiple perspectives (Chang & Im, 2014; Faqih & Jaradat, 2015; Jaradat & Al-Mashaqba, 2014).

To address to limitations of the aforementioned models, UTAUT model was proposed by Venkatesh et al. (2003), and is considered an all-inclusive and robust theoretical model that included the most significant factors from previous models. Figure 2.1 summarized the basic concepts of user acceptance models.

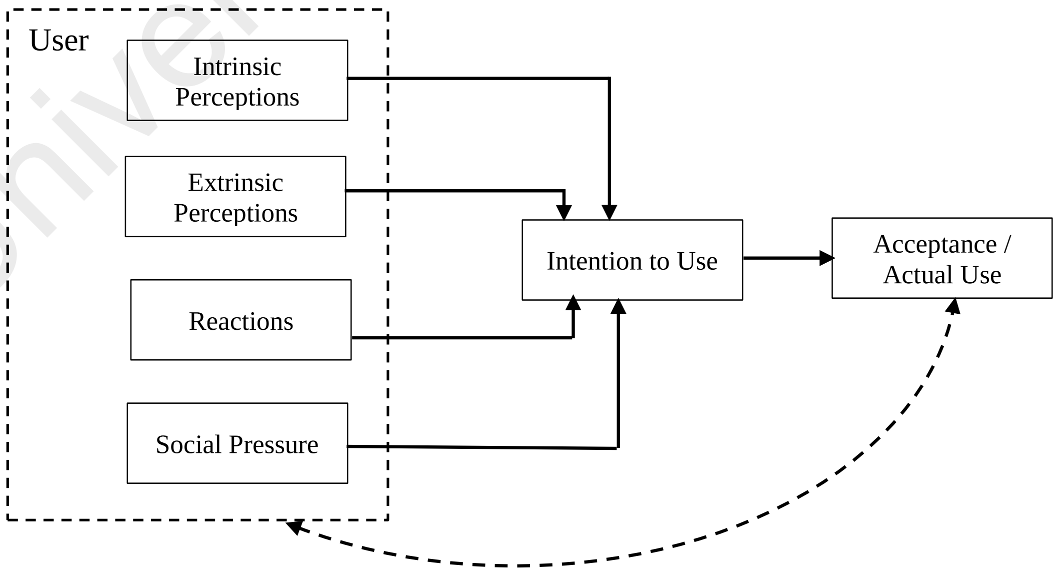

Figure 2.1: Basic concepts of user acceptance models (modified from Venkatesh et al., 2003)

Though newer models provided researchers with the means to predict acceptance of technology from multiple dimensions focusing on understanding the needs of the targeted users, they do not address the influence of system design and data characteristics. Thus, using UTAUT and TAM3 for instance provide limited means of assessing user acceptance based on the system and data qualities, thus a complete holistic examination of user acceptance is not possible.

2.2 Modelling Information System Success

Delone and McLean's (1992) Information System (IS) success model is also one of the most widely used and cited model in studies of user technology acceptance, especially the model's two key variables of system quality and information quality. The original model is an inclusive framework with six interconnected variables that relate different dimensions of IS success. They are system quality, information quality, system use, user satisfaction, individual impact, and organizational impact.

The model put forth two antecedents for predicting system use by the users, and users' satisfaction - information quality and system quality. System use was also theorized to affect user satisfaction, and vice versa. This differs from TAM or UTAUT that emphasized users' perceptions and beliefs as indicators of system use. Information quality encompasses the effectiveness of how a system captures input and generates output, the attractiveness of a system interface design, and most importantly the capability to generate relevant, useful and concise information for its user. System quality on the other hand relates to the characteristics of the whole system, such as response time, completeness of functionalities, availability, and reliability of the system, ability to handle large number of user requests in a timely manner, minimal interruptions or bottlenecks, and strong security measures in place to prevent security risks. TAM's perceived usefulness was conceptualized as a measurement of belief that an information system will help to improve efficiency, and factors such as information quality and system quality play crucial roles, though high quality of information and system features do not guarantee system acceptance (Leonardi, 2009; Silva & Dias, 2008). The causal relationships in the model have been tested in numerous studies, and results obtained generally found the hypothesized relationships to be generally significant (Hsu et al., 2014; Petter, DeLone, & McLean, 2008, 2013; Rai, Lang, & Welker, 2002; Seddon, 1997; Wang & Liao, 2008; Wu & Wang, 2006).

Ten years later, DeLone and McLean (2003) modified their original IS success model by including an additional determinant of system use and user satisfaction – service quality. The new quality concept deals with factors not directly related to the system, but on services such as the ease of maintenance and end-user support (DeLone & McLean, 2003). DeLone and McLean (2003) argued that each of the three major dimensions of qualities differ from one another, and the strength of their significance depend on the context of the studies and the type of statistical analyses utilised. Qualities of system and data are advocated to be fundamental for measuring success of an IS for an individual, whilst service quality is vital for measuring the success of the IS at the organizational level.

Despite decreasing cost of technology hardware, development and maintenance of information systems require substantial amount of monetary investment by organizations. Rejection of information systems may stem from lack of quality functionalities and slow system responses, the presence of constant system interruptions, and lack of adequate user training (Gorla, Somers, & Wong, 2010; Papadomichelaki & Mentzas, 2012). As such, system quality, information quality, as well as service quality are vital in predicting the successful acceptance and implementation of technology for its users, as well as for organizations on the whole.

2.3 Alternative Perspectives of Technology Acceptance

The above literature reviews provided researchers with the tools for the prediction of technology acceptance from the users' views on the ease, usefulness, and extrinsic benefits of the technology in question. This research also considers alternative perspectives of technology acceptance and usage from the cognitive, motivational and cultural contexts in order to provide alternative insights. A simplistic conception of technology acceptance does not acknowledge the differing dynamics and needs of technology users today and may lead to erroneous assumptions. A more heterogeneous approach must be undertaken in the quest to understand in what ways users find the technology useful, and how it benefits them in different ways.

2.3.1 Social Cognitive Theory

Social Cognitive Theory (SCT) is grounded in the field of cognitive psychology, the study of humans' mental processes of social interactions, problem solving, thinking, attention or memory, and thus provides a framework for understanding and predicting user behaviour (Bandura, 1977). Bandura (1988, 2001) theorized that when we interact with others, we may be influenced by others' perceptions and actions, hence are susceptible to modifying our thoughts and beliefs, and adapt our actions to suit the physical environment that we live in. In addition, given the same set of stimulus, our reactions or responses to the stimulus differ from one another based on our personal characters and beliefs.

In studies of technology acceptances, SCT is used to explain usage behaviour by placing importance on self-efficacy as a determinant of technology acceptance. Self-efficacy reflects an individual's belief in his or her capabilities to execute a set of task in order to achieve specific performance goals (Bandura, 2001). In other words, self-efficacy reflects one's level of confidence. Bandura (1993) claims that low self-efficacy increases the likelihood of people avoiding tasks that are thought to be unfamiliar or difficult to perform. Compeau, Higgins, and Huff (1999) tested the influence of computer self-efficacy, outcome expectations and anxiety on computer usage. Results gained proved self-efficacy to strongly impact users' reactions to technology. The effects of self-efficacy on technology usage have also been explored and proven vital in many other studies, such as older studies on web-based IS acceptance (Mun & Hwang, 2003), e-service acceptance (Hsu & Chiu, 2004), and IS acceptance (Hasan, 2006), to recent studies relating to educators' technology acceptances (Celik & Yesilyurt, 2013; Hong & Rada, 2011), Internet banking (Ariff et al., 2012), and e-learning acceptance (Calisir et al., 2014; Hsia, Chang, & Tseng, 2014).

2.3.2 Motivational Model

In the field of motivational psychology, there are two broad forms of motivations: extrinsic and intrinsic motivations (Scott, Farh, & Podsakoff, 1988). Extrinsic motivations are driven by the expectation of external rewards after the completion of a task, such as monetary rewards, job promotions and recognition. On the other hand, intrinsic motivations stem purely from an individual's sense of enjoyment when performing a task, without the need for external reinforcements (Scott et al., 1988; Vallerand, 1997). Davis, Bagozzi, and Warshaw (1992) applied motivational theory to study the influence of perceived usefulness (extrinsic) and enjoyment (intrinsic) on users' intentions to use computers in the workplace, and found both factors strongly associated with technology usage intention. However, Igbaria, Parasuraman, and Baroudi (1996) found perceived usefulness to be the stronger predictor of microcomputer usage compared to perceived fun or social pressure.

While technology acceptance models focus on perceived ease of use and perceived usefulness, user perception changes over time, and perceived ease of use and perceived usefulness may be inadequate to explain users' acceptances of technologies. Growing number of studies have explored the importance of intrinsic motivational factors as significant predictors of technology acceptances, such as playfulness (Venkatesh, 2000), enjoyment (Park et al., 2014a), and self-efficacy (Laver et al., 2012). Recent study on e-commerce readiness among consumers posited that both enjoyment and self-efficacy were significant as mediating predictors influencing the perceived value of online purchase (Wang, Yeh, & Liao, 2013). Taken together, the role of intrinsic motivators is pivotal.

2.3.3 Culture in Technology Acceptance

Culture encompasses a multitude of definitions and connotations for different members of societies. In simpler term, culture can be described as the common beliefs, norms, values and habits shared by members of a society (Groeschl & Doherty, 2000; Herzog, 2008; Persell, 1984; Rosman & Rubel, 1995). Kluckhohn (1961) defined culture as the social norms that distinctively differentiate a society from one another. Geertz (1973) extended the definition of culture to include the shared channels for communication in a society. One of the most widely known definitions of culture came from Geert Hofstede who conducted comprehensive studies to investigate the influence of culture on workers' values in organizations. Hofstede (2001) defined culture as the "programming of the human mind with which one group distinguishes itself from another group."

Studies to examine the connection between culture and technology adoption are gaining prominence. Researchers have long advocated the importance of cultural influences, and how the values and beliefs shared by members of a society affect the diffusion, adoption, use, and performance of the technology (Straub, 1994). Organizations seeking creative ways to promote new technological innovations while ignoring cultural context may suffer from adverse reactions by the users toward the technology (Matta & Boutros, 1989). Straub, Keil, & Brenner (1997) applied the model of TAM to understand the adoption of information systems in the United States, Switzerland, and Japan. As TAM is widely recognised for its versatility and applicability for examining users' intentions and use of technology, results obtained by Straub et al. (1997) were not consistent when predicting users' behavioural intention in Japan.

Subsequently, the UTAUT model was used to determine the influence of culture on the relationships of the model's constructs among users in Korea and the United States (Im, Hong & Kang, 2011). Notable differences were observed where the effects of effort expectancy on behavioural intention, and the effects of behavioural intention on use behaviour were higher in the United States (Im et al., 2011). Similarly, Alsajjan & Dennis (2010) applied a revised TAM to measure United Kingdom and Saudi Arabia's consumers' acceptance of Internet banking, and confirmed the significant differences on the influence of trust and system usefulness between the two countries, suggesting the potential role of culture in IS adoption. Conversely, Venkatesh and Zhang (2010) proved the generalizability of the UTAUT model when comparing technology users in the United States and China. On the influence of culture on consumer e-commerce adoption, Van Slyke et al. (2010) asserted that culture does influence consumers' intentions to purchase online. Cross-cultural validation of the UTAUT model on educational technology users from three European countries (Germany, Romania, and Turkey) revealed varying differences in the model's constructs' causal relationships' significance (Nistor, Göğüş, & Lerche, 2013). Culture was also found to moderate effects of mobile commerce adoption (Zhang et al., 2012).

Hofstede et al.'s (2010) ground-breaking work in cultural dimensions theory provided researchers with a framework to examine the influence of culture and society on users' attitudes and behaviours. The following sections summarize five dimensions of Hofstede et al.'s (2010) model of national culture.

2.3.3.1 Power Distance

The power distance dimension is the "degree to which less powerful members of a society accept and expect that power is distributed unequally" (Hofstede, 2001). Low power distance countries such as Denmark and Austria have lesser inequalities among its people, whilst countries including Malaysia and the Philippines with high power distance indexes are presumed to have far more inequalities. In high power distance countries, employees holding key positions tend to enjoy high social status whilst the opposite tend to occur in low power distance countries. Hofstede (2001) posits that the adoption of technology, such as mobile technology indicates the high social status of the adopter in higher power distance culture.

Despite Malaysia scoring highly in power distance index, approximately 67 per cent of the population are active Internet users (Internet World Stats, 2014), 47 per cent own more than one mobile phones, more than 10 million of them are 3G subscribers (Teller, 2014), and with social media penetration of over 50% of all Internet users in Malaysia (The Statistics Portal, 2015). Therefore, it contradicts the supposition that technology use confers high social status in Malaysia's society.

2.3.3.2 Individualism / Collectivism

Another cultural dimension is individualism versus collectivism. Individualistic societies generally exhibit a preference for a loosely knit social system where the individuals are expected to care for themselves and their immediate family members. Collectivism is on the other end of the spectrum, and generally refers to a preference for close-knitted society where people look out for one another. Countries such as Malaysia and Indonesia generally have collectivist societies, while citizens in developed countries such as the United States and Australia are individualistic. In relating these characteristics to the work place, employees who are highly individualistic tend to be highly independent, and make their own decisions to use or not to use new technologies, whilst collectivists are generally team players who tend to gather feedback from their friends or families prior to making decisions (Hofstede, 2001).

2.3.3.3 Masculinity / Femininity

Hofstede's (2001) masculinity dimension represents societies that are generally self-assured, assertive, high achievers, and highly motivated to attain extrinsic rewards. The opposite is the femininity dimension where the societies in countries such as Sweden and Thailand at large are not very competitive, are highly cooperative with one another, and emphasizes quality of life. In terms of technology acceptances, femininity society share similar attributes with collectivism where other people's opinions matter and are taken into consideration prior to deciding. Job prestige is considered very important in masculinity culture in countries such as Japan and the United States, and stiff competition among colleagues is typical (Hofstede, 2001). As such, members of masculine culture may use technology aggressively to increase their work performance, whilst members of the femininity culture may adopt technology to improve quality of life and connect with others.

2.3.3.4 Long Term Orientation / Short Term Orientation

The fourth dimension measures a society's emphasis on its history or towards the future. This dimension is drawn from Confucian ideas of social obligations, and the continuing practice of time-honoured traditions (Hofstede, 2001; Smith & Bond, 1999). Cultures with short-term orientation, such as in Venezuela, respect their ancestors' traditions and social hierarchy, and typically live their lives in the present moment (Hofstede, 2001; Smith & Bond, 1999). On the contrary, long-term orientation societies (for instance China and South Korea) are cautious about spending money, and prefer to save for their children's' education, or invest in real estate. Such societies focus on the future and highly emphasize traits of persistence, pragmatisms, and the ability to adapt to changing circumstances (Hofstede, 2001; Smith & Bond, 1999).

2.3.3.5 Uncertainty Avoidance

One of Hofstede's national cultural dimensions of particular interest in the study of technology acceptances is uncertainty avoidance, defined as "the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity" (Hofstede et al., 2010). In other words, uncertainty avoidance encompasses the unease, anxiousness, and hesitation people feel due to the lack of predictability and the presence of uncertainties (Hofstede et al., 2010). Uncertainty avoidance has its roots in the study of how values in organizations are influenced by cultural dimensions. Lee, Garbarino, and Lerman (2007) revealed significant increase of uncertainty avoidance when the consumers are doubtful about the quality of the products.

Unlike the aforementioned cultural dimensions, there are numerous researches done to examine the effects of uncertainty avoidance towards technology acceptance. Aykut (2009) revealed that high level of uncertainty avoidance lowers e-government acceptance. However, Lean et al. (2009) found uncertainty avoidance to be insignificant for predicting e-government acceptance. Hwang (2005) reported uncertainty avoidance to be significant for predicting an enterprise resource planning system adoption, whereas Yoon (2009) explored the effects of culture on consumer adoption of e-commerce, with evidence pointing to uncertainty avoidance having moderate effects on the relationships between trust and intention to use.

Recent studies point to uncertainty avoidance as a significant predictor of user behaviour and technology acceptance. For instance, lower levels of uncertainty avoidance correlated to higher acceptance of cell phones' subscriptions and Internet usage (Matusitz & Musambira, 2013). Hwang and Lee (2012) investigated factors supporting consumer online purchasing decisions, and confirmed that low uncertainty avoidance correlated to higher consumer trust, and vice versa. Uncertainty avoidance was also found to moderate both perceived value and enjoyment of online purchases (Sabiote, Frías, & Castañeda, 2012). In a comparative study between two groups of students (Americans and Koreans), the Korean students exhibited higher level of apprehension towards adopting Web 2.0 tools (Yoo and Huang, 2011).

2.4 Summary of Models and Theories for Technology Acceptance

Having reviewed technology acceptance and IS success models, theories of social cognitive, motivational and cultural dimensions, the variables theorized in each model and theory can be categorized into four main classes of user perceptions – technology competence (one's reflection of his or her capability to use new technology), personal (demographic factors and one's attitude towards the technology), usage benefits (the expected benefits of technology usage), and societal / cultural influences (see table 2.1).

Table 2.1: Summary of technology acceptances models, IS success model, and alternative theories of technology acceptance

Author(s) / Literature Source	Model / Theory	Model / Theory Variables			
		Perceived ease of using Mobile Technology	Intrinsic Motivations	Features of Mobile Technology	Societal / Cultural Norms
Rogers (1976, 1995)	DOI	▪ Perceived Ease of Use	▪ Voluntariness of Use	▪ Relative Advantage ▪ Compatibility ▪ Results demonstrability	▪ Image ▪ Visibility
Fishbein and Ajzen (1975)	TRA		▪ Attitude toward Behaviour		▪ Subjective norm
Ajzen (1991)	TPB	▪ Perceived Behavioural Control	▪ Attitude toward Behaviour **adapted from TRA*		▪ Subjective norm **adapted from TRA*
Davis (1989)	TAM	▪ Perceived Ease of Use		▪ Perceived Usefulness	

Table 2.1 continued

Author(s) / Literature Source	Model / Theory	Model / Theory Variables			
		Perceived ease of using Mobile Technology	Intrinsic Motivations	Features of Mobile Technology	Societal / Cultural Norms
Venkatesh et al. (2003)	UTAUT	▪ Effort Expectancy	▪ Gender ▪ Age ▪ Experience ▪ Voluntariness of Use **adapted from TRA*	▪ Performance Expectancy ▪ Facilitating Conditions	▪ Social Influence
Delone and McLean (1992)	IS success model			▪ System Quality ▪ Information Quality	
Bandura (1977, 2001)	SCT		▪ Self-efficacy ▪ Affect ▪ Anxiety ▪ Outcome Expectations - Personal	▪ Outcome Expectations - Performance	

Table 2.1 continued

Author(s) / Literature Source	Model / Theory	Model / Theory Variables			
		Perceived ease of using Mobile Technology	Intrinsic Motivations	Features of Mobile Technology	Societal / Cultural Norms
Scott et al. (1988), Vallerand (1997)	Motivational Model		▪ Intrinsic Motivations	▪ Extrinsic Motivations	
Hofstede (2001), Hofstede et al. (2010)	National Cultural Dimensions				▪ Power Distance ▪ Individualism / Collectivism ▪ Masculinity / Femininity ▪ Long Term Orientation / Short Term Orientation ▪ Uncertainty Avoidance

2.5 Conceptual Background - Integrating Technology Acceptance, IS Success, Motivations, Social Cognitive and Cultural Dimension

The main objectives of the current study are to establish an Interactive Mobile Messaging Acceptance (IMMA) theoretical framework, and empirically identify the framework's significant factors predicting the adoption intentions of mobile technology for increasing student-lecturer interactions.

Davis's (1989) TAM's perceived ease of use and perceived usefulness are well supported across a wide range of studies, and recent studies have also highlighted the importance of intrinsic motivators such as enjoyment and self-efficacy (Giesbers et al., 2013; Park et al., 2012; Turel et al., 2011; Yoo et al., 2012). One of the key phases of the system development life cycle is system design, and system with high quality of functionalities are deemed pivotal for ensuring success of information system adoption (DeLone & McLean, 2003; Detlor et al., 2013; Lin & Wang, 2012). Cultural influences are also gaining recognition in the field of system acceptances studies, with uncertainty avoidance from the national cultural dimension theory (Hofstede et al., 2010) proving to be an important determinant of technology acceptance (Hwang & Lee, 2012; Yoo & Huang, 2011).

This research thus intends to integrate TAM's perceived ease of use and perceived usefulness variables, and also include variables of enjoyment, self-efficacy, information quality, system quality, and uncertainty avoidance in the proposed IMMA theoretical model to examine the acceptance of mobile technology from four perspectives – the users' technology competency, personal characteristics, expected benefits from technology usage, and lastly societal or cultural norms. The purpose of proposing the integrated theoretical model is to address the identified research problems presented in chapter one, and the research gaps in the existing body of knowledge from reviews of related literature. The research gaps identified are described in section 2.6.

The proposed theoretical model is unique in the sense that factors from varying sources of technology acceptances, cognitive and motivational theories, quality of the system functionalities and information generated, and cultural influences are unified and examined in an integrated manner. It is hoped that by assimilating these factors together in a single framework, new insights in the field of mobile technology adoption in the classrooms of higher education can be obtained as well as to understand the technology requirements to support the teaching and learning activities of lecturers and students alike. Drawing upon the discoveries of past researchers' significant works and contributions, the conceptual background for the development of this research's theoretical framework is described in the following sections.

2.5.1 Perceived Ease of Use

TAM postulated that behavioural intention determines user acceptance of the technology, with perceived usefulness and perceived ease of use posited as antecedents of behavioural intention (Davis, 1989). Davis (1989) defines perceived ease of use as "…the degree to which a person believes that using a particular system would be free of effort." The TAM model claimed that if a specific technology improves user efficiency or performance, and doesn't require the user to invest much time and effort in learning how to operate the system's functionalities, it is considered relatively easy to use and subsequently increases the likelihood of the user using the technology in the near future. It is asserted that system with measures implemented to ensure that the technology can be learned and used with relative ease by people from all walks of life increases the positive perceptions of the technology in question, especially for users with limited technological prowess. As such, ensuring technologies' ease of use is of utmost importance, and is an integral feature that should be inherent in all information systems or mobile applications.

User perceptions of the ease of use and usefulness of computing technology, putting aside the complexities and technicalities of the technology implementation, are consistently validated as key predictors of acceptance. Ease of use was also the chief factor influencing user attitude, such as in the study of online banking by Nasri and Charfeddine (2012) and students' behavioural intention to use an e-portfolio system (Shroff, Deneen, & Ng, 2011). A recent study in students' acceptance of collaborative technologies affirms the significance of ease of use towards explaining the variance of attitude and perceived usefulness (Cheung & Vogel, 2013). However, user acceptance of YouTube for learning purposes by Lee and Lehto (2013) revealed the insignificance of perceived ease of use direct influence on behavioural intention. Perceived ease of use was also insignificant in influencing user attitude for online co-design process in mass customization among Korean consumers (Lee & Chang, 2011). Shyu and Huang (2011) set out to verify the TAM model, and results revealed that perceived ease of use does not influence user attitude of e-government web-based technologies to facilitate learning about issues useful for its citizens in Taiwan.

With both Theory of Reasoned Action (Fishbein & Ajzen, 1975) and Theory of Planned Behaviour (Ajzen, 1991) pointing to behavioural intention as the key predictor of actual usage, it stands to reason that Davis's (1989) model predicts actual usage of system acceptances if perceived ease of use and perceived usefulness significantly predict intention to use. Turner et al. (2010) systematic review of past empirical studies concluded that behavioural intention is likely to correlate to actual usage, providing support for the TRA, TPB, TAM, and UTAUT models of acceptance. However, the reviews discovered weak correlations of perceived ease of use and usefulness with actual usage. This is suggestive that though the acceptance models were generally confirmed and validated for its robustness, it doesn't sufficiently explain user actual behaviour (Djamasbi, Strong, & Dishaw, 2010).

Visinescu et al. (2015) examined consumer behavioural intention to buy online using websites with three-dimensional design features, with contradictory findings. Their findings confirmed that perceptions of ease of use is positively related to purchasing intention in two-dimensional designed e-commerce websites, while perceived ease of use was significantly lower towards purchasing intention in three-dimensional designed e-commerce websites. This is chiefly due to users' perception that two-dimensional websites were easier to use compared with the more sophisticated three-dimensional websites.

In the field of education technology however, the importance of the perceived ease of use factor for predicting learner intention and usage behaviour are well documented (Edmunds, Thorpe, & Conole, 2012; Escobar-Rodriguez & Monge-Lozano, 2012). From the educators' perspective, perceived ease of use significantly predicts acceptance of an educational portal (Pynoo et al., 2012) and satisfaction with e-learning (Teo, 2014), in addition to positively associated with intention to use learning management systems (Schoonenboom, 2014). Crucially, the acceptability of perceived ease of use to explain students' acceptance of mobile learning were affirmed in recent studies (Hsu et al., 2013; Iqbal & Qureshi, 2012; Nassuora, 2012; Park et al., 2012; Tan et al., 2014; Tan et al., 2012). Interestingly, Huang et al. (2012) compared active students and passive students' perceptions of an online learning system, and found that the passive students placed higher importance on the perceived ease of use of the online learning system, while active students' perceived usefulness were higher. In addition, perceived ease of use also significantly influenced students' satisfaction of e-learning (Joo et al., 2011).

Despite evidences of the lesser role of perceived ease of use to affect usage behaviour of technology, literature also provided ample evidence proving the significance of perceived ease of use in educational technology acceptance among students and educators. Therefore, the influence of perceived ease of use remains relevant.

2.5.2 Perceived Usefulness

In the workplace environment, perceived usefulness proposes the perception that using an information system will improve productivity (Davis, 1989), thereby bringing the focus towards users' expected benefits when using the technology. Perceived usefulness is therefore a form of extrinsic motivation, i.e. the idea that performing a set of actions are expected to yield positive outcomes. Coming back to the research questions that the study are attempting to answer, the influence of perceived usefulness in empirical studies of behavioural intention, particularly in system acceptances need to be examined.

Turner et al. (2010) systematic review of past empirical studies asserted weak correlation of perceived usefulness with actual usage, thereby insufficient to explain user behaviour. On the other hand, Wallace and Sheetz (2014) explored the effects of perceived usefulness toward four system measurements, i.e. system perceived prescriptiveness, language independence, life cycle applicability and validity. Results gained strongly supported perceived usefulness importance toward influencing users' perceptions on all four system measurements. Given that users' perceptions of the system were shown to be very much influenced by the usefulness of the system's functional attributes, Wallace and Sheetz (2014) contributed vital insights on the relevance of perceived usefulness.

Perceived usefulness was also found to positively influence user attitude toward blended learning (Padilla-Meléndez, del Aguila-Obra, & Garrido-Moreno, 2013), consumer repurchase intention (Jang & Noh, 2011), and students' acceptance of collaborative technologies to aid their learning endeavours (Cheung & Vogel, 2013). Literature have demonstrated perceived usefulness to significantly influence user satisfaction in a study by Lee and Lehto (2013) on behavioural intention to use YouTube for procedural learning, and Lee's (2010) investigation of learners' continuance intention to use towards e-learning. Contrary to perceived ease of use, perceived usefulness has consistently been proven to influence user attitude and behavioural intention across many fields of technology acceptances (Khor, 2014; Park et al., 2014b; Park & Joon Kim, 2013; Tarhini, Hone, & Liu, 2014a). A notable study to elicit mobile cloud services' determinants revealed perceived usefulness to strongly influence user attitude and intention to use (Park & Kim, 2014).

Higher education institutions have embraced computing technology in efforts to ease dissemination of information to their academics and students. Information systems are also used to facilitate key processes, such as students' registration and payment of courses online. Recent studies proved that both perceived usefulness and perceived ease of use remain relevant as pivotal predictors of technology acceptances in the education field. For instance, Calisir et al.'s, (2014) study of web-based learning system acceptances among college students, Tarhini, Hone, and Liu (2014b) study on e-learning readiness, and the effectiveness of blended learning approaches in the classroom (Padilla-Meléndez et al., 2013). Use of social media tools, for instance Facebook, Twitter, and YouTube on mobile devices eases communication and information sharing among students and with their lecturers (Hrastinski & Aghaee, 2012; Veletsianos & Navarrete, 2012). Such tools are popular among students and lecturers, and may be attributed to its usefulness and ease of use characteristics. For instance Twitter, a free social networking microblogging services, provides users with the ability to share information in real-time.

Therefore, considerable number of researchers has proven beyond doubt the importance of perceived ease of use and perceived usefulness to predict user technology intention. Therefore, both the constructs are included in this research's theoretical framework.

2.5.3 Self-Efficacy

SCT was proposed as an attempt to explain human behaviour, and one of the variables proposed in the theory, i.e. self-efficacy has gained prominence in studies of technology acceptance for predicting intention to use and usage behaviour (Compeau & Higgins, 1995; Bandura, 1977, 2011). Generally, self-efficacy reflects a person's level of confidence. Many studies have proven the influence of self-efficacy on extrinsic factors of ease of use and usefulness, and its direct effects on behavioural intention and adoption in studies of technology acceptances. Use of self-efficacy as a determinant of users' technology acceptance pervades literature. For instance, self-efficacy significantly influenced consumer adoption of Internet banking in Jordon (Alalwan et al., 2015), acceptance of mobile health services (Sun et al., 2013), and usage of web-based learning system (Tarhini et al., 2014b).

Kulviwat, Bruner II, and Neelankavil (2014) examined self-efficacy as an antecedent of emotional reactions, one of which was pleasure. Pleasure was posited as an antecedent of user attitude toward technology adoption. Results revealed that self-efficacy positively and significantly affect levels of user pleasure, and subsequent acceptance. Chen, Shih, and Yu (2012) explored the effectiveness of disaster prevention programs using virtual reality. Self-efficacy was posited as the antecedent of perceived usefulness, perceived ease of use, and perceived playfulness. All three hypothesized relationships were significant. However, Lee, Lee, and Hwang (2015) extensive analysis of the associations of motivation and technology acceptance challenges the impact of self-efficacy towards behavioural intention. Their findings revealed extrinsic motivation (performance expectancy) and intrinsic motivation (enjoyment) to influence behavioural intention but users' perceptions of their competence (self-efficacy) on the other hand did not predict behavioural intention. However, self-efficacy has been examined for its effect on learners' intention to use technology for learning purposes, with encouraging results (Chester et al., 2011; Dinther, Dochy, & Segers, 2011; Hillier, Beauchamp, & Whyte, 2013; Shank & Cotten, 2014).

In the context of mobile technology use in higher education, self-efficacy is defined as a student's personal confidence in his or her competency to use mobile technology to aid their learning endeavours, and interact with their lecturers using mobile technology (Holden & Rada, 2011). Pituch and Lee (2006) examined system characteristics that promote the adoption of e-learning, and found system functionality, system interactivity, system response, self-efficacy and Internet experience to be important determinants of e-learning acceptance. On the other hand, feelings of anxiety towards new technology implementation and security concerns also directly reduced the users' self-efficacy, and thus negatively affect user adoption decision (Yeow et al., 2008). To understand learner attitudes toward e-learning, self-efficacy was hypothesized to influence perceived satisfaction and usefulness, and results proved that the significance of the hypothesized relationships (Liaw & Huang, 2013). Holden and Rada (2011) further validated the importance of technology self-efficacy as having a positive influence on teachers' technology acceptance. Lee and Lehto (2013) examined user behavioural intention to use YouTube for procedural learning, and findings acknowledged self-efficacy as significant predictor of usefulness towards behavioural intention.

Therefore, it is believed that self-efficacy is an important determinant for predicting students' intention to use mobile technology in higher education.

2.5.4 System Quality and Information Quality

In the DeLone and McLean's (1992) IS success model, system quality and information quality are the antecedents predicting system use and user satisfaction. They are not posited as direct determinants predicting IS adoption successes in organizations. However, the significant indirect effects of system quality and information quality towards acceptance of IS for organizations as well as individual users are undeniable (DeLone & McLean, 2003; Detlor et al., 2013; Lin & Wang, 2012; Zhou, 2011). Traditional software development life cycle (SDLC) methodology for system development emphasizes the importance of ensuring that the design and construction of IS incorporate key characteristics that contribute to its acceptance and usefulness for its intended user.

Key features of good information systems include ensuring user understand and interpret the information generated by the system correctly, ensuring that the information generated is relevant and meaningful, and contain all the facts necessary for assisting users in problem solving tasks. These are essential attributes of information quality. On the other hand, ensuring the system availability and reliability, and usefulness of the functionalities are chief attributes of system quality. Adopting both system quality and information quality as predicting factors in this research's framework presents an opportunity for investigating factors that may have significant effects on system and information quality. Integration of Davis's (1989) TAM with other technology adoption and social psychological theories have yielded new findings and revealed the complexity of the multi-faceted influence of social psychology and IS attributes (Gamal Aboelmaged, 2010; Nasri & Charfeddine, 2012; Yaghoubi, 2010; Yen et al., 2010).

Delone and McLean's (1992) IS success model identified two determinants that bring the focus back to the information system, i.e. information quality and system quality. This differs from TAM or motivational theories that emphasizes users' perceptions and beliefs as indicators of system acceptance. In this model, information quality and system quality are put forth as factors influencing system use and user satisfaction. Information quality encompasses the effectiveness of how a system captures input and generates output, attractiveness of a system interface design, and most importantly the capability to generate relevant, useful and concise information for its user. System quality on the other hand relates to the characteristics of the whole system, such as response time, completeness of functionalities, availability and reliability of the system, ability to handle large number of user requests in a timely manner, minimal interruptions or bottlenecks, and strong security measures in place to prevent security risks. TAM perceived usefulness was conceptualized as a measurement of belief that an information system will help to improve user efficiency, and factors such as information quality and system quality play crucial roles (Leonardi, 2009; Silva & Dias, 2008).

A review of existing literature validated information quality and system quality as pivotal determinants. Lin and Wang's (2012) study integrated the D&M IS success model and TAM, and findings reported both information quality and usefulness as significant predictors of e-learning acceptance. System and content quality were also identified as significant predictors of e-government services acceptance (Tan, Benbasat, & Cenfetelli, 2013). Pai and Huang (2011) also integrated the D&M IS success model and TAM, and information quality, service quality, and system quality were mediated by perceived usefulness and ease of use to influence behavioural intention of a healthcare system. In a study to measure the acceptance of an organization's intranet, results reported that the intranet usability, design and information quality were significant factors of behavioural intention, albeit with lower significant levels than perceived usefulness and social influence factors (Barnes & Vidgen, 2012).

Chuang and Lin (2013) strived to examine the role of customer relationship management performance in mediating the relationship between customer information quality and overall firm performance. Customer information quality was found to influence the performance of customer relationship, which in turn significantly affects the company overall performance. The results were strongly suggestive of the importance of information quality towards influencing the performance of the research subject matter. Information quality was also found to be important in indirectly influencing use of an online community municipal portal (Detlor et al., 2013). However, information quality was found to be insignificant in predicting user intention for continuous use of electronic data exchange system, though information quality was found to negatively influence perceived risk and positively impact user expected transaction performance, and trust (Nicolaou, Ibrahim, & Van Heck, 2013). Quality of information was explored to predict acceptance of information systems, and found that the input feed into a system directly affects the quality of information (Michel-Verkerke, 2012). For that reason, equally important is the quality of the system functionalities, exemplified by key features such as data validation for preventing data entry errors and ensuring timeliness and consistent of data backups, and security mechanism for ensuring data kept in the database are virus free. It is uncommon to come across literature of system acceptances that excluded either information quality or system quality if the DeLone and McLean's (1992) IS success model is integrated.

Barnes and Vidgen's (2012) examination of user acceptance for intranet quality and acceptance demonstrated the importance of quality towards predicting user behavioural intention, and quality is highly influenced by the information, design and usability features. Equally important is the findings from the integration of DeLone and McLean's (1992) IS success Model for predicting adoption of e-learning in higher education, where system quality and information quality, together with instructional quality positively influenced user satisfaction of the course management system (Kim et al., 2012). In short, the crucial roles of both system quality and information quality towards influencing acceptances technology behavioural intention and usage are justified.

2.5.5 Enjoyment

While technology acceptance models focus on perceived ease of use and perceived usefulness, user perception changes and acceptances of technology no longer only depend on both ease of use and usefulness. Intrinsic factors, such as enjoyment or joy are proven to be an important determinant of technology acceptance. Enjoyment is defined as the degree to which an individual experience happiness when using mobile technology (Scott et al., 1988). Enjoyment, defined within the context of mobile technology use, is the level of joy a user experience while using mobile applications for leisure or work purposes (Vallerand, 1997; Van der Heijden, 2004).

Growing number of studies have explored the importance of intrinsic motivational factors as significant predictors of technology acceptances, such as playfulness (Venkatesh, 2000), enjoyment (Park et al., 2014a), and self-efficacy (Laver et al., 2012). Particularly among students of higher education, enjoyment was identified as a factor predicting behavioural intention to use clickers for learning purposes (Wu & Gao, 2011). Teo and Noyes (2011) examined the influence of enjoyment among pre-service teachers, and their findings point to enjoyment as a significant predictor of intention to use technology. A comparative study among undergraduates identified playfulness as an important predictor towards system use (Padilla-Meléndez et al., 2013). In other fields, a recent study on e-commerce readiness among consumers hold that both enjoyment and self-efficacy were significant as mediating predictors influencing perceived value of consumer online purchase (Wang et al., 2013).

To explore the role of intrinsic motivators in technology acceptances, Davis et al. (1992) first examined and confirmed the impact of enjoyment on user behavioural intention. The significance of enjoyment towards behavioural intention in technology adoption was also well examined and validated in numerous recent studies (Padilla-Meléndez et al., 2013; Park et al., 2014b; Teo & Noyes, 2011; Wu & Gao, 2011). Lee, Lee, and Hwang (2015) studied the associations of user motivations with communication technology acceptance and verified the significance of user perceived enjoyment towards predicting user intention. User intrinsic and extrinsic motivations were also positively and significantly related to Internet usage intention for small and medium sized enterprises (Caniëls, Lenaerts, & Gelderman, 2014).

In the same way, both perceived usefulness and perceived enjoyment positively affect the adoption intentions of haptic enabling technology products, designed to enhance the interface between humans and virtual environments via mechanical devices (Oh & Yoon, 2014). In addition, perceived enjoyment was revealed as the stronger predictor (Oh & Yoon, 2014). Consumer behavioural studies, for instance Sheng and Zolfagharian's (2014) investigation of consumer participation in online product recommendation services revealed enjoyment as a significant factor influencing user intention to use online product recommendation agent services. Chang et al. (2015) examined consumers' behavioural intentions to use mobile commerce yielded a clear finding – the positive significant impact of user enjoyment towards user attitude and behavioural intention. Likewise, consumers' behavioural intentions to adopt mobile commerce also revealed perceived enjoyment as a significant predictor (Zhang et al., 2012).

Moving to studies of Internet user habits, perceived enjoyment together with user involvement and satisfaction predicted user continuance intention to use web blogs (Shiau & Luo, 2013). Sun et al. (2014) examined user continuance intentions to use online social networks supported the supposition of enjoyment impacting user continuance intention, as well as user satisfaction from using online social networks. Knowledge sharing intentions among employees was investigated using factors prescribed by established knowledge management research streams, and the enjoyment factor was positively significantly associated with intentions to share both tacit and explicit knowledge (Hau et al., 2013).

A similar finding pertaining to the influence of enjoyment was also reported in a study of user acceptance of the virtual environment (Junglas et al., 2013). In investigating college students' adoption of e-textbook, enjoyment was also revealed as a critical factor influencing user attitude towards usage of the e-textbooks (Hsiao, Tang, & Lin, 2015). A comparative study on the impact of chronological age on mobile data services adoption produced crucial insights into the perceptions of the younger respondents where perceived enjoyment played a significant role in their adoption decision, whereas for older respondents, enjoyment factor was not significant (Hong et al., 2013).

Based on older and recent findings, it has been verified that enjoyment does have a significant impact towards user's decision on technology use and continuance of usage. Therefore, there are considerable supportive evidences of the significance of enjoyment to predict mobile technology acceptances. This provided strong justifications for the inclusion of the enjoyment variable as the targeted respondents are students of higher education (with the assumption that the average age of the students are relatively young and in their early 20s), and compounded with the fact that the study's main objective is to predict mobile technology adoption intention.

2.5.6 Uncertainty Avoidance

Uncertainty avoidance denotes a user's tolerance for uncertainties and ambiguities, one of Hofstede's cultural dimensions to understand the effects of a society's culture on the values of its members and how they drive behaviours (Hofstede et al., 2010). Positive impact of culture or social influence on information technology adoption have been explored in other studies such as German employees' intentions to adopt technology (Eckhardt, Laumer, & Weitzel, 2009), user acceptance of a prepayment metering system in India (Bandyopadhyay & Fraccastoro, 2007), and Taiwan's undergraduates usage of instant messaging (Lin & Anol, 2008). Chong et al. (2011) extended TAM to investigate the adoption of mobile learning in Malaysia by including technical feasibility, cost effectiveness, quality of services, and cultural traits. Results showed that besides perceived ease of use, perceived usefulness and quality of services, cultural aspects strongly impacted the adoption of mobile learning in Malaysia. Belkhamza and Wafa's (2014) comparative analysis of Malaysia and Algeria e-commerce acceptance revealed uncertainty avoidance plays an important role across both cultures in their acceptance of e-commerce. Thus, social influence is of particular interest in the context of this study involving lecturers and students readiness to adopt mobile wireless technology as an interaction tool.

It is hypothesized that high levels of self-efficacy in one's computing expertise would lower users' uncertainties when it comes to new technology acceptance and use. Chen, Chuang, and Chen (2012) examined and confirmed the effects of knowledge management system's self-efficacy towards feelings of uncertainties among its targeted users. Varma and Marler (2013) studied technology acceptance based on prior computer usage experience, and their findings revealed that experience in using computer systems was found to lower feelings of uncertainties and positively influenced behavioural intention of future use. However, uncertainty avoidance was found to have no significant effect on the acceptance of e-commerce (Capece et al., 2013). A similar result was reported in a study examining adoption and use of information and communication technology where the supposition that uncertainty avoidance impacts user behavioural intention was not supported. These contradict recent findings by Alhirz and Sajeev (2015) on user acceptance of enterprise resource planning system where uncertainty avoidance was found to significantly influence user involvement and resistance with the system.

The role of national culture as moderating factors to predict system acceptances are emerging. Review of literature revealed considerable recent findings of studies using national culture dimensions for explaining differences between different groups of user. Then again, results were inconsistent. For instance, Viberg and Grönlund’s (2013) cross-cultural analysis of users’ attitudes towards use of mobile devices in second and foreign language learning in higher education, comparing respondents from Sweden and China found that cultural factors did not explain differences in the mobile assisted language learning attitudes among the two groups of respondents. The findings concluded that the technology characteristics are more important than respondents’ cultural characteristic to predict system use.

Choi et al.’s (2014) examined the influence of culture using collectivism and uncertainty avoidance on user attitude towards mobile recommender systems found that both collectivism and uncertainty avoidance significantly moderate factors of social influence and perceived recommendation quality towards user attitude, respectively. A large global study on the effects of national culture on e-government diffusion of 55 countries hypothesized uncertainty avoidance negatively impact e-government diffusion, with the country economic development (divided into two groups – richer nations and poorer nations) used as the moderator (Zhao, Shen, & Collier, 2014). Findings from Zhao et al. (2014) revealed that uncertainty avoidance negatively affects the poorer nations’ e-government diffusion, but it had no impact on e-government diffusion for richer nations. Then again, Zhao et al. (2014) also examined the effects of culture on e-government diffusion. Findings proved the significance of power distance, long-term orientation and individualism, but uncertainty avoidance was insigificant.

That aside, Al-Hujran et al. (2015) analysed the influence of cultural factors toward e-government services' perceived value and ease of use. Specifically on uncertainty avoidance, low levels of uncertainty avoidance was hypothesized to positively and significantly influence perceived value and ease of use of the e-government services. Findings proved both hypotheses to be supported. Lee, Trimi, and Kim (2013) on the other hand, analysed the impact of cultural differences on mobile phone adoption patterns between two countries, the United States (low uncertainty avoidance) and South Korea (high uncertainty avoidance). Evidences point to culture with low uncertainty avoidance had a significantly higher level of effect on adoption. User perceptions of website design, trust and security were examined for differences, and results also point to users with low uncertainty avoidance have a significantly higher favourable perceptions of website design (Cyr, 2013).

Studies on consumers' perceptions yielded interesting findings. Kim, Yang, and Yong Kim's (2013) analysed the cultural differences of the United States and South Korea's consumers' perceptions of risk, and its impact on online purchase intentions. Findings on the differences of perceived risk between the two groups were inconclusive. Gelbrich and Sattler (2014) endeavoured to understand the effects of technology anxiety using the variables of perceived crowding and perceived time pressure, on the intention to use self-service technology. Their findings found technology anxiety to negatively affect intention to use. Participation in virtual academic communities study revealed that use of the virtual online communities was negatively influenced by technology anxiety (Nistor et al., 2013). Similarly, Park et al. (2014b) also found that feelings of anxiety negatively impact employees' acceptance of teleconferencing systems.

To summarise, the influence of uncertainty avoidance one user behavioural intention, particularly in studies of system acceptances and mobile technology, is inconclusive. Cultural norms may play a vital role towards influencing technology adoption. Thus, the present study theorizes that uncertainty avoidance may affect mobile technology adoption intention.

2.6 Gaps in the Literature

Having reviewed the literature of past and recent years on technology acceptances, in particular pertaining to educational technology, five main gaps were identified as depicted in Figure 2.2.

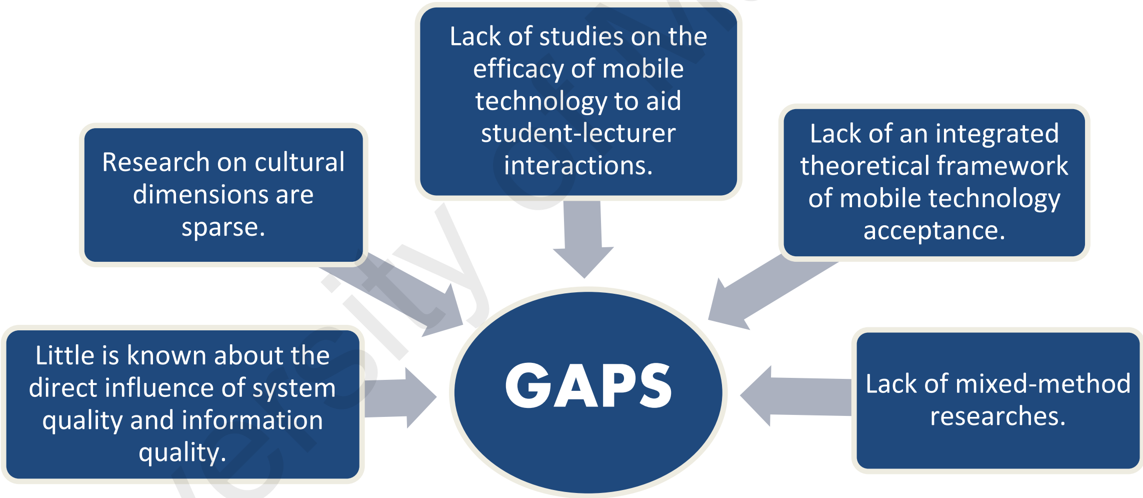

Figure 2.2: Summary of gaps in the literature of mobile technology acceptance in higher education in Malaysia

After reviewing the literature pertaining to Delone and McLean's (1992) IS success model, much has been done by researchers to investigate the model's main independent variables of system quality and information quality impact on user intention to use and usage behaviour in many fields of technology acceptance studies. Narrowing down the search for literature in studies using the IS success model for predicting higher education's use of educational technological tools revealed a scarcity of research done in this field, particularly in Malaysia. However, overwhelming empirical evidences strongly suggest the importance of system quality and information quality for predicting technology acceptance. Thus by including these antecedents, this study expands the knowledge pertaining to the effects of mobile technology quality attributes towards students and educators' adoption decision, in particular based on the mobile applications' functionalities, ease of input and usefulness of output produced.

Similarly, not much has been done to investigate the applicability and influence of culture in mobile technology adoption in higher education for aiding teaching and learning undertakings of educators and students alike. Nevertheless, the depth of past and current studies on the relevance of culture, particularly uncertainty avoidance in various contexts of technology adoption strongly points to the promising ability of uncertainty avoidance to predict mobile technology adoption behaviours of students and lecturers in order to aid student-lecturer interactions. This study thus intends to apply uncertainty avoidance, which reflects the culture of Malaysia, and provide new findings that might broaden the generalizability and increase the significance of uncertainty avoidance in higher education technology adoption.

The majority of the literature reviewed so far primarily utilised various statistical analyses to verify the proposed conceptual framework and confirmed the hypothesized causal relationships of the variables in the framework. To the best knowledge of the author, none of these studies leveraged the advantages of qualitative and quantitative analyses, followed by experiment procedures to demonstrate the results obtained from the statistical analyses, examine the validity of the hypotheses, and finally determine the efficacy of the proposed solutions. The benefits of mixed method research approach are well espoused in various research studies that successfully combined qualitative and quantitative methods to verify new or integrated theories and test the hypotheses (Creswell, 2008; Creswell & Plano Clark, 2007; Jabbour et al., 2014; Venkatesh, Brown,

& Bala, 2013). Experimental procedures also allow researchers the benefit of concluding whether the significant results derived from sound statistical means are due to the intervention introduced by the researcher (Campbell, Stanley, & Gage, 1963). Thus this study intends to capitalize on the advantages of all three research approaches.

In addition, many of the studies on educational technology acceptance in higher education focus on specific platforms for enabling teaching and learning processes, such as e-learning, mobile learning, learning management systems, and blended learning utilising numerous Web 2.0 tools. To the best knowledge of the researcher, none of these studies examined the efficacy of mobile technology specifically to aid student-lecturer interactions relating to academic matters in Malaysia, given the challenges of large lecture classes. Findings obtained from studies on e-learning and mobile learning acceptance from other countries might not be applicable in the context of Malaysian society with high power distance index, and are collectivist in nature. As such, this study intends to provide new findings that reflect Malaysian values.

Finally, to the best of the researcher's knowledge, none of the previous significant studies integrated factors in a single theoretical model for determining user intention to use or usage behaviour of mobile technology based on their technology competency (perceived ease of use), expectations from technology usage (perceived usefulness, system quality, information quality), cultural value (uncertainty avoidance), and personal motivations (enjoyment, self-efficacy). The benefit of integrating prominent technology acceptance models or related theories is that it allows researchers to examine a phenomenon from multiple perspectives. Findings obtained can lead to crucial new insights and expand the potential applicability and generalizability of established models and theories, such as TAM2 (Venkatesh & Davis, 2000) and Combined TAM and TPB (C-TAM-TPB) (Taylor & Todd, 1995) models.

2.7 Interactive Mobile Messaging Acceptance Framework

In pursuant of this, this study put forth an integrated theoretical model to lay the groundwork for this research. In short, this doctoral research is carried out with the aim to fill the gaps in the literature, and hopefully make a significant contribution to the existing body of knowledge. The above reviews of literature and research gaps described led to the development of the theoretical framework in this research. Figure 2.3 illustrate the theoretical framework of this research.

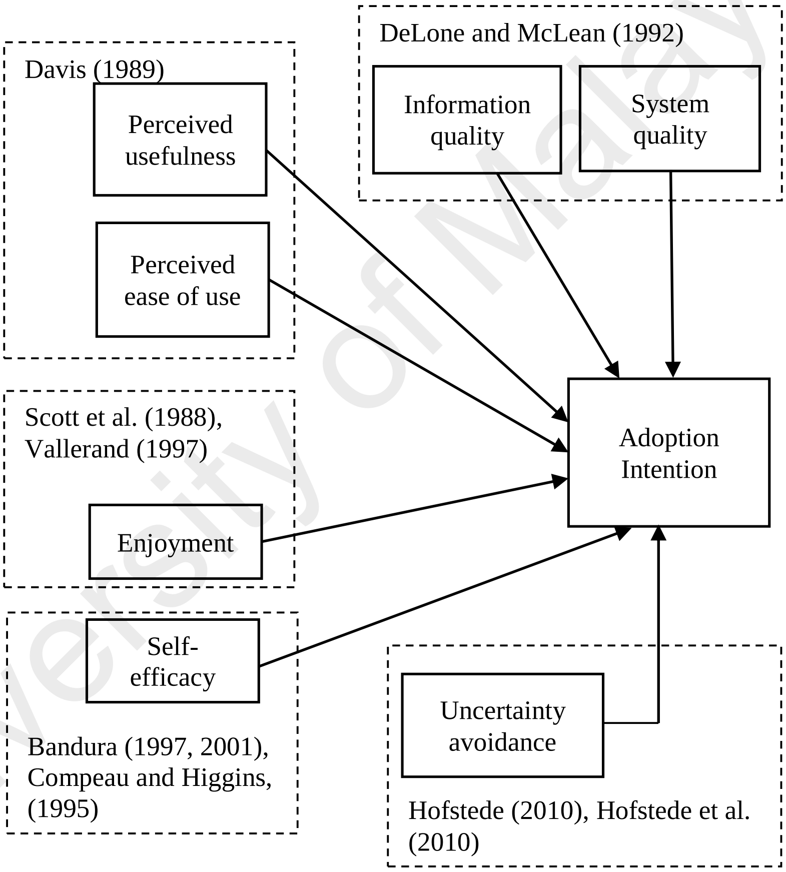

Figure 2.3: Interactive Mobile Messaging Acceptance (IMMA) framework

The framework was conceptualized based on the integration of prominent technology acceptance models (Davis, 1989; Venkatesh & Bala, 2008; Venkatesh & Davis, 2000; Venkatesh et al., 2003), social cognitive theory (Compeau & Higgins, 1995; Bandura, 1977, 2001), information system success factors (Delone & McLean, 1992, 2003), motivational theories (Scott et al., 1988), and cultural dimensions (Hofstede et al., 2010).

The framework thus fulfils the conditions of causal relationships by Hair et al. (2006), i.e. sufficient associations between the constructs and grounded in related literature that identified the research gaps. Table 2.2 presents the operational definition of each of the variable

Table 2.2: Operational definition of the research model constructs

Construct	Definition	Source
Perceived Ease Of Use	The degree to which an individual believes that using mobile technology would be free of cognitive effort.	Davis (1989) Davis, Bagozzi, and Warshaw (1992) Venkatesh (2000)
Perceived Usefulness	The degree to which an individual believes that using mobile technology would promote and ease interactions between students and lecturers.	Davis (1989) Davis, Bagozzi, and Warshaw (1992) Venkatesh (2000)
Self-Efficacy	An individual's confidence in his or her capability to use new mobile devices and applications.	Bandura (1977, 2001) Compeau and Higgins (1995)
System Quality	Measure the desired mobile operating system and/or applications' characteristics that are valued by users of mobile devices (error recovery response time, reliability, usability, functionality).	DeLone and McLean (1992, 2003, 2004)
Information Quality	Measure the desired content characteristics of mobile operating system and/or applications that are valued by users of mobile devices (customization of data, clarity of mobile operating system or applications' instructions, clarity and attractiveness of the interface design, and clarity and usefulness of the output generated).	DeLone and McLean (1992, 2003, 2004)
Enjoyment	The degree to which an individual experience joy when using mobile technology.	Davis, Bagozzi, and Warshaw (1992) Scott et al. (1988) Vallerand (1997)
Uncertainty Avoidance	The degree to which an individual is comfortable with uncertainties when using new mobile devices or applications.	Hofstede et al. (2010)

Adoption intention	The likelihood that the individual will use mobile technology (to interact with their lecturers.	Ajzen, (1991) Fishbein and Ajzen (1975) Davis (1989)

Findings from recent studies on educational technology acceptance among students and educators provided substantial evidence supporting the pivotal influence of perceived usefulness, perceived ease of use, enjoyment, and self-efficacy as predictors of technology acceptance. Among others, perceived ease of use and perceived usefulness were found influential in predicting nursing students' acceptance of e-learning in healthcare education (Chow et al., 2012). Interestingly, playfulness (enjoyment) was proven more significant than perceived usefulness or perceived ease of use when predicting teachers' technology acceptance (Chen, Shih, & Yu, 2012; Teo & Noyes, 2011). Holden and Rada (2011) stressed the importance of educators' technology self-efficacy, together with perceptions of system usability, as influential predicting factors of educational technology acceptance. Perceived system usefulness and perceived ease of use were also pivotal factors in determining teachers' intention to use educational technologies (Teo, Lee, Chai, 2012).

Escobar-Rodriguez and Monge-Lozano (2012) investigated students' acceptance of Moodle, a form of learning management system used by higher education, and perceived usefulness, perceived ease of use were highly significant as predictors of students' intention to use Moodle. Perceived usefulness and user satisfaction were also found predictive of students' behavioural intention to use YouTube for procedural learning (Lee & Lehto, 2013). Tarhini, Hone, and Liu's (2013) investigation of students' acceptance of e-learning also proved the significance of perceived ease of use, perceived usefulness, and computer self-efficacy. Technology self-efficacy was also proven pivotal in determining educators' use of online educational resources for teaching and learning purposes (Kelly, 2014). Lai & Rushikesh Ulhas (2012) examined students' intentions to use e-book applications for learning, and found perceived usefulness, convenience of the applications (attribute of system quality), compatibility of the applications (attribute of system quality), and perceived enjoyment as significant predicting factors. Furthermore, Padilla-Meléndez et al. (2013) examined the influence of perceived playfulness on students' acceptance of blended learning, and results obtained affirmed the significance of the playfulness construct.

Mobile learning has also gained prominence in recent years, with the proliferation of numerous mobile devices that have greatly ease the delivery and access of educational resources for students and educators alike. A multitude of studies have been conducted to determine students and educators' readiness to use mobile learning (Wu et al., 2012). Among others, Tan et al. (2012) investigated Malaysian students' readiness to adopt mobile learning, and perceived usefulness, perceived ease of use and subjective norm were positively associated with the intention to adopt mobile learning. Self-efficacy, system accessibility (attribute of system quality), perceived usefulness, perceived ease of use, and user attitude also influenced students' behavioural intentions toward mobile learning (Park et al., 2012). Iqbal and Qureshi (2012) examined students' mobile learning adoption intentions from the perspective of a developing country, and results point to perceived usefulness, ease of use, and facilitating conditions as significant factors.

Students' attitudes and self-efficacy were also deemed pivotal in their acceptance and use of mobile technology in an English language course (Yang, 2012b). Similarly, advanced mobile technology skills (computer self-efficacy) significantly impact the students' intention to adopt mobile learning (Mac Callum & Jeffrey, 2013). In addition, performance expectancy (degree of usefulness), effort expectancy (degree of ease), quality of system services, and personal innovativeness (willingness to try new technology) significantly affected the students' behavioural intention to use mobile learning (Abu-Al-Aish & Love, 2013). Notably, Briz-Ponce and García-Peñalvo (2015) examined medical students' acceptance of mobile technology and mobile applications for learning, and perceived ease of use and perceived usefulness were asserted as pivotal factors. In addition, mobile devices' compatibility, user self-efficacy, and perceived ease of use were pivotal predictors of mobile technology for learning languages (Chung, Chen, & Kuo, 2015).

However, though system quality and information quality's significance as predictors of technology acceptance in various fields have been consistently validated, the constructs' predictive relevance are under research when it comes to higher education's use of educational mobile technological tools. Notably, Lin and Wang (2012) examined students' continued intentions to use e-learning system in a blended learning platform, and information quality significantly influenced system acceptance. In addition, comparative studies across culture acknowledged the moderating effects of cultural dimensions on educational technology acceptances (Arenas-Gaitán, Ramírez-Correa, & Rondán-Cataluña, 2011; Gogus et al., 2012; Nistor et al., 2013; Tarhini et al., 2014b; Terzis et al., 2013). However, despite the abundance of literature on the influence of culture in educational technologies, there is a lack of studies investigating the direct effects of cultural dimensions on educational technology acceptance.

2.8 Summary

Based on the review of literature, several gaps were identified in the field of mobile technology acceptance. This research is conducted with the aim to fill these gaps. Comprehensive literature reviews presented in this chapter lead to the identification of eight independent variables – independent variables of perceived ease of use, perceived usefulness, self-efficacy, enjoyment, system quality, information quality, and uncertainty avoidance; and mobile technology adoption intention as the dependent variable. These variables taken together with their definitions, and references to relevant literature and existing theories laid the groundwork for the conceptualization of the theoretical framework in this research. The theoretical framework guides this research and provides a rational for predictions about the relationships among the independent variables and dependent variable. Detailed explanation of the IMMA framework and development of hypotheses for this research are presented in the next chapter.

CHAPTER 3: METHODOLOGY

This chapter describes the Interactive Mobile Messaging Acceptance (IMMA) framework, development of the hypotheses, and the methodology used in this study. The chapter has six major sections, and begins with the research design used in this study, followed by the timeline of the major stages. Following this section, the IMMA theoretical framework and the posited hypotheses are explained. The next three sections provide explanation regarding the qualitative, quantitative, and the pretest-posttest research methods, specifically the sampling frame and justifications of the selected samples, and research procedures. A short summary concludes this chapter.

3.1 Research Design

Three main research approaches were undertaken during the initial data collection stage in this study: (i) Inductive, exploratory approach via qualitative means, (ii) deductive, confirmatory approach via quantitative means, and (iii) experimental assessment via pretest-posttest designs.

The exploratory research aims to examine a data-set and source for potential relationships between the variables identified in theoretical frameworks. It is used when researchers possess theoretical knowledge about the relationships between the variables from reviews of literature, but lack the insights about the direction and strength of the relationships (Stebbins, 2001; Thompson, 2004). The advantage of exploratory research is that it is less rigorous than confirmatory approach methods, thus allowing researchers the freedom to explore and conduct observations pertaining to the study, in particular discoveries that strengthen and support the conceptualization of the theoretical framework's independent and dependent variables, and the subsequent posited hypotheses. This study employed an exploratory approach at the beginning of the research by conducting non-participatory observations of large lecture classes, and interviews with selected academics of higher learning institutions in Malaysia. The objective is to determine and corroborate the effects of large classes on student-lecturer interactions identified previously from reviews of past studies. Results from the observations and interviews helped to confirm the problem statement put forth in this study, and also gauged academics' perceptions pertaining to the use of mobile technology in the classrooms for enabling interactions with their students. However, the main disadvantage of relying solely on exploratory research is that findings obtained cannot be used to confirm hypotheses set forth in the study. Biases also occur when researchers do not objectively interpret the events observed (Patton, 2014).

Confirmatory research on the other hand is deductive in nature, seeking to infer outcomes from predictions, i.e. hypotheses posited via quantitative means (Venkatesh et al., 2013). This study utilised both descriptive and inferential statistical measures to test the hypotheses proposed, and to prove the predictive accuracy and relevance of the IMMA framework. The benefit of the confirmatory approach to research is that it allows researchers to utilise probability models in order to derive definitive answers to the research questions and objectives (Smith & Heshusius, 1986). However, the disadvantage of confirmatory research is that results obtained from statistical analyses may not be accurate due to varying factors which the researchers cannot control, such as truthfulness of the respondents' answers in online self-reported questionnaires. In addition, respondents' answers may differ substantially from those that did not participate in the study, thus resulting in findings that cannot be generalized to represent the sample population (Armstrong & Overton, 1977). To address these issues, measures to address non-response issues, common method variance, social desirability and missing values associated with self-reported online surveys were implemented in this study (section 3.5.4).

Findings from the exploratory and confirmatory methods were corroborated for the design and development of the IMMAP, the mobile application that is customized with features to enable students and lecturers to interact on academic matters. A pretest-posttest experiment was conducted to assess the effectiveness of IMMAP to support and enhance interactions between students and lecturers. Pretest-posttest research is a common experimental procedure where participants are studied before, and after the experimental manipulation (Shadish, Cook, & Campbell, 2002). The main reason for conducting pretest-posttest research is to observe whether the intervention or manipulation introduced to the participants has caused a change. Since all the participants are manipulated in the same manner, changes observed can be inferred to be due to the intervention introduced by the researcher. Participants are gauged prior to the experiment (pretest), followed by the commencement of the experiment in which an intervention are introduced to a single group or multiple groups of participants, and the participants are assessed again after the experiment (posttest). Differences between the two sets of data collected from the pretest and posttest can then be statistically measured for significance and strength (Pratt, McGuigan, & Katzev, 2000).

Though pretest-posttest experimental researches are similar to traditional randomized controlled experiments, they lack the element of random assignment (Howard, 1980). Instead, the experiment is controlled by the researcher, i.e. the selection of the respondents, and locations of the experiments. Due to the impracticality of conducting randomized experiments for this study, pretest-posttest experimental design was deemed suitable. Furthermore, pretest-posttest experiments are conducted in natural environments, and allow researchers to generalize the findings to the sample population (Bawden & Sonenstein, 1992).

The researcher gauged respondents' initial perceptions and collected data on existing mobile technology practices prior to the experiment (pretest). After the experiment concluded, posttest assessment was conducted to gather respondents' perceptions pertaining to the efficacy of IMMAP to aid student-lecturer interactions (posttest). Rigorous statistical methods to analyse the pretest and posttest responses were utilised in this study, including the verification of the key statistical assumptions to prevent misleading results. Chapter five describes the development of IMMAP, and the findings obtained.

The research design is summarized and illustrated in figure 3.1, which depicts the steps undertaken in this study.

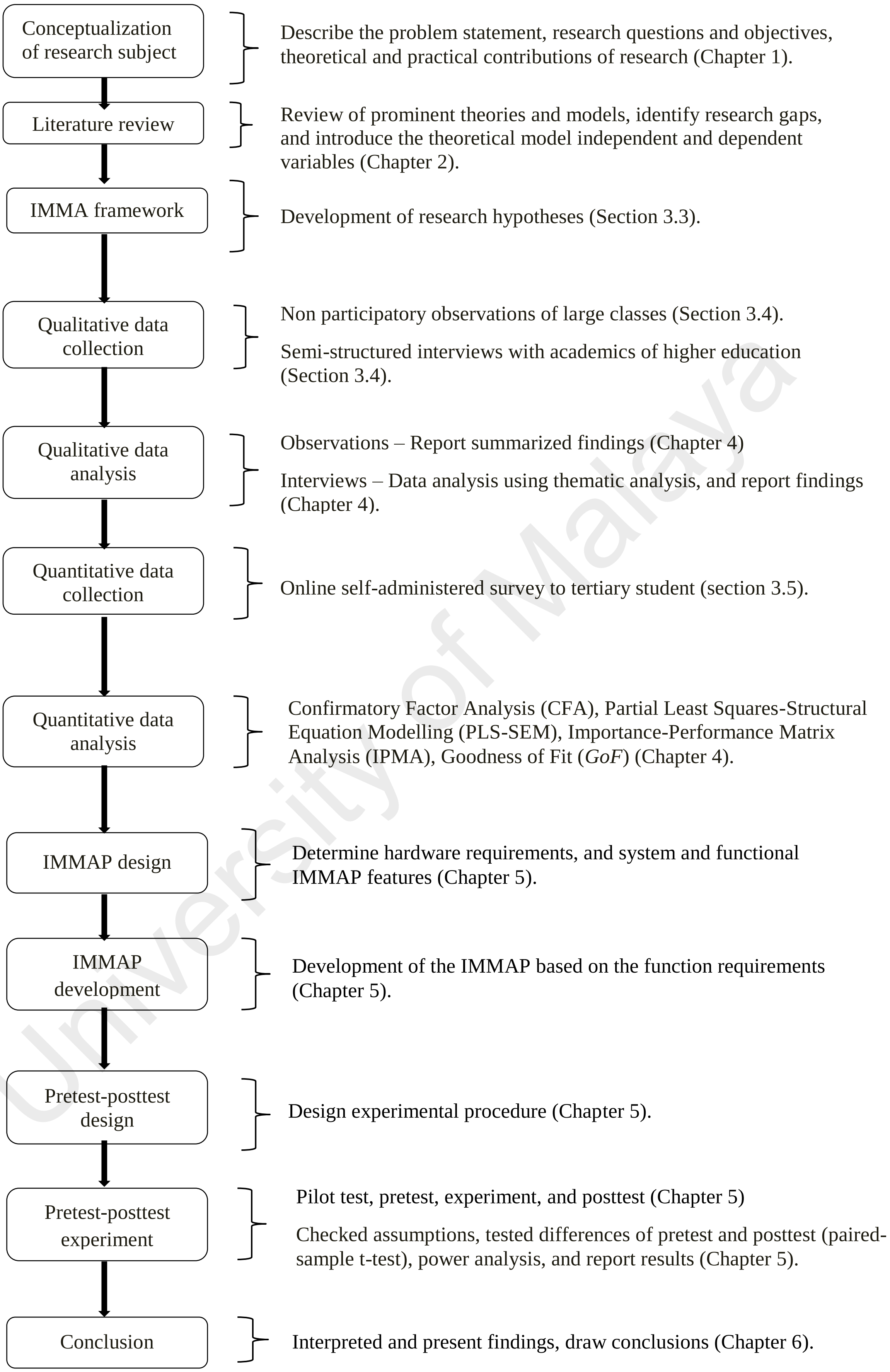

Figure 3.1: Overview of research design

3.2 Research Timeline

The experimental procedure took approximately six months (December 2014 till May 2015). Table 3.1 details the timeline of each stage. Stage one was conducted over a period of eleven months (November 2012 till September 2013). Stage two commenced in October 2013 till October 2014, approximately one year. Stage three commend in December 2014 till May 2015.

In stage one, thematic analysis was used to analyse the qualitative data obtained from the interviews. The data were transcribed, deconstructed, and important recurring concepts (themes) were categorized. In addition, each theme's theoretical perspectives were researched, and key findings for supporting the study's framework were reported.

Findings from stage one provided the theoretical foundation for developing the measurements for the quantitative research in stage two. Data collection was conducted via self-reported online survey consisting of open-ended and close-ended items measuring all the framework's constructs, in addition to respondents' personal and academic details, and current use of mobile technology and the Internet. This is followed by the preparation of the quantitative data collected for empirical analyses. Data were subjected to a rigorous examination in order to detect missing data, suspicious response patterns, outliers, normality of the data, and evidence of common method bias. Subsequently, descriptive statistics, inferential statistics, and hypotheses testing results were obtained and discussed.

Table 3.1: Research Timeline

	Timeline	Action(s)
Stage 1		
Qualitative method - Non-participatory observations	Nov 2012	▪ Drafted observation checklist. ▪ Emailed observation requests. ▪ Met with the lecturers for brief discussions.
	Nov – Dec 2012	▪ Non-participatory observations were conducted. ▪ Drafted observation reports.
Qualitative method - Interviews	Feb 2013	▪ Emailed requests for interviews.
	April – June 2013	▪ Face to face and telephone interviews were conducted.
	July – Sept 2013	▪ Analysed the qualitative data (thematic analysis).
Stage 2		
Quantitative methods – Online survey	Oct – Nov 2013	▪ Development of survey instrument.
	Dec 2013 – March 2014	▪ Expert reviews of survey instrument (verified reliability of survey instrument). ▪ Conducted survey pre-test (survey instrument was enhanced). ▪ Obtained approval from University Malaya Research Ethics Committee.
	April – July 2014	▪ Emailed requests for survey participation. ▪ Online survey data collection commenced.
	Aug – Oct 2014	▪ Analysed the quantitative data.
Stage 3		
Pretest-posttest experiment - Assessment of IMMAP	Dec 2014 – March 2015	▪ Designed and developed IMMAP. ▪ Drafted survey for pretest and posttest assessments. ▪ Conducted pilot test. ▪ Enhancement of IMMAP and surveys' scale items.
	April – May 2015	▪ Conducted pretest-posttest experiment. ▪ Analysed quantitative data.

Findings obtained from stage two were then used in stage three, i.e. the design and development of IMMAP, and the development of the pretest and posttest surveys. A pilot test was conducted to gather user feedback, and enhancements of IMMAP's key functionalities and the surveys' scale items were made prior to the experiment and subsequent statistical analyses.

3.3 Research Hypotheses

Figure 3.2 depicts the IMMA framework to be examined in this study. The framework illustrates the predictors of mobile technology as the independent variables: system quality, information quality, perceived usefulness, perceived ease of use, enjoyment, self-efficacy, and uncertainty avoidance (exogenous variables). The dependent variable in this study is the adoption intention of mobile messaging technology for aiding student-lecturer interactions (endogenous variable), which is measured by the set of independent variables.

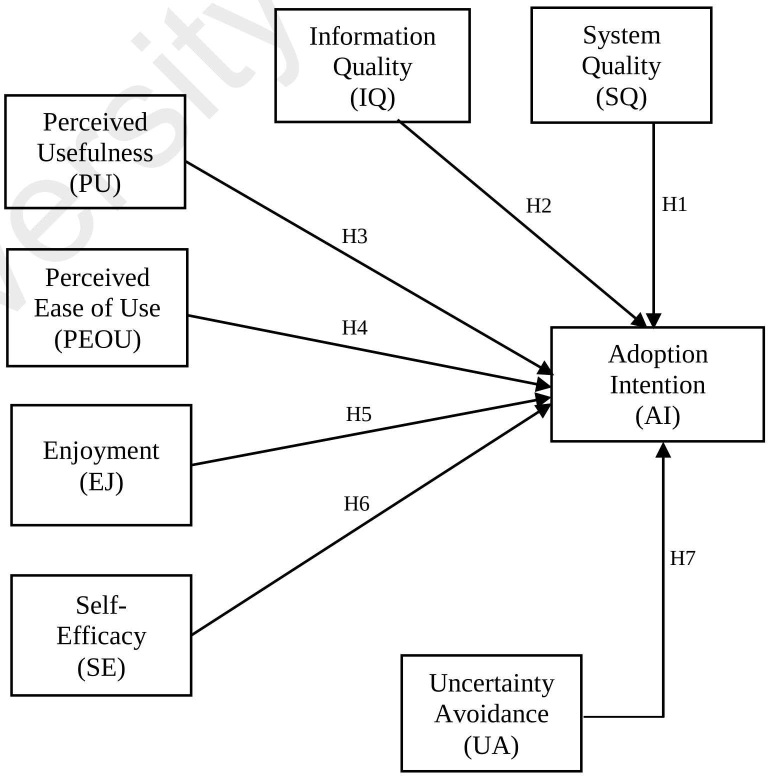

Figure 3.2: IMMA framework

The following hypotheses are posited:

H1: System quality is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.

H2: Information quality is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.

H3: Perceived usefulness is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.

H4: Perceived ease of use is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.

H5: Enjoyment is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.

H6: Self-efficacy is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.

H7: Low uncertainty avoidance is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.

3.4 Qualitative Methods and Analysis

The qualitative data are expected to provide the researcher with crucial insights, in particular the nature of interactions between students and lecturers in large classes, and the perceptions of academics regarding use of mobile technology to aid communication with their students. While qualitative data are constrained when it comes to statistical analyses and for confirming the hypotheses, findings derived can be used to support and build existing theories. Two qualitative methods were conducted in this study with the purpose of supporting the problem statement, to obtain academics' perceptions regarding interaction issues in large lecture classes, and determine their intentions to use mobile technology to interact with their students on academic matters. The qualitative methods are non-participatory observations of large lecture classes, and semi-structured interviews with academics of higher education.

3.4.1 Non-Participatory Observation

Initial qualitative data collection efforts in this study focused on the non-participatory observations of selected large lecture classes, i.e. lecture classes with a minimum of 50 students. The targeted number of observations was at least two lecture classes, i.e. a non-technical course, for instance business ethics, and a technical course, for instance object-oriented programming or mathematics courses. The purpose of observing large lecture classes is to determine whether there are interaction issues present, specifically lack of interactions between students and lecturers, as discovered and presented in the literature. The lack of interactions in large lecture classes form the backbone of this study's problem statement. However, dependence on literature is insufficient, and as there are opportunities for the researcher to observe lecture classes, it was decided that the initial data collection will come from large classes' observations.

Findings derived from observations cannot be used for verifying the validity of models or for confirming hypotheses. For instance, attempting to conduct content or thematic analysis on data recorded from observations may result in numerous codes that can be difficult to categorize into themes, as data are collected from occurrences that transpire naturally without "guidance" from the researchers, for instance a set of interview questions or the survey instrument (Patton, 2014). In addition to the unpredictability of how events will unfold during observations, adequate number of observations needed to be conducted to justify the findings or to find common threads. Reporting of occurrences observed relies also on the researchers' non-bias judgements, i.e. the ability to observe and record objectively. For these reasons, observations are rarely conducted in studies of educational technology acceptance as rigorous empirical analysis are not possible. However, in this study, the non-participatory observations of large lecture classes are beneficial for drawing findings that would serve as the foundation to formulate the instrument for subsequent qualitative interviews with academics, and quantitative survey with students of higher education. Figure 3.3 depicts the overall observations' procedures.

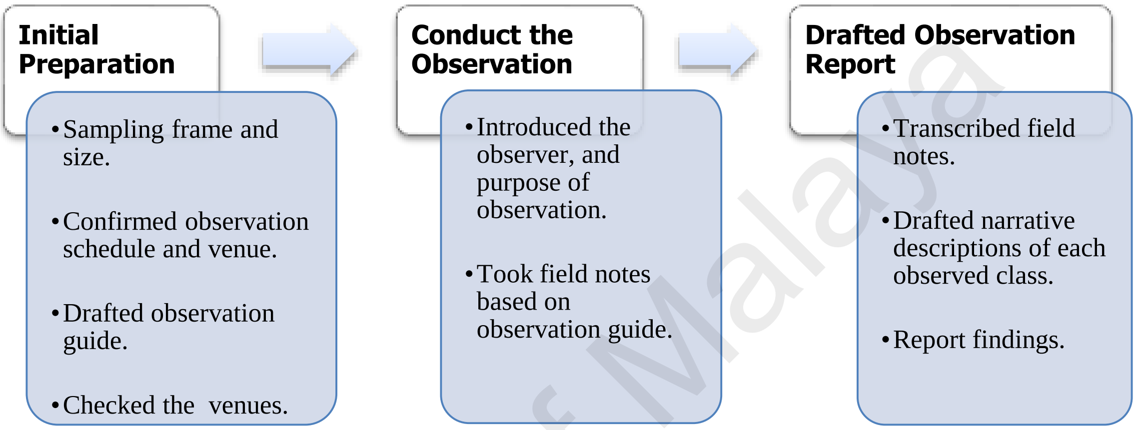

Figure 3.3: Observation procedure

3.4.1.1 Participants

The participants for the non-participatory observations were lecturers of a local university in Malaysia, and their students. Four lecturers were selected. The requirements for selection were kept to a minimum: (i) The lecturer is currently lecturing a course for that semester, (ii) the lecture class has a minimum of 50 students, and (iii) the lecturer has a minimum of five years of teaching experience in tertiary institutions. All participants (lecturers and their students) were guaranteed anonymity. Non probability convenience sampling was used. Selected lectures were from undergraduate courses, namely mathematics, multimedia, programming (science) and e-commerce (non-science). Science and non-science courses were chosen to discern possible interaction variances between technical and theoretical courses. In addition, a minimum of five years of teaching experience was included as part of the selection requirements to ensure that the academic has taught classes of varying sizes, and has sufficient experience with students from different backgrounds.

A total of six lecturers who fulfilled the requirements were approached personally. When the lecturers were first approached, the purpose of the observations, and how the observations will be conducted were explained. Requests to record the lectures were put forth. Assurances of anonymity during reporting obtained were also given. Reservations about the observations were exhibited by the lecturers, and two of them declined to participate. Three lecturers agreed on the condition of anonymity but they did not want their classes recorded. Thus, only one observed lecture class was filmed.

3.4.1.2 Guidelines

When conducting non-participatory observations, the observer needs to be reticent and discreet so as not to disrupt the flow of the phenomena being observed (Stebbins, 2001). The goal here is to discreetly watch the chain of events unfold and to make oneself as invisible as possible. In such circumstances, participants should be unaware of the observers' presence or at least unaffected by it. Participants should not be made to feel that their conducts are judged, to feel uncomfortable, or to feel that their privacy is compromised by the observers' presence (Stebbins, 2001). The observers should also ensure that their movements are minimal, and that they should not do anything that may attract undue attention or distract the participants.

Ethical considerations may necessitate the need for observers to announce their role and the purpose of the observations (Patton, 2014). For non-participatory observations however, it is not possible for the observers to sit and observe without the participants noticing their presence. In this study, it was decided that the lecturer will introduce the presence of the observer at the beginning of the lecture, and to explain briefly to the students the purpose of the observation. The students were assured that their conduct during the lecture will not discriminate them in whatever way whatsoever, and that the observation was purely done for scholarly purposes. Therefore, students were advised to behave as they always have in classes.

Observers also need to be meticulous when recording occurrences observed, especially if videotaping is not allowed or feasible (Patton, 2014). In such cases, observers needed to be quick when writing down or when typing key points observed. This exercise needs to be done with rigor so that facts are not embellished. After the observations concluded, it is imperative that the observer start writing the reports as soon as possible. Writing the report after several hours have passed is undesirable as the memory of what have transpired may have faded, and the reliability of reporting after time have passed is reduced considerably (Patton, 2014). If videotaping was allowed, the observer has the luxury to replay the events and produce an accurate report of the events that have transpired. In sum, observers need to exercise objectivity when reporting events observed, and to be very careful not to overstate the magnitude of the events.

If the observation reports are to be published, confidentiality of the participants need to be carefully guarded. Ensuring confidentiality entails that the official report produced does not contain references that link the report back to the participants' identities. Therefore, all personal details that might allow future readers to guess the name of the higher education institutions, the lecturers' identities, and the students in the classes were omitted. If contacted by readers with a scholarly interest in the published reports and enquiries regarding the observations' characteristics, observers must not divulge any information that might compromise the confidentiality ensured to the participants. In sum, the above guidelines were adhered in this study to ensure the validity of the observations' findings.

3.4.1.3 Instrument

The observer attempts to observe the lecture methods demonstrated, i.e. pacing and presentation methods, learning activities conducted (group discussions, students' presentations, etc.), and use of technological tools or instructional aids (computer, projector, mobile devices, software, etc.). An area that needed to be ascertained, and is directly related to the objective of this study, is the lecturers' interactions with their students based on these four traits: (i) Do the lecturers prompt the students to provide feedback?, (ii) do they encourage class discussions?, (iii) do they interact with all students fairly?, and (iii) do they demonstrate awareness when students require further clarifications and responses? Another area of interest is whether the students are attentive and responsive when their lecturer requested for feedback, and whether they actively participate in any learning activities conducted.

Each of these areas was rated based on the judgement of the observer: "Require improvement", "Satisfactory", "Excellent", and "Not observed". Thus, observations' guidelines described in the previous section were adhered. Please refer to Appendix A for the observation instrument.

3.4.1.4 Procedure

The following sections describe the non-participatory observations' procedures.

(a) ***Preparing for the Observations***

For this study, the following preparation activities were done in the sequence listed below:

1. Selection of participants, i.e. lecturers' classes to be observed (section 3.4.1.1).
2. Drafted observation guidelines (section 3.4.1.2).

3. An observation instrument was prepared, detailing important areas that needed to be observed (section 3.4.1.3).

4. The last step was to visit the venue in advance in order to select the best position to sit in order to be as circumspect and unassuming as possible.

It was hoped that the presence of the observer will not cause uneasiness among the students, or cause them to behave differently than how they will normally behave.

(b) ***Observation***

During the day of the observation, the observer arrived ten minutes earlier than the scheduled lecture. After taking the spot chosen at the back of the classroom, materials needed for the observation were arranged. After the participants (lecturer and students) arrived, and the lecture was about to start, the lecturer introduced the observer and explained the purpose of the observation. A general explanation for the purpose of conducting the observation was given, that is only for scholarly purpose. Students were assured that they should just behave as they normally do in classes. This took around a minute or so, after which the lecture commenced immediately. During the course of the class, based on the observation guide, field notes were taken.

(c) ***Reporting***

Field notes were typed using a laptop for three of the lecture classes observed that were not videotaped. Field notes were handwritten for the class that was video taped. After each observation concluded, the notes were converted to proper sentences. They were then elaborated and expanded to form a narrative description. Each observation report was then summarized, and presented in chapter four. As a precaution, field notes and reports were stored in a password protected computer. Backup copies on thumb drives were kept in a secure location.

3.4.2 Semi-structured interview

The lack of face to face insights of quantitative research makes qualitative research, especially interviews, valuable to researchers. The data collected from the interviews in this study were subjected to thematic analysis, and it is hoped that the findings derived will support the subsequent quantitative research efforts, and provide new insights into the interaction issues of large lecture classes in tertiary education.

Interviews are typically divided into three categories: structured, semi-structured, or unstructured. Structured interviews are characterized by adhering to the same set of questions for all the interviewees, asked in the same order. Responses to the questions can be predicted and limited to a set of categories (close-ended) but a few open-ended questions might be included. Surveys fall under this category. Unstructured interviews are the reverse of structured interviews. Open-ended questions form the bulk of the set of questions, and respondents' responses will vary. Respondents are also encouraged to express their opinions freely. The advantage of unstructured interviews over structured ones is that they allow researchers to obtain a thorough understanding of the interview subjects (Patton, 2014). However, structured interviews allow researchers to obtain relevant and appropriate responses in each targeted area. Hence, use of either of these techniques is not exclusive and are often merged, known as semi-structured interviews (Elliott, Fischer, & Rennie, 1999).

In semi-structured interviews, a list of questions listed chronologically will be fielded by the interviewers in the same order. In this sense, semi-structured interviews is quite similar to structured interviews. However, the questions fielded are usually a combination of open-ended and close-ended types. Answers to close-ended and open-ended questions can be accompanied by suitable follow-up questions, thus allowing the interviewer to gain deeper insights from the respondents' answers (Elliott, Fischer, & Rennie, 1999).

Inclusion of close-ended questions allow the interview sessions to stay on track, as well as to obtain relevant responses, while open-ended questions allow for the opportunities to gain deeper insights of the subject matter. Based on the merits of this type of interview, this study's interviews will be semi-structured in nature.

Figure 3.4 summarizes the overall procedure of the semi-structured interviews.

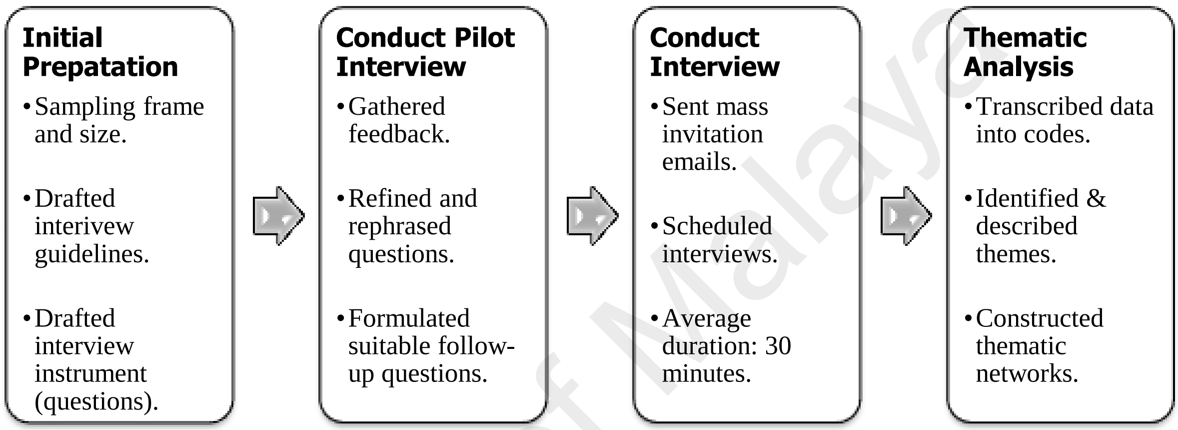

Figure 3.4: Interview procedure

3.4.2.1 Respondents

Academics from various disciplines were approached to participate. The criteria for respondents is less stringent. Respondents just need to possess a minimum of two years of teaching experience, as the focus of the interview was to mainly elicit perceptions of mobile technology use for aiding student-lecturer interactions. All respondents have taught both large and small classes. In Malaysia, weekly lecture classes and small tutorial classes typify each course. Thus, no difficulties were encountered during the selection of academics that fulfilled both requirements. Academics of various backgrounds were sought that are representative of the education landscape in Malaysia. Interviews were scheduled to be individual face to face sessions. However, when it was not feasible for the interviewer and interviewee to meet, telephone interviews were conducted instead. Section 3.4.2.4b explains the sampling method and demographics of the respondents.

3.4.2.2 Guidelines

The emphasis of the interviews was to determine the effects of large lecture classes toward the quality of interactions between students and lecturers. The data collected from the interviews were analysed and the findings obtained were reviewed and associated with the study's problem statement. The interviews also seek to understand academics' perceptions of using mobile technology to interact with their students, and their intentions to use mobile technology for interaction purposes in future classes. Therefore, an interview instrument consisting of a list of chronologically listed questions to be asked in the same order was adhered to. As with all semi-structured interviews, depending on the respondents' answers, some of the questions have follow-up questions in order to obtain deeper perspectives. Plus, rather than adhering to a script, questions were memorized to the best of the researcher's ability and were only referred to intermittently when necessary.

Bearing in mind that interviews can be time consuming, thirteen main questions were posed to the respondents. To soothe any possible uneasiness, the respondents' were asked simple questions first in order to ensure they are comfortable, and to encourage them to open up. To review, a set of guidelines proposed by Myers and Newman (2007) was found suitable and followed in this study. The guidelines are:

1. *Situating the researcher as actor* – Understand the interviewees' academic backgrounds.
2. *Minimise social dissonance* –Objective of the interviews, the manner in which they interviews will be conducted and the approximate duration, were communicated clearly in order to obtain interviewees' trust.

3. *Represent various "voices"* – Academics from diverse academic disciplines were selected, namely information technology, engineering, business, law, mathematics and language participated in the semi-structured interviews.
4. *Flexibility* – Depending on interviewees' responses, the appropriate follow-up questions ensued.
5. *Confidentiality of disclosures* – All records of the data collected were kept secured, and evidences linking the data to the respondent's identity were carefully omitted.

Other guidelines followed closely were ensuring that the respondents were at ease, subtly encouraged them to answer freely, looked for appropriate body cues, and probed when necessary (Rosemann & Vessey, 2008).

3.4.2.3 Instrument

In drafting the interview's questions, the emphasis were to determine the respondents' current interaction issues or barriers with students in large lecture classes, and their perceptions and intentions to use mobile technology to interact with their students. Prior to the start of the interviews, respondents were requested to provide basic personal details: gender, age, teaching experience (years), and academic field. The interview questions are divided into three areas, i.e. current interaction issues or barriers with students (eight questions), intention to use mobile technology in future classes to interact with their students (five questions). Please refer to Appendix B for the interview instrument.

3.4.2.4 Procedure

The following sections describe the interviews' procedures.

(a) ***Pilot Interview***

Pilot interview sessions were conducted to confirm the validity and clarity of the interview questions, during which five lecturers were interviewed. They were selected based on the following requirements: possessing a minimum of two years' of lecturing experience across inter-disciplinary undergraduate degree programmes, and have taught both small and large lecture classes. Feedback gathered were used to rephrase some of the interview questions to improve clarity, and also to formulate suitable follow up questions. Simple, unambiguous direct words and sentences were incorporated into the final interview questions.

The respondents were audiotaped during the interviews. Generally, answers obtained were satisfactory although some discomfort were observed (the respondents intermittently adjusted their microphones). After each interview ended, and feedback pertaining to the clarity and relevance of the questions have been gathered, the respondent was then queried regarding the appropriateness of the recording. Three of them voiced their reservations, and cited possible confidentiality issues in the future. Two of the respondents preferred if the interviews were not recorded. Thus, based on the feedback gathered, it was decided that the final interview sessions will not be recorded. Instead, responses will be written down.

(b) ***Final Interview***

The respondents for the final interviews were recruited from five higher learning institutions in the country based on the same requirements used for the pilot interviews. Interview requests were emailed to lecturers from multiple disciplines. The researcher's background, and the purpose of the interview were succinctly explained in the emails. Ten emails were sent to the randomly selected academics from six major faculties of information technology, engineering, business, law, mathematics and language in five higher learning institutions. Thus, the sampling method used is essentially non-probability quota sampling method. A total of 300 emails were sent out. Nevertheless, responses were low.

Table 3.3 tabulates the number of academics that responded and accepted the invitation to be interviewed. Most of the academics who agreed came from institution #1. Names of the institutions are not provided to protect the identity of the academics. Thus, a total of 22 academics participated. Though it is a small number, it is sufficient for qualitative studies (Guest, Bunce, & Johnson, 2006).

Table 3.2: Number of academics that responded

Faculty	Institution #1	#2	#3	#4	#5	Total responses
Information Technology	5		2			7
Engineering	3	1				4
Business	2			1	1	4
Law	3					3
Mathematics	3					3
Language	0		1			1

After the lecturers have agreed, a convenient date and time for each interview was then arranged. It was agreed that all interviews will be conducted at their offices to ensure participants' convenience and comfort. Each interview was estimated to take approximately half an hour based on the pilot interviews conducted previously. Before the interview commenced, each respondent was briefed to ensure that they understood the purpose of the interview, how the interview will be conducted, and how the data will be recorded and analysed. Participants were also assured that their identities will not be disclosed. After the brief introduction, each participant was requested to provide basic demographics and job details. Interviews with academics from institution #1 and #3 were conducted face to face, whereas with academics from institution #2, #4, and #5, telephone interviews were conducted.

(c) ***Content Analysis and Themes Conceptualization***

Thematic analysis was applied to derive findings from the qualitative data with the aid of NVivo 10 software. All data collected from the interviews were transcribed and critical information were highlighted. These crucial information are known as topics or units. These data units were then deconstructed and categorized, and important recurring concepts (codes) for each categories identified (Berg, 2000; Tuckett, 2005). Inferences were made to each code to explain its meaning. Cautions were taken to preserve the original meaning of each response obtained. In thematic analysis, the next phase involves combining the codes into themes for further analysis (Tuckett, 2005).

Each theme's theoretical perspectives were researched. Themes were further refined until a satisfactory set of themes in each category was identified (Braun & Clarke, 2006). The purpose of undertaking this approach was to ultimately derive categories (thematic areas) which represent the data by converging the codes into sub-themes (first-order themes) and main themes (second-order themes). Each thematic area was then examined for correlations with other identified thematic areas in order to present emergent theories and findings (Braun & Clarke, 2006). This process was repeated iteratively until all themes were extracted satisfactorily, and their meaning sufficiently explained (Fereday & Muir-Cochrane, 2008).

The limitation of this analysis is the difficulty for the researcher to maintain objectivity when deriving the codes and the subsequent themes. Themes might be wrongly conceptualized due to a variety of reasons, for instance errors in data transcription, and wrong interpretations of the responses (Braun & Clarke, 2006). Nevertheless, rigor can be maintained by adhering to the steps proposed by Attride-Stirling (2001), who conceptualized methodological techniques for conducting thematic analysis on qualitative data. Findings obtained from thematic analysis can be further clarified and illustrated by constructing thematic networks (graphical representations of the themes). The steps employed by this study for the thematic analysis follow closely to those proposed by Attride-Stirling (2001). They are:

1. Data coding – Data reduction by reducing the transcribed data into topics or units (codes).
2. Identify themes – Deriving and refining themes based on the data codes. Themes theoretical perspectives were identified and described.
3. Present thematic results – Each theme and its meaning were presented using a table format to ease reading.
4. Construct thematic networks – Themes were arranged and organized to form thematic networks so that correlations among the themes can be illustrated clearly.
5. Themes exploration and summarization – Findings obtained were discussed in relation to IMMA's framework.

Results obtained from the thematic analysis are presented in chapter four.

3.5 Quantitative Methods and Analysis

This section describes the details of the quantitative data collection procedure and statistical analyses used to validate the IMMA framework, and subsequently to determine factors that are significant to predict Malaysia's tertiary students' intentions to use mobile technology to interact with their lecturers. Briefly, the survey instrument for all the constructs is outlined. Item statements for each construct were reviewed and adapted from previous studies wherever possible. Revisions to the constructs' items were made to ensure the relevance and content validity of the survey based on feedback gathered from the pre-test. The sampling methods, and the procedure for the administration of the survey are outlined next. Finally, statistical analyses utilised for analysing the quantitative data are described. Figure 3.5 sums up the overall procedure of the quantitative methods.

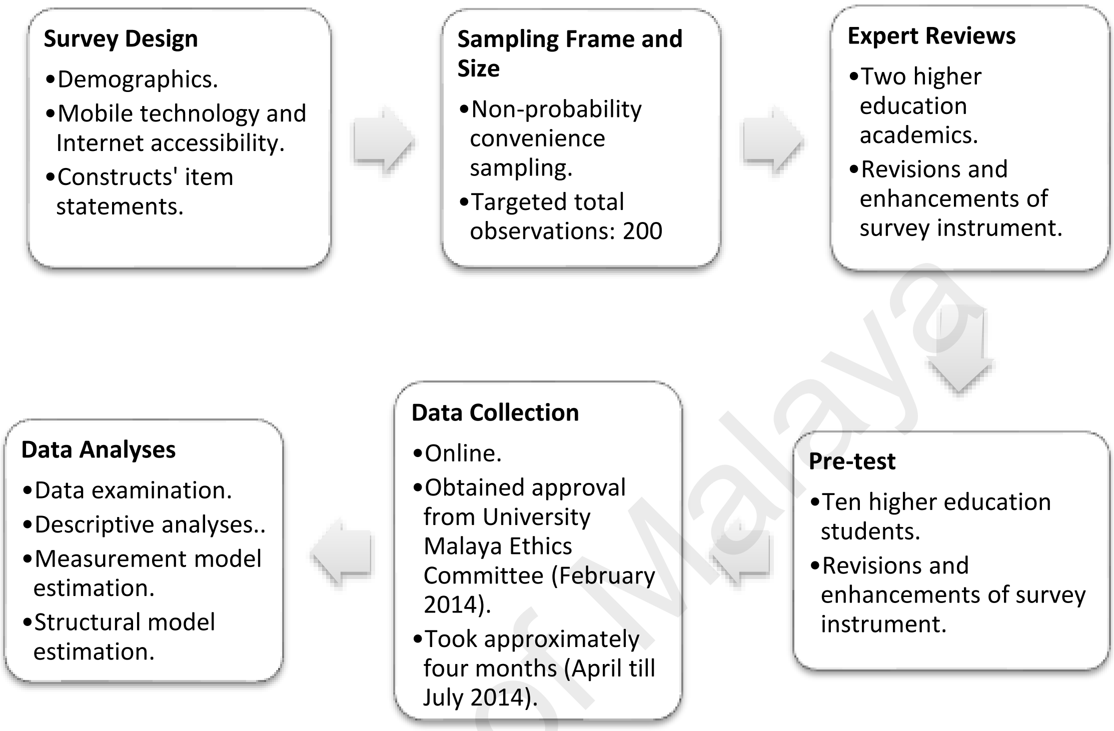

Figure 3.5: Survey procedure

3.5.1 Survey Design

The survey was written in the English language. During the construction of the survey, each construct (variable) from the framework was translated into scale item statements. The survey for this study was designed to be self-administered by the respondents, and attempts to collect respondents' demographics and mobile technology use characteristics, and perceptions of each construct.

The survey instrument comprised of three main sections. The first section consisted of statements to gather respondents' personal details and academic background, and the second section gathered details of respondents' use of mobile technology and means of Internet access. The third section comprised the constructs' item statements. Likert scales are a common method to measure exogenous and endogenous constructs (Kent, 2001). All the constructs in the survey consisted of five item statements measured using a five-point Likert scales ranging from 1 = "strongly disagree" to 5 = "strongly agree". The reason for choosing the five-point Likert scales was to reduce the survey complexity (Lascu et al., 1995; Sekaran, 2000). Using more than five scales may require extra judgement in discriminating the difference that each scale implies, therefore making it harder for the respondents to answer accurately. Therefore, to avoid respondents' confusion and to allow them to answer with ease, the standard five-point Likert scales was used. In sum, a total of 40 scale item statements were developed based on reviews of relevant literature.

The constructs' item statements were sentenced to fit the objective of the study. The constructs' items from the original surveys were referenced as a guideline. They were not adopted for this study as the research areas where the surveys were applied are not in the fields of mobile technology or higher education. Therefore, suitability of adopting the original survey items were very low. However, they carry significant importance in their respective fields of studies, and noteworthy as a source of guideline.

Perceived ease of use focuses on deriving respondents' opinions in regards to the ease of installing and using mobile applications, in particular the use of mobile messaging applications. For instance, respondents were enquired on whether they use mobile applications daily, and whether they applications are easy to use. Perceived usefulness indicators set out to obtain perceptions of mobile technology practicality for learning purposes, and its usefulness to encourage communication and collaboration works with their peers and lecturers. An example of a statement measuring perceived usefulness was "Mobile technology allows me to communicate with my classmates easily.". Self-efficacy on the other hand concentrates on assessing respondents' level of confidence to use mobile technology based on their technology savviness. Item statements for the enjoyment construct were constructed to ascertain respondents' joy when using mobile technology for communication purposes, sharing of messages, graphics, and videos, playing online games, and surfing the Internet.

System quality aims to obtain respondents' perceptions of mobile applications' quality, specifically the frequency of errors encountered and the ability to recover from the errors, quality of mobile applications' functionalities. Information quality on the other hand focuses on determining perceptions of input and output qualites, and system interface design quality. Uncertainty avoidance scale items attempt to determine respondents' tolerance with ambiguities pertaining to mobile technology use, specifically their willingness to use new mobile technology, frequency of downloading and using new mobile applications.

Adoption intention of mobile technology for aiding student-lecturer interactions acts as the endogenous construct in this study. The indicators were constructed carefully to reflect respondents' intention to use mobile technology to communicate with their lecturers, for instance using mobile messaging applications to send queries to their lecturers. The scale items also aim to gather respondents' opinions on whether lecturers and the university should allow and encourage the use of mobile technology in the classrooms to support the students' learning process. Examples of the indicators of adoption intention were "My lecturer should allow and encourage us to send or answer questions during lectures using mobile messaging application.", and "My university/college should promote the use of mobile technology to allow students and lecturers to communicate during lectures.". Please refer to Appendix C for the complete survey instrument.

3.5.2 Sampling Techniques

Quantitative studies require adequate sample for empirical analyses (Hair et al., 2006). Probability sampling is costly as the time and cost of travelling to all higher education institutions in various states in Malaysia would be astronomical. Therefore, non-probability convenience sampling was chosen for this study (Arlene, 2002). Three public and three private higher education institutions were chosen based on the accessibility of the students to the researcher. As the targeted respondents were students of higher learning institutions, no exclusion rules were required, and all students regardless of academic disciplines and levels were welcomed to participate in the survey. Data collection efforts ceased when the total responses reached a sufficient sample size required for statistical analyses.

3.5.3 Sampling Size

Sample size is an important consideration in Structural Equation Modelling (SEM) due to their effects on the validity and reliability of the parameter estimates, model fit, and statistical power (Shah & Goldstein, 2006). Various rules have been suggested for determining the minimum number of responses required for regression analyses. For Partial Least Squares SEM (PLS-SEM), the condition for the minimum sample size is less stringent than Covariance-Based SEM (CB-SEM). CB-SEM sample size requires a minimum number of responses based on the complexity of the framework. For PLS-SEM, literature usually uses the "10 times" rule of thumb as the guide to estimate the minimum sample size requirement. The "10 times" rule of thumb established that only a minimum sample size of ten times the most complex relationships in the research model. The most complex relationships is the larger value between the construct with the biggest number of formative indicators and the endogenous construct with the largest number of independent exogenous constructs predicting it (Peng & Lai, 2012).

In this study's framework, all the constructs are reflective. The endogenous construct with the largest number of exogenous constructs is adoption intention (with seven exogenous predictors). This implies that this study only requires a minimum sample of 70 (10 × 7). However, this rule is only applicable if certain conditions are fulfilled, for instance adequate effect sizes, large number of items per construct, and highly reliable constructs (Goodhue, Lewis, & Thompson, 2006). The framework constructs' have five items each. Furthermore, results for effect sizes are unpredictable. Green (1991) proposes using the number of predictors and the study's desired effect sizes for determining the minimum sample size. According to Cohen (1988), an effect size is categorized as large, medium and small for values of 0.35, 0.15, and 0.02 respectively. Using Green's (1991) proposed sample size recommendations based on the desired effect size, the research model has seven predictor constructs and assuming a moderate effect size, a minimum of 102 responses needed to be collected.

Marcoulides and Saunders (2006) proposed the use of the statistical power calculation to determine power size adequacy. Their Monte Carlo simulation proves that the sample size required to achieve a 0.80 statistical power increases as factor loadings and items' inter-correlations decreases. Thus, using the G*Power 3.1.9.2 software, with a moderate effect size of 0.15, and an error probability of 5%, the framework's number of predictors were used as input to calculate the total sample size required. Results indicate that a sample size of 153 will yield a 0.95 statistical power. In sum, taken into consideration the sample size recommendations, this study sets down to gather at least 200 responses from the targeted population due to the heterogeneous characteristics of the population, for instance the respondents' diverse demographic backgrounds and education disciplines demanded that an adequate sample size is achieved for subsequent data analysis. Hair et al. (2006) regard large samples size to consist of 200 or more responses.

3.5.4 Procedures

This section will describe the sequence of methods undertaken for the quantitative data collection and analyses.

3.5.4.1 Expert reviews

The survey was first subjected to expert reviews by two selected academics of higher education in Malaysia. Both academics have more than ten years of teaching and research experience in social studies and experimental procedures. A copy of the survey, together with a review form, was sent to each academic. The main reason for subjecting the survey for reviews was to obtain feedback relating to the validity of the survey instrument from experienced academic researchers (Creswell, 2008).

Primarily, each construct's contribution to the overall objective of the study, and its grouped scale items were assessed for reliability. Feedback from the academics resulted in the following amendments:

1. Unnecessary demographics relating to respondents' background were removed.
2. Statements measuring each construct were narrowed down to five (redundant statements were removed).
3. Lastly, sentences were rephrased to improve clarity.

3.5.4.2 Pilot Test

Pilot test is a small scale preliminary study conducted by researchers to evaluate the survey prior to its distribution to the targeted respondents (Kent, 2001). It is considered a prerequisite for validating the survey measurements, and is conducted with a small group of respondents (Arlene, 2002; Sekaran, 2000). Therefore, weaknesses in the survey design, for instance ambiguous scale items can be rectified prior to the final survey distribution. Respondents' abilities to understand and answer the survey without requiring further clarification or assistance, in particular the constructs' scale items based on the Likert scales, are assessed. This is very important as the survey was designed to be a self-administered online survey and distributed via email invitations. Some of the issues related to self-administered survey are non-response bias, social desirability bias, missing data, and common method bias.

Non-response bias occurs when results obtained from respondents who participated in the survey data collection are different from those that did not participate (Armstrong & Overton, 1977). It affects the validity of the findings obtained from the sample, and doesn't allow findings to be generalized to the sample population (Armstrong & Overton, 1977).

On the other hand, social desirability bias describes respondents' tendency to respond favourably when answering the questions. Such situations may occur when respondents respond in accordance to social norms, or in a manner that they believe the researcher desires, rather than what they truly feel (King & Bruner, 2000). Social desirability bias causes serious consequences in terms of the validity of the results, and the subsequent interpretations and generalizations of the findings to the sample population (Chung & Monroe, 2003).

Missing data are inevitable in self-administered surveys. When dealing with missing data, researchers need to replace the missing data with substituted values. This process is known as imputation, and is necessary as missing data create problems during the analysis stage. Thus, imputation allow researchers to retain responses with some missing values by replacing them with a probable value (Efron, 1994). Traditional methods of imputations include randomly selected values to replace the missing data, using the mid-point value, or using the mean value of the other respondents' responses. However, large number of missing data causes serious concerns pertaining to the validity of the results obtained, even with the application of rigorous imputation methods and is a source of concern for many researchers.

Constructs measured using common methods, for instance multiple item scales in the same survey may lead to the inflation of the relationships caused by shared method variance (Podsakoff & Organ, 1986). In this sense, respondents who needed to rate multiple constructs at the same time in a single survey may produce a series of correlations among the constructs' items due to numerous factors, such as social desirability or adhering to a consistent response style. This "biases" the constructs' validity and reliability assessments (Baumgartner & Steenkamp, 2001; Podsakoff, MacKenzie, & Podsakoff, 2012). Evidence for common method bias exists if results from the factor analysis reveal one factor accounting for the majority of the variance explained or a single factor emerges (Podsakoff et al., 2003).

Measures to address the above mentioned concerns in this study are described in the following sections.

(a) ***Preparation***

There are fundamentally two main approaches for controlling common method bias (MacKenzie & Podsakoff, 2012; Podsakoff e al., 2003). It can be controlled using statistical methods, and minimized through the careful design of the study's data collection procedures. This study used a set of procedural remedies in order to minimize non-response bias, social desirability bias, and common method bias. The statistical methods used to detect common method bias are discussed in chapter four. The procedural guidelines observed below are proposed by MacKenzie and Podsakoff (2012), and Nunnally and Bernstein (1994). They are followed strictly when preparing the survey prior to the pilot test. They are:

1. Ensure anonymity and confidentiality of the respondents in the survey. Ten tertiary students were recruited by the researcher to participate in the pre-test. Therefore, the respondents' identities are known only to the researcher. The objective of the pre-test, i.e. to determine weaknesses in the survey was explained to the students.
2. Constructs' scale items were clearly written.
3. Clear instructions for completing the survey were outlined, and definitions of key terms were included when necessary.
4. The amount of time each respondent took to complete the survey was noted.

(b) ***Survey Amendments***

All respondents recruited to participate in the pilot test were emailed the hyperlink to the online survey, and requested to complete the survey. Then each respondent was invited for a brief individual face-to-face interview with the researcher to discuss possible shortcomings of the survey instrument, and ways to improve it. The respondents were queried about the demographic items' suitability. No issues of privacy were reported, and respondents were generally comfortable to provide the demographic details required. Next they were queried regarding the clarity and suitability of the mobile technology and Internet access section. No issues were reported.

The constructs' five-point Likert scales were presented to the respondents, and respondents were asked whether they understood the meaning of each Likert scale and how it is used to rate the constructs' items. Overall, respondents expressed no difficulties in understanding the five-point Likert scale, with offhand comments such as "I've seen it before.", "Other surveys are the same.", and "No problem." mentioned. The constructs' items were examined next for clarity and brevity. The overall reviews of perceived ease of use, perceived usefulness, self-efficacy, enjoyment, system quality, information quality, uncertainty avoidance, and adoption intention were positive. Respondents were able to understand the meaning of the sentences. Answers given were generally consistent with minor variations based on personal beliefs or perceptions.

Two respondents gave glaringly inconsistent answers to the uncertainty avoidance items. For instance, they gave high ratings for all the other constructs, including uncertainty avoidance. During the interviews, two of the respondents were queried regarding the uncertainty avoidance items. Two of them misunderstood the negative construction of the uncertainty avoidance scale items' sentences, and scored highly when they should have rated lower. Other respondents were queried pertaining to the negative sentences' constructions. They concurred that it took a while for them to adjust to the negative meaning of the sentences and rate their answers accordingly on the Likert scale. The sentences were then adjusted and shown to the respondents. They agreed that standardising the tone of all the uncertainty avoidance items' sentences with all the other constructs will make it easier to answer. Table 3.4 presents the original and the finalised amended scale items of the construct.

Respondents were then queried pertaining to the clarity and brevity of the constructs' scale items. General feedback highlighted were the ambiguity and lengthy sentences of certain constructs' scale items. The scale items were then revised, where ambiguous words highlighted were replaced by simpler ones, and lengthy sentences were shorten.

Table 3.3: Amendments to the uncertainty avoidance scale items.

Original scale items	Amended scale items
1. I find it troublesome to use new mobile devices/applications.	1. I do not find it troublesome to use new mobile devices/applications.
2. I am not willing to try use a mobile device/application even if overall reviews are not good.	2. I am willing to try out new mobile applications even if the overall online reviews about the applications are not good.
3. I do not frequently download mobile applications.	3. I frequently download mobile applications.
4. I do not enjoy trying out new mobile applications.	4. I enjoy trying out new mobile applications.
5. Overall, I am not willing to try using new mobile technologies or applications.	5. Overall, I am willing to try using new mobile technologies or applications.

The approximate duration it took for them to complete the survey were noted. The shortest duration reported was five minutes, and the longest duration reported was twenty minutes. After the pilot test interviews concluded, the respondents were asked if they would like to participate in the final survey. All of them express their willingness to participate, answering “Ok.” or “No problem.”.

3.5.4.3 Final Survey

Approximately six months were needed to design and confirm the final survey. Approval for the study’s survey for students of higher learning institutions in the country was obtained from University Malaya Research Ethics Committee in February 2014. Due to confidentiality of students’ records, the researcher was unable to obtain the student population frame in each institutions. Respondents were then recruited via email invitations sent to students at selected higher education institutions, and data were collected for approximately four months from April till July 2014. Mass emails were sent to the following higher learning institutions in Malaysia: University of Malaya, Universiti Teknologi Mara, Universiti Teknologi Malaysia, Universiti Teknologi Petronas, Multimedia University, and University of Kuala Lumpur. The email contained a hyperlink which took the respondents to the online survey hosted by Google drive. Data were then transferred from the excel worksheet into the IBM SPSS Statistics 21 software and organized for statistical analyses.

3.5.4.4 Data Analysis

SEM is a collection of statistical models that attempts to explain relationships among multiple constructs (Hair et al., 2014; Kline, 2011). Constructs are distinguished as exogenous latent variables (independent variables) and endogenous latent variables (dependent variables). The structure of interrelationships represented as a series of equations, similar to a series of multiple regression equations, is examined in SEM (Gefen, Straub, & Boudreau, 2000; Lohmoller, 2013).

Conventional analyses, for instance multiple and logistic regressions, analysis of variance, and exploratory factor analysis are unable to determine measurement errors (Anderson & Gerbing, 1988). Conventional statistical analyses also do not take into account unobserved variables. SEM on the other hand takes a confirmatory approach rather than an exploratory one, are able to assess measurement errors, and uses both unobserved and observed variables (Gefen, Straub, & Boudreau, 2000). Various researchers in the field of technology acceptance have applied SEM and found it appropriate to assess the validity and reliability of the technology acceptance frameworks, and for confirming hypotheses (Escobar-Rodriguez & Monge-Lozano, 2012; Lee, Xiong, & Hu, 2012; Nasri & Charfeddine, 2012; Park et al., 2012; Teo & Noyes, 2011).

There are two main variations of SEM: CB-SEM and PLS-SEM. CB-SEM aims to reproduce the theoretical covariance matrix, and focus less on explained variance. In other words, researchers who used CB-SEM are interested to see whether the empirical data fits the theoretical model adopted and replicated within the context of the research area. Less emphasis is placed on the explained variance (R^2) of the endogenous constructs. CB-SEM attempts to create parameter estimates that are close to population parameters, and are deemed suitable when the underlying research uses well-established theories (Peng & Lai, 2012). CB-SEM strengths lie in the well-established procedures for evaluating reflective constructs where the constructs' indicators are highly correlated (Hulland, 1999).

PLS-SEM is used to maximize the explained variance of the endogenous constructs, and is less grounded in statistical theory (Chin, 1995). PLS-SEM however can evaluate both reflective constructs and formative constructs where the indicators share similarities, but may not possess conceptual unity (Bollen, 2011). Furthermore, PLS-SEM is useful for prediction as it aims to assess the degree in which a set of exogenous constructs predict an endogenous variable (Fornell & Bookstein, 1982). Therefore, PLS-SEM is appropriate for use in studies that attempt to integrate develop new theories. Reinartz, Haenlein, and Henseler (2009) reiterated Fornell and Bookstein (1982) argument for PLS-SEM as the preferred choice when the focus of the researchers is on the prediction and theory development aspects.

Based on these arguments, PLS-SEM was deemed to be appropriate for data analyses in association to the study's main objective, which is to predict adoption intention of mobile technology in the classrooms of higher education to encourage active interactions among students and lecturers based on a set of identified predictors. Other justifications for using PLS-SEM are based on the following arguments by Chin (1998):

1. Theories and technology acceptance models of mobile educational technologies are under explored.

2. New untested structural paths are introduced in the IMMA framework, and constructs are based on the integration of prominent technology acceptance models, motivational theories and cultural dimensions.
3. Data collection may not be normally distributed, in particular social science studies (Peng & Lai, 2012). This may lead to underestimation of the standard errors and inflate the goodness-of-fit statistics in CB-SEM (MacCallumm, Roznowskim, & Necowitz, 1992).

Furthermore, as with other self-administered online surveys, responses from the targeted population are not guaranteed. In cases where the sample size and data normality are not met, PLS-SEM is a better choice as it can reach a given level of statistical power with approximately half as many observations as CB-SEM. However, small sample size is not desirable in any empirical studies, and the more diverse the population is, more responses are needed. In this study, the varying educational disciplines of the respondents, and their demographic backgrounds necessitated an adequate sample size.

In order to empirically analyse the quantitative data collected from the self-administered survey, IBM SPSS Statistics 21 was used to examine the preliminary data to detect the presence of outliers, to assess data normality, and to generate the descriptive statistics. It is also used to discover evidence of common method bias using exploratory factory analysis (EFA), and to confirm the reliability of the constructs' scale items based on the results of item-to-total correlations and inter-item correlations. SmartPLS Version 2.0.M3 was used to run CFA and PLS-SEM to verify the IMMA framework's internal consistency, reliability and validity. Most importantly, PLS-SEM was used to estimate the IMMA structural framework, and to prove the proposed hypotheses. The following sections will describe and justify the different stages of the quantitative data analyses.

(a) ***Data Examination***

The responses obtained were subjected to rigorous examinations prior to the descriptive and inferential statistical analyses. In particular, the study sets out to detect suspicious response patterns and the presence of outliers. Straight lining responses of all 1s, 3s, or 5s detected were discarded (Hair et al., 2014). SEM requires the assumption of multivariate normality. PLS-SEM does not assume univariate and multivariate normality (Hait et al., 2014). Nevertheless, it is still important to verify that data are not too far from normal as it may cause problems when determining the significance of exogenous constructs (Hair et al., 2014).

Kolmogorov-Smirnov and Shapiro-Wilks tests for data normality by comparing the data to normal distribution with the same mean and standard deviation as in the sample (Mooi & Sarstedt, 2011). Both tests indicate whether the null hypothesis of normally distributed data should be rejected or not. As bootstrapping procedure performs vigorously when data are non-normal, both tests provide limited guidance when deciding whether the data are far from being normally distributed (Hair et al., 2014). Therefore, skewness (measure of the symmetry of a variable's distribution) and kurtosis (measure of whether the data are peak or flat relative to a normal distribution) were selected to assess the normality of the data.

(b) ***Descriptive Analysis***

Respondents' demographic data were analysed and presented. Respondents' mobile technology usage, type of mobile devices currently owned by the respondents, Internet accessibility, and use of mobile devices for learning purposes were presented next.

(c) ***Measurement of Validity***

Due to the nature of the data collection via self-reported survey, and with both independent and dependent constructs' data obtained from the same respondents, there are concerns regarding same-source bias or common method variance (Podsakoff and Organ, 1986). Common method bias, variance attributed to measurement method rather than variance explained by the study's constructs was examined using Harman's single factor (Podsakoff and Organ, 1986), and examination of inter-constructs' correlations. Evidence for common method bias exists if results from the factor analysis reveals one factor accounting for the majority of the variance explained or a single factor emerges (Podsakoff et al., 2003). There is evidence for the occurrence of common method bias if there exists extremely high correlations between the constructs (Bagozzi, Yi, & Phillips, 1991).

All constructs in the framework were measured by five indicators each, and are reflective in nature. The constructs were assessed for internal consistency reliability through examinations of the inter-item and item-to-total correlations. To further examine the reliability of the reflective constructs, all constructs' Cronbach alpha and composite reliability were scrutinised. Convergent validity is the extent in which a set of the construct's indicators share a high proportion of variance in common. Indicators of a construct should converge or share a high proportion of variance (Hair et al., 2014). To determine convergent validity, indicators' outer loadings should be statistically significant (Hair et al., 2014), and above 0.7 (Nunnally, 1978). AVE values exceeding 0.5 suggest adequate convergent validity (Bagozzi & Yi, 1988; Fornell & Larcker, 1981).

Discriminant validity is the extent to which constructs are truly distinct from each other. Discriminant validity is important as it implies that a construct is unique (Fornell & Larcker, 1981). The cross loadings of the indicators, and Fornell-Larcker criterion and were used to assess discriminant validity, the extent to which constructs are truly distinct from each other (Fornell & Larcker, 1981). To establish discriminant validity, the cross loadings of the indicators were first examined. Loadings of an item on its assigned latent construct should be higher than its loadings on other latent variables (cross loadings). Cross loadings criterion is considered a rather lax method to determine discriminant validity (Hair, Ringle, & Sarstedt, 2011). The Fornell-Larcker criterion on the other hand is considered a more stringent measure, on the principle that a latent construct should explain better the variance of its own indicators than the variance of other constructs (Fornell & Larcker, 1981). The square root of the AVE of the latent construct should be higher than the correlations between the latent construct and all other constructs (Chin, 2010; Fornell & Larcker, 1981).

(d) ***Structural Model Estimation and Assessment***

After the constructs' reliability and validity were confirmed, the next phase of the data analysis is the assessment of the IMMA's structural framework. This involves the examination of the framework's predictive capability, and the hypothesized relationships among the constructs. Standard errors and the parameter estimates' significance were estimated using a bootstrapping procedure. The following analyses were conducted based on the guidelines recommended by Hair et al. (2014), and Peng and Lai, (2012):

1. Collinearity diagnostics in the structural model were examined. Path coefficients might be bias if structural estimations involve significant level of collinearities among the predictor constructs. To assess the collinearity, tolerance and variance inflation factor (VIF) were determined. Tolerance value of 0.20 or lower, and VIF value of 5 or higher, are suggestive of potential collinearity problem (Hair et al., 2011).

2. The research model's predictive capability and the relationships between the constructs were examined. The value of the coefficient (Beta) among constructs with standardized values between −1 and +1 represent the strength (the closer the

estimated coefficient is to 0, the weaker is the relationship, and vice versa), and direction of the relationship (positive versus negative relationships). Path coefficient of 0.1 or above is acceptable (Lohmoller, 2013).

Bootstrapping was used to assess the sign, magnitude, and significance of the path coefficients (Hair et al., 2011). Significance of the coefficients were obtained using bootstrapping with a resample of 5000 to assess the *t*-values based on Hair et al.'s (2011) recommended threshold: 1.96 (significance level = 5%), and 2.57 (significance level = 1%). In addition to the *t*-values, the *p*-values that correspond to the probability of erroneously rejecting the null hypothesis were presented.

3. To assess the predictive power of the IMMA framework, the explained variance (R^2) of the endogenous construct was examined. R^2 is a measure of the model's predictive accuracy, ranging from 0 to 1 (Chin, 1998; Hair et al., 2014). A general rule of thumb is the closer the R^2 value is to 1, the higher is the level of predictive accuracy (Chin, 1998). Chin (1998) proposed the R^2 threshold values of 0.67, 0.33 and 0.19 as substantial, moderate, and weak respectively. According to Cohen (1988), R^2 values of 0.26, 0.13 and 0.02 evaluate to substantial, moderate, and weak respectively. Values of 0.2 or above are considered sufficiently high for studies in the area of understanding behavioural perceptions of users (Hair et al., 2014). For studies in the areas of marketing, higher values of 0.75, 0.50, and 0.25 are considered as substantial, moderate, and weak respectively (Hair et al., 2011; Henseler, 2010).

   Therefore, this study will use Cohen (1988) assessment for R^2, a moderately conservative assessment on the basis of the exploratory nature of the study to determine users' behavioural intentions.).

4. The effect sizes (f^2) of the significant constructs were also assessed. The change in the R^2 value when a significant exogenous construct is removed from the model can be used to evaluate whether the omitted construct has a substantive impact on the endogenous construct (Hair et al., 2014). Cohen's (1988) effect size assessment of 0.35, 0.15, and 0.02 indicating large, medium, and small effect size is followed.

5. Stone-Geisser's Q^2 (Geisser, 1974; Stone, 1974) was then used to assess predictive relevance, calculated using the blindfolding procedure. It is a sample reuse technique that omits every *d*th data point in the endogenous construct's items and estimates the parameters with the remaining data points (Chin, 1998; Henseler, 2010). The endogenous construct in the IMMA framework is reflective with multiple items, and are thus suitable for blindfolding procedure (Hair et al., 2014). If the Q^2 value is larger than zero, then the endogenous construct is viewed as having predictive relevance in the model, with values of 0.02, 0.15, and 0.35 indicating small, medium, and large predictive relevance respectively (Hair et al., 2014). An omission distance value of $D = 7$ was used.

6. In addition, the importance-performance matrix analysis (IPMA) was also conducted. The IPMA extends the results obtained from PLS-SEM that provided results on the relative importance of each construct, by taking into consideration the performance of the constructs (Hair et al., 2014).

3.6 Pretest-Posttest Experimentation

Students' behavioural intentions were determined via a pretest-posttest research. Perceptions of mobile technology were first elicited (pretest), and followed by the assessment on IMMAP's effectiveness to support students' interactions with their lecturers (posttest). Data obtained after the experiments concluded were then analysed to discern significant differences. The following sections the sampling frame and the experimental procedures.

3.6.1 Sampling Size

Power analysis using the G*Power software (Faul et al., 2007) indicated that a minimum sample size of 34 would be needed to detect medium effects (Cohen's (1998) $d = 0.5$), and to achieve minimum 80% power when conducting the subsequent paired *t*-test analysis for two dependent means with alpha set to 0.05.

3.6.2 Sampling Technique

Convenience sampling, a non-probability sampling technique was used due to the experimental nature of the pretest-posttest research that requires the convenient accessibility and proximity of the participants to the researcher (Levy & Lemeshow, 1999). A total of 38 tertiary students from an Information Technology course and Business Administration course participated. Therefore, the total number of participants fulfilled the minimum sample size requirement in order to achieve sufficient power, and to detect medium effects.

3.6.3 Experimental Procedures

The following sections describe the experimental procedures of the pretest-posttest experimental procedures.

3.6.3.1 IMMAP Development

The first phase was the design and development of IMMAP. The IMMA framework was used to guide the development of IMMAP. The intervention in this study's pretest-posttest research was IMMAP, a mobile messaging application developed for supporting the interactions between two groups of users – students and lecturers of higher education, and runs on Android mobile devices. Chapter six details the development of IMMAP.

3.6.3.2 Pretest-Posttest Scale Development

The validity of the pretest-posttest results may be compromised due to response-shift bias, particularly for studies that attempt to gather participants' perceptions rather than factual knowledge (Howard, 1980). Response-shift bias occurs when participants rate themselves higher or lower at the posttest evaluations than their pretest evaluations due to a shift in the frame of reference (Shadish et al., 2002). In other words, participants who felt that they have overrated or underrated their perceptions' level in the constructs' statements during pretest assessment may then shift their responses in the opposite directions during posttest. Therefore, development of the pretest and posttest survey instruments is of utmost importance to prevent or minimize the occurrence of response-shift bias.

Each construct in the pretest and posttest surveys consisted of five statements to be rated based on a five-point Likert scale (1: strongly disagree to 5: strongly agree). A total of 40 scale items were used to measure all the constructs. Pretest constructs' scale items is the same scale items used to validate the IMMA framework. Using the prestest constructs' scale items, the posttest constructs' scale items were modified and constructed to reflect IMMAP's suitability and efficacy for supporting student-lecturer interactions.

(a) ***Perceived Ease of Use***

Table 3.4 presents the pretest and posttest scale items for the perceived ease of use construct. From the pretest scales, the statements have been altered slightly to shift general perceptions of mobile technology towards IMMAP. For instance, scale item "Mobile messaging applications such as WhatsApp are easy to use." from pretest is modified to "I find it easy to get IMMAP to send queries to my lecturer." in posttest. In order to prevent response-shift bias among the participants, sentences were constructed to be as brief and clear as possible. This might shorten the reading time and enhance clarity and understanding.

Table 3.4: Pretest's and posttest's perceived ease of use construct

Pretest scale items	Posttest scale items
1. I find it easy to install new mobile applications on my mobile devices.	1. I find it easy to install IMMAP on my mobile devices.
2. I use various mobile applications in my daily life.	2. Learning to operate IMMAP is easy for me.
3. Mobile messaging applications such as WhatsApp are easy to use.	3. I find it easy to get IMMAP to send queries to my lecturer.
4. Using mobile messaging applications require little mental effort.	4. My interaction with IMMAP is clear and understandable.
5. Overall, I find mobile technology easy to use.	5. Overall, I find IMMAP easy to use.

(b) ***Perceived Usefulness***

Perceived usefulness scale items for posttest narrows the focus of the participants from usefulness of mobile technology to IMMAP. Table 3.5 presents the pretest and posttest scale items for the perceived usefulness construct. Posttest sentences are comparatively longer than pretest. For instance, "It is convenient for me to access learning materials anytime, anywhere using mobile technology." from pretest was modified to "IMMAP makes it easier for me to query my lecturer immediately whenever I don't understand the subject content or when I need to seek further clarification." in the posttest. However, the longer sentences in the posttest were necessary to achieve clarity. Themes explored in the pretest and posttest scales of perceived usefulness centres on convenience, functionalities, user effort, and ultimately usefulness.

Table 3.5: Pretest's and posttest's perceived usefulness construct

Pretest scale items	Posttest scale items
1. It is convenient for me to access learning materials anytime, anywhere using mobile technology.	1. IMMAP makes it easier for me to query my lecturer immediately whenever I don't understand the subject content or when I need to seek further clarification.
2. Mobile technology allows me to interact with my classmates easily.	2. IMMAP increases my understanding of the subject when my lecturer responds to my queries.
3. Mobile technology allows me to interact with my lecturer easily.	3. It would be difficult to query my lecturer verbally in the middle of the lecture without IMMAP.
4. Mobile technology allows me to collaborate in group assignments with my classmates easily.	4. Using IMMAP saves me time and effort to interact with my lecturer during lecture.
5. Overall, I find mobile technology to be useful in my studies.	5. Overall, I find IMMAP to be useful for me to interact with my lecturer.

(c) ***Self-Efficacy***

Self-efficacy denotes user confidence to use mobile technology in this study. The posttest scales were designed to gauge participants' ability to install and use IMMAP with ease, whether they are comfortable using IMMAP, and most importantly, whether they are confident to use IMMAP to interact with their peers and lecturers. In designing the scale, brevity and clarity were achieved in the sentences. Table 3.6 presents the pretest and posttest scale items of the self-efficacy construct.

Table 3.6: Pretest's and posttest's self-efficacy construct

Pretest scale items	Posttest scale items
1. I have the knowledge to install mobile applications.	1. I have the knowledge to install IMMAP.
2. I have the knowledge to use mobile technology.	2. I have the knowledge to use IMMAP.
3. I can communicate with my classmates comfortably using mobile technology.	3. I can interact with my classmates comfortably using IMMAP.
4. I can communicate with my lecturers comfortably using mobile technology.	4. I can interact with my lecturers comfortably using IMMAP.
5. Overall, I am confident to use mobile technology to communicate with my lecturers or classmates.	5. Overall, I am confident to use IMMAP to interact with my lecturers or classmates.

(d) ***System Quality***

Table 3.7 presents the system quality scale items for the pretest and posttest surveys. Posttest items were constructed to draw participants' attention towards the evaluation of IMMAP qualities as a mobile messaging application, namely reliability, response time, storage and memory requirements, and lastly, the overall quality of IMMAP functionalities. Pretest items were focused on the same traits, but towards mainstream mobile operating systems and applications.

Table 3.7: Pretest's and posttest's system quality construct

Pretest scale items	Posttest scale items
1. I rarely encounter system errors when using mobile devices/applications.	1. I did not encounter system errors when installing or using IMMAP.
2. It is easy to recover from errors encountered when using mobile devices/applications.	2. IMMAP executes and responds to my instructions quickly.
3. I find it easy to get mobile applications to do what I want it to do.	3. IMMAP requires very little storage/memory space to run.
4. Mobile messaging application(s) which I am currently using has very good features.	4. IMMAP has good functionalities that enable me to interact with ease with my lecturer.
5. Overall, the quality of mobile applications' functionalities is very important.	5. Overall, the quality of IMMAP functionalities are good.

(e) ***Information Quality***

In pretest, information quality construct seeks to capture participants' perceptions of the content characteristics of mainstream mobile operating systems and applications that are valued by users of mobile devices, namely customization of data, clearness of mobile operating system or applications' instructions, clarity and attractiveness of the interface designs, and clarity of input instructions and the output generated. The posttest seeks to obtain from the participants their perceptions on the same information quality traits, but specifically focuses on IMMAP. Table 3.8 presents the scale items of information quality for both assessments.

Table 3.8: Pretest's and posttest's information quality construct

Pretest scale items	Posttest scale items
1. My mobile devices' operating system allows me to customize the way I prefer my data to be presented.	1. I like the fact that I can set my queries to private (only lecturer can view) or public (all students and the subject lecturer can view) status.
2. I have no problem understanding my mobile messaging application(s) instructions.	2. I like the way IMMAP organizes my messages and lecturers' replies on my screen.
3. My mobile messaging application(s) interface layout is attractive.	3. IMMAP interface layout design is simple and pleasing to the eyes.
4. My mobile messaging application(s) generates output (data) in an organized format that is easy for me to understand.	4. I have no problem understanding IMMAP navigation instructions.
5. Overall, quality of data output generated by mobile messaging applications is important.	5. Overall, quality of data output generated by IMMAP is good.

(f) ***Enjoyment***

Table 3.9 presents the pretest and posttest scale items of the enjoyment construct, constructed for the purpose of capturing participants' level of enjoyment when they are using mobile technology, and later specifically on IMMAP during the posttest. Pretest seeks to capture participants' general sense of enjoyment when they use mobile technology to interact and share messages, pictures or videos with their friends and family. Posttest items were constructed from the pretest items, but modified to shift participants' focus towards IMMAP instead. For instance, pretest gauge participants' perception on "Sharing messages, pictures, videos, etc. online using mobile technology is fun.", whilst posttest attempts to gauge participants' perception on "Being able to send queries to my lecturer using IMMAP is cool.".

Table 3.9: Pretest's and posttest's enjoyment construct

Pretest scale items	Posttest scale items
1. I like using mobile technology to interact with friends and family.	1. I like using IMMAP to interact with my lecturers.
2. Sharing messages, pictures, videos, etc. online using mobile technology is fun.	2. Being able to send queries to my lecturer using IMMAP is cool.
3. It is fun surfing the Internet using mobile technology.	3. I enjoy reading my fellow classmates' public queries and the lecturers' replies.
4. I enjoy exploring and using various mobile applications in my daily life.	4. It is really fun to use IMMAP.
5. Overall, I enjoy using mobile technology.	5. Overall, I enjoy using IMMAP.

(g) ***Uncertainty Avoidance***

Uncertainty avoidance attempts to obtain participants' level of uncertainties when using new mobile application in the classrooms to interact with their lecturer, specifically on IMMAP during posttest. Similar to the strategy used during the quantitative survey scale development, use of negative statements were avoided. The argument against using negative statements is that they tell the participants what is not happening, whereas positive statements infers what is. For instance, instead of using "I am not willing to use IMMAP to interact with my lecturers even when I'm not sure that my lecturers will reply to my queries.", "I am willing to use IMMAP to interact with my lecturers even when I'm not sure that my lecturers will reply to my queries." was used.

Therefore, higher scores of the uncertainty avoidance scales indicates lower levels of uncertainty avoidance, and vice versa. Constructing positive statements for uncertainty avoidance was done in order to maintain consistency of thinking. On the whole, uncertainty avoidance in the pretest focuses on assessing participants' hesitation and willingness to use new mobile applications and frequency of downloading new mobile applications, whilst the posttest focusses on IMMAP specifically. Table 3.10 presents the scale items of uncertainty avoidance for pretest and posttest.

Table 3.10: Pretest's and posttest's uncertainty avoidance construct

Pretest scale items	Posttest scale items
1. I frequently download new mobile applications.	1. I frequently download new mobile applications.
2. I do not hesitate to try out new mobile applications even when I'm not sure about the applications' functionalities.	2. I do not hesitate to try out new mobile applications even when I'm not sure about the applications' functionalities.
3. I am willing to try out new mobile applications even if the overall online reviews about the applications are not good.	3. I am willing to use IMMAP to interact with my lecturers even when I'm not sure that my lecturers will reply to my queries.
4. I am willing to use mobile messaging applications such as WhatsApp to interact with my lecturers even when I'm not sure that my lecturers will reply to my queries.	4. I am willing to use IMMAP even if overall reviews about the application from my classmates are not good.
5. Overall, I am willing to try using new mobile technologies or applications.	5. Overall, I am willing to try using IMMAP in the classroom to send queries to my lecturers.

(h) ***Adoption Intention***

Pretest scale items focus on deriving participants' perceptions of using mobile messaging applications to interact with their lecturers and peers, using WhatsApp as an example, and whether the tertiary institutions should allow or encourage students and lecturers to interact in the classrooms using mobile messaging applications. Posttest scale items shift the focus on IMMAP, and attempt to gauge the participants' perceptions of IMMAP for promoting student-lecturer interactions. Table 3.11 presents the scale items of the adoption intention construct in pretest and posttest.

Table 3.11: Pretest's and posttest's adoption intention construct

Pretest scale items	Posttest scale items
1. I prefer to ask questions during lectures using mobile messaging applications such as WhatsApp.	1. I prefer to ask questions during lectures using IMMAP.
2. I prefer to respond to my lecturers' questions during lecture using mobile messaging applications.	2. I prefer to respond to my lecturers' questions during lecture using IMMAP.
3. My lecturers should allow and encourage us to send queries during lectures using mobile messaging applications.	3. My lecturers should allow and encourage us to send queries during lectures using IMMAP.
4. My university/college should promote the use of mobile technology to allow students and lecturers to interact.	4. My university/college should promote the use of IMMAP to allow students and lecturers to communicate during lectures.
5. Overall, I prefer to use mobile technology to interact with my classmates and lecturers during lectures.	5. Overall, I prefer to use IMMAP to send queries to my lecturers during lectures.

3.6.3.3 Experimental Manipulation

An initial pilot study was conducted to assess IMMAP's features, as well as the posttest survey instrument indicators. Feedback gathered were used to enhance IMMAP functionalities, as well as to refine the posttest survey instrument. Chapter five further describes the results of the pilot test.

After the pilot study, the experiment commenced. In phase one (pretest), the quantitative survey instrument used to confirm the study's hypotheses, and also to verify the validity of the framework, was used to discover the participants' perceptions of mobile technology in general. In the second phase, experiments involving two groups of participants (tertiary students selected from two courses, and their lecturers) using

IMMAP for half a semester commenced. Following this, in the third phase, the posttest survey was distributed to the participants (tertiary students) for the evaluation of IMMAP.

3.6.4 Data Analyses

The last phase entailed the necessary data analyses and reporting of the results obtained. Paired sample *t*-test was conducted to discern significant differences of the pretest and posttest assessment. Chapter six details the findings of the pretest and posttest assessments, and the ensuing discussion.

3.7 Summary

This chapter justifies the need for a mix-method research to answer the research questions with the aim of testing the framework's hypotheses. In addition, the chapter outlined the methods used in this study, including the research design, sampling methods, administration of the instruments, pilot studies, and data analyses. The research methods include both qualitative and quantitative means, the first being qualitative for ascertaining academics' perceptions of interaction issues with their students in large classes. Non-participatory observations of large classes, and semi-structured interviews with thematic analyses were conducted.

Validity of the IMMA framework and the hypotheses put forth were ascertained via quantitative research methods. An invitation to complete the online survey was emailed to students of selected higher education institutions in Malaysia. Following the findings from the quantitative research, the IMMA framework's constructs were used to guide the development of IMMAP and the pretest-posttest survey instrument. All data obtained were subjected to rigorous sound statistical analyses. Qualitative research, and quantitative results are discussed in chapter four, while findings from the pretest-posttest experimentation are discussed in chapter five.

CHAPTER 4: RESULTS AND DISCUSSIONS

Chapter three described the research methodology of the study, the IMMA framework, and the hypothesized relationships among the framework's constructs. The research methodology outlined the data collection methods and data analyses, and the justifications for conducting qualitative (observations and interviews) and quantitative (survey) research. This chapter first presents the results and discussion of the qualitative data analysis. Non-participatory observations of large lecture classes were conducted to verify the research problem, and confirm research gaps identified in the literature. In addition, data collected from the semi-structured interviews with lecturers were subjected to thematic analysis to confirm the relevance of the constructs in the framework.

Next, quantitative data were analysed. Descriptive statistics' measures of means, and standard deviations are presented to describe the framework's constructs (independent and dependent variables). To confirm the underlying structure of the framework, EFA was applied. In addition, CFA was also used to verify the framework's internal consistency, reliability and validity. The structural model of the framework, and its postulated hypotheses were assessed using PLS-SEM. The framework's predictive accuracy and relevance, and the effect sizes of the significant constructs were examined next. To further investigate the impact of the exogenous constructs found significant, IPMA was conducted. Rigor was exercised to ensure the accuracy and trustworthiness of the quantitative results and discussion.

4.1 Qualitative Research

Qualitative research was conducted to identify barriers hindering interactions among lecturers and students in large lecture classes. In addition, the research also aims to discover lecturers' perceptions regarding the quality of interactions with their students in the classrooms, and their intentions to use mobile technology to interact with their students.

4.1.1 Observation of Large Lecture Classes

Reviews from the literature point to the negative effects of large classes on students' engagement on the whole, in particular interactions between students and lecturers. It can be difficult for lecturers of large classes to conduct discussions or gather feedback from their students. Time constraint, unconducive large lecture halls' layout, as well as students' personalities (shyness or introversion) as among the key reasons for the lack of meaningful and active discussions in large classrooms (Bachman & Bachman, 2011; Lane & Harris, 2015; Owston et al., 2011; Smith & Cardaciotto, 2012). In addition, large classes may promote a teacher-centred teaching approach (Biggs, 2012; Smith & Cardaciotto, 2012).

Observations of selected large lecture classes were conducted in this study. The aim for conducting the observations was to determine the effects of large classes on student-lecturer interactions. A checklist was prepared detailing the observations' focus areas. During the observations, the focus were on the (i) lecture methods (i.e. lecturers' pacing and presentation, learning activities, use of technological tools or instructional aids), (ii) lecturers' interactions with their students (i.e. do they prompt students for feedback, encourage discussions, demonstrate awareness and respond accordingly when students' require further clarifications, and interactions barriers), and (iii) students' engagement (i.e. are the students attentive and responsive).

A total of four non-participatory observations of large classes with a minimum of 50 students were conducted at one of the universities in Malaysia. Convenience sampling method was used in selecting classes for observations. Selected classes were from undergraduate degree courses, namely Mathematics, Multimedia, Programming and E-commerce. Technical and non-technical courses were chosen to discern possible interaction variances between technical and theoretical courses. Table 4.1 outlines the details of the observed class for each course.

Table 4.1: Observed class details

Class	Course	Number of students present	Number of absentees
#1	Mathematics	62	6
#2	Multimedia	116	5
#3	Programming	65	4
#4	E-commerce	112	15

None of the lecturers were observed using any forms of mobile technology for aiding the delivery of the lectures. Tools utilized by the lecturers were personal computers, overhead projectors, and the traditional whiteboards provided by the university. Delivery of the classes were aided with the projection of the PowerPoint slides, and/or use of the conventional whiteboards and marker pens.

Use of the whiteboards and marker pens were apparent in the technical subjects of Mathematics and Programming. In both classes, lecturers were observed utilising the whiteboard and marker pens to elaborate key points. In addition, supplementary notes were written by the lecturers, and students were then instructed to copy them down. Use of the whiteboard was less frequent for the Multimedia class, and was used for illustrative purposes by the lecturer occasionally. The E-commerce lecturer did not use the whiteboard during the observation. The pacing and presentation clarity for all the lecturers were generally satisfactory.

Findings obtained corroborated and confirmed the discoveries from the literature on large classes. Three main outcomes were derived from the observations. First, there was lack of interactions between students and their lecturers in the observed classes. Secondly, the lecturers were unable to provide adequate attention to all of their students, and lastly, students seated towards the back were observed to be nonchalant and inattentive. It must be noted that none of the lecturers utilized mobile technology or other instructional aids, other than the personal computer, overhead projector, and the whiteboard provided in each classroom. The following sections describe further each of the main outcomes derived.

4.1.1.1 Inequities in Lecturers' Attention

The rooms' layout are the typical long vertical classrooms found in many higher education institutions in Malaysia. The personal computer was positioned in front of each classroom, and the overhead projector projects the lecturer's Powerpoint slides and other educational materials in front as well. The tables and chairs were arranged sequentially in a row format, with a lane in the middle for walking. The lowest number of students present was 62 (Mathematics), and the highest number was 116 (Multimedia). All lecturers mainly positioned themselves in front of the classrooms. Lecturers from the Programming and Mathematics classes occasionally walked to the back to observe their students' progress. All the lecturers were observed to be to be paying more attention to the students seated near them across all four observed classes.

Literature on the effects of large classes have stressed several factors that may result in inadequate attention given to the students. Time constraint was surmised to be insufficient for lecturers to adequately monitor their students' progress in the observed classes. With the traditional layout of the classrooms, the lecturers also cannot walk over to check on their students seated near the sides of the classroom. This conjectures were also reiterated by Ragan et al. (2014), and Smith and Cardaciotto (2012), therefore eventually contributing towards the lack of student-lecturer interactions and low students' engagement in large classes, describe in the following sections.

4.1.1.2 Low Student-Lecturer Interactions

Across all four observed classes, interactions between students and lecturers were low. This is particularly evident from the multimedia and e-commerce classes. Students from the e-commerce class in particular were observed to be indifferent to their lecturer's prompts for feedback. In other words, the students did not provide any sort of acknowledgements when their lecturer enquired whether they understood or required further clarifications. Most of the students kept quiet throughout the lesson, but as the class progresses, some students can be seen chatting with their friends beside them, or were discreetly using their mobile phones.

Similar occurrences were also observed in the multimedia class, though front-seated students were seen nodding their heads to indicate that they understood when enquired. It was conjectured that the lack of interactivity in both classes stemmed from the theoretical nature of the syllabus covered during the observation day, as well as the lack of collaboration or discussion activities. As such, lecturers were mainly "lecturing". In other words, one-way method of communication were observed in both classes.

For the mathematics and computer programming classes, student-lecturer interactions were slightly higher comparatively. Mainly, the lessons conducted in both classes during the observation day combined traditional lecturing and hands-on exercises. Exercises and examples were written on the whiteboards in both classes, and students were instructed to copy and attempt them. The lecturers waited for the students to complete their solutions. It was not possible to discern whether the students successfully completed the exercises assigned. During the discussions of the solutions, some students seated towards the front of the classrooms requested for further clarifications and were generally responsive when their lecturers queried them on certain points.

As for the rest of the students, the attention level was deemed satisfactory but these students did not provide any feedback nor fielded questions. It was speculated that students in the Mathematics and Programming classes exhibited better attention span, and were more responsive than students from the multimedia or e-commerce classes due to the technical nature of both subjects' syllabus.

The general lack of student-lecturer interactions observed across all four classes was supported by Pollock et al. (2011), Lane and Harris (2015), and Owston et al. (2011). Findings from all three studies concluded that large classes reduce student-lecturer interactivity. Therefore, though this research was conducted within the context of Malaysia's higher education, the similarities of the findings produced with previous studies proved that low student-lecturer interactions is a common and global problem faced by academics around the world when teaching large classes.

4.1.1.3 Low Students' Engagement

It was also surmised that due to the lecturers' attention being on the students seated near them, students seated in the middle or back rows did not provide any feedback or attempt to query their lecturers. Particularly, students in the multimedia and e-commerce classes were rather quiet, and exhibited a relaxed indifferent mannerism. As the lessons progressed further, the attention span of both groups of students were observed to be decreasing, especially students at the back of the classrooms appeared to lose interest.

Again in both classes, some students were observed to be casually chatting with their friends discreetly, as well as using their mobile phones. It was not possible to determine why they were using their mobile phones, though the usage of mobile devices weren't required for learning during the lessons. However, Zakaria et al. (2010), and Rossing et al. (2012) found that tech-savvy students use their mobile devices such as tablets in the classrooms to access online learning materials, and share learning resources with their friends.

Students in the Mathematics and Programming classes exhibited higher attention span, and a few of the students seated in front the classrooms also took the initiatives to request for further clarifications, and replied when their lecturers asked questions. Though the students seated in the middle and back of the classrooms did not interact with their lecturers, they were observed to be paying attention throughout the lectures, and were cooperative when requested to copy the exercises or examples provided. In addition, during the Mathematics class, some students were also observed to be referring to their friends' study materials, or engaging in discussions when they were given time to attempt the hands-on exercises.

Literature have provided numerous evidences relating the positive effects of innovative teaching strategies on students' engagement (Garrison & Vaughan, 2013).

Increasing students' engagement were also shown to improve students' academic achievements of the learning outcomes (Pike, Smart, & Ethington, 2012). Though the Mathematics and Programming lecturers used the traditional ways to engage their students through hands-on exercises and examples to reinforce understanding, despite the low interactivity between students and lecturers. On the other hand, using the teacher-centred approach of "lecturing", as observed in the E-commerce and Multimedia classes suffer from lack of student-lecturer interactions and engagements.

Table 4.2 summarizes the overall outcomes of the observations

Table 4.2: Observation result summary

	Lecture #1 (Mathematics)	**Lecture #2** (Multimedia)	**Lecture #3** (Programming)	**Lecture #4** (E-commerce)
Lecture methods: Observer focused on the general pacing of the lecture, techniques used by the lecturer in his or her presentation, types of collaborative learning activities conducted, and the use of instructional aids or tools.				
1. Pacing and presentation method	Did not rely on PowerPoint slides. Mainly fielded hands-on exercises.	Lecture was conducted using PowerPoint slides. After each slide, the lecturer paused and enquired whether the students understood before continuing to the next slide.	PowerPoint slides were used sparsely, i.e. not for the entire class. Students were provided with ample examples of program source codes. Codes were written on the white board, and students were instructed to copy them down. It was observed that some students were struggling to finish copying down the source codes within the duration given by their lecturer.	Class was conducted mainly using PowerPoint slides. Only intermittent pause for feedback were observed. Focus was solely to ensure that the students understood the various concepts or terminologies in that particular chapter.

Table 4.2 continued

	Lecture #1 (Mathematics)	**Lecture #2** (Multimedia)	**Lecture #3** (Programming)	**Lecture #4** (E-commerce)
2. Collaborative learning activities	Not observed. Questions were written down on the whiteboard, and students were required to attempt them. It was observed that front seated students seem to have completed the questions given. Nonetheless, others were observed attempting the questions. After the allocated time, solutions were given and explained by the lecturer.	Not observed. Only one question was written on the white board. Students were given time to solve the problem after which volunteers were sought. A student seated in front volunteered to write the answer on the white board. Discussion ensued.	Not observed. Programming questions were written on the whiteboard, students were then given time to solve the problem, followed by explanation by the lecturer.	Not observed. Students were not given any questions to solve.
3. Use of technological or instructional tools	Not observed. Lecture delivery was traditional face to face mode using the whiteboard and marker pens only.	Utilised the PC and overhead projector provided in the lecture hall, and the PowerPoint software.	Utilised the PC and overhead projector provided in the lecture hall, and the PowerPoint software. Lecture delivery was traditional face to face mode using the whiteboard and marker pen, with the PowerPoint slides shown.	Utilised the PC and overhead projector provided in the lecture hall, and the PowerPoint software.

Table 4.2 continued

	Lecture #1 (Mathematics)	**Lecture #2** (Multimedia)	**Lecture #3** (Programming)	**Lecture #4** (E-commerce)
Lecturers' interactions with their students: Focused was on the lecturers' initiatives to encourage communication with their students, and how they responded to their students' queries.				
1. Encourage students to give feedback	After solutions were discussed, lecturers enquired whether the students understood the solution. Some students seated in front requested for additional clarifications. Lecturer then repeated the necessary sections with further explanations.	After the lecturer completed the explanations for a number of slides, students were prompt whether they understood. Students seated in front were seen giving some sort of acknowledgement or confirmation. Some students were seen nodding their heads.	After each example, students were prompt whether they understood how the source codes work. Some students were seen nodding their heads, with students seated in front requesting for further clarifications. Lecturers will then provide additional sample codes and explained accordingly.	Lecturer on the whole prompt the students whether they understood the concepts explained. However, students were nonchalant and unresponsive. Lecturer then proceeded to the following slides.
2. Class discussions	Not observed.	Not observed.	Not observed.	Not observed.

Table 4.2 continued

.	**Lecture #1** (Mathematics)	**Lecture #2** (Multimedia)	**Lecture #3** (Programming)	**Lecture #4** (E-commerce)
3. Interact with all students fairly.	Lecturer made attempt to interact with the whole class generally. Interactions seems to be occurring mainly with the students seated at the first few rows. Partiality observed towards front seated students.	The lecturer did not singled out any students during prompting. She looked at the entire class in general when enquiring. Majority of the interactions took place at the front of the classroom.	Lecturer looked at the whole class in general when interacting to get students' feedback. Students seated at the first few rows generally responded to the lecturers' queries.	Not observed.
4. Demonstrate awareness when students require further clarification and responds to students' questions and comments.	Lecturer demonstrated awareness when front seated students fielded request for further clarification. Students seated towards the back were passive.	Not observed. Students did not field any questions, only confirmation such as nodding their heads when asked whether they understood the lecturer's explanation.	Lecturer responded when the front seated students requested for further clarification pertaining to a specific set of codes.	Not observed. Students were unresponsive and none of them asked any questions.

Table 4.2 continued

	Lecture #1 (Mathematics)	**Lecture #2** (Multimedia)	**Lecture #3** (Programming)	**Lecture #4** (E-commerce)
Students' interactions with their lecturer: The observer focused on the students' initiatives to communicate with their lecturer.				
1. Attentiveness.	Majority of the students were observed to be paying attention. However, some students seated at the back rows were seen chatting and using their mobile phones.	Generally, moderate level of attentiveness was observed. Students seated at the back rows were observed to be chatting, and some were observed using their mobile phones.	On the whole, students were busy copying down the source codes given.	Not observed. Students on the whole, including the front seated ones, appeared nonchalant and uninterested in the subject matter.
2. Responsiveness	Only students seated in front fielded questions, and generally provided some sort of acknowledgement to demonstrate that they understood.	Only students seated in front were seen nodding their heads as a sign of acknowledgement when the lecturer asked whether they understood. None asked any questions.	Only front seated students requested for further clarifications.	Not observed. None of the students attempted to ask the lecturers any questions, or requested further clarifications.

4.1.2 Interview with Academics of Higher Education

Semi-structured interviews were conducted in English with selected academics of higher education. The purpose for conducting the interviews was to elicit the academics' perceptions relating to issues of interactions with their students, as well as to obtain their opinions regarding the use of mobile technology to interact with their students on academic matters. Though the findings obtained cannot be used to empirically validate the relationships among the exogenous and endogenous constructs (hypotheses), nevertheless, the findings are considered an important precursor on the relevance of each exogenous construct. The following sections describe the respondents' background, data analysis used, results obtained, and discussion.

4.1.2.1 Respondent Demographics

A total of 22 lecturers (male = 9; female = 13) were interviewed from multiple disciplines such as law, information technology, and management, among others. The majority of the respondents were from information technology background (31.8%), followed by engineering (18.2%), and management (18.2%). The least number of respondents were from the language discipline (4.6%). The majority of the respondents taught only undergraduate courses (68.2%), postgraduate courses (13.6%), and diploma courses (13.6%). Only one respondent has taught both undergraduate and postgraduate courses (4.6%). In addition, the percentage of females (59.1%) were higher than the men (40.9%), and the percentage of the respondents was the highest in the age group of 30 – 39 years (54.5%). Notably, 50% of them possess have more than ten years of teaching experience.

The average number of students in each class was 83. Table 4.3 presents the demographic details of the respondents.

Table 4.3: Background information of interview respondents

Respondent characteristics	Count	%
Gender		
Male	9	40.9
Female	13	59.1
Age (years)		
Less than 30	1	4.6
30 − 39	12	54.5
40 − 49	8	36.3
50 − 59	1	4.6
Teaching experience (years)		
2 – 5	2	9.1
6 – 10	9	40.9
More than 10	11	50.0
Courses		
Postgraduate	3	13.6
Undergraduate	15	68.2
Postgraduate & undergraduate	1	4.6
Diploma	3	13.6
Academic field		
Information Technology	7	31.8
Engineering	4	18.2
Management	4	18.2
Law	3	13.6
Mathematics	3	13.6
Language	1	4.6

4.1.2.2 Data Analysis

With the aid of the NViVo 10 software, thematic analysis was conducted to organise and analyse the data from the interviews. All data collected from the interviews were transcribed and critical information highlighted. The transcribed interview data were then deconstructed and categorized, and important recurring concepts (codes) for each category were identified (Berg, 2000). Inferences were made to each code to explain its meaning. Caution was taken to preserve the original meaning of each code derived. Next, the codes were combined into themes for further analysis.

Each theme's theoretical contribution were researched and further refined until a satisfactory set of themes were identified. The purpose of undertaking this approach was to derive thematic areas by converging the codes into sub-themes (first-order themes) and main themes (second-order themes). Each thematic area was examined for correlations with other identified thematic areas, and the results illustrated using thematic networks.

4.1.2.3 Results and Discussion

The frequency and percentage of the data that fit each theme was calculated and presented in table 4.4, table 4.5, and table 4.6. Figure 4.1 and figure 4.2 illustrate the relationships among the themes identified.

(a) Students' Willingness to Interact in the Classrooms

Four thematic areas were identified. They are: (i) types of responsive students, (ii) the importance of interaction, (iii) barriers preventing students from interacting, and lastly (iv) lecturers' interaction techniques. A total of 136 responses were coded.

Front seated students (40.0%) and academically motivated students (36.7%) were deemed as most responsive to lecturers' enquiries or prompts during lectures, followed by students who possessed good articulation skills (16.7%). Students who possess working experience were also mentioned (6.6%). Interactions during lectures were deemed important in order to ensure students' understanding (72.7%) and attentiveness in the classrooms (13.6%), as well as to ensure that interactions in the classrooms involve both students and lecturers (13.6%). Most importantly, the findings corresponded with the observed mathematics and programming classes, whereby some of the students seated in front of the classrooms took the initiative to request for further clarifications and responded to their lecturers' queries.

Notably, the respondents' perceptions on the barriers that prevent students from interacting or providing feedback during classes are due to their attitude (39.5%), such as attending classes unprepared, are unresponsive or lack understanding. Another major reason cited was that introvert students (26.3%) who feel shy or inferior that their peers rarely provide feedback or initiate interactions in the classrooms. Notably, time constraint (18.4%) were also voiced as one of the barriers hindering interactions in the classrooms, due to the need to complete the lesson as planned, thus resulting in insufficient time to encourage students to feedback or conduct class discussions. These findings concur with what was discovered from reviews of literature that time constraint is one of the chief factors of low student-lecturer interactions in the classrooms (Bachman & Bachman, 2011; Caldwell, 2007; Davidson, Gillies, & Pelletier, 2015; Lane & Harris, 2015; Murberg, 2010; Owston et al., 2011; Ragan et al., 2014; Smith & Cardaciotto, 2012).

In order to elicit students' to respond, the majority of the respondents conduct question and answer (Q&A) sessions (71.7%) in the form of direct questioning and constant prompts during classes, followed by organizing class activities (28.3%) such as group discussions or presentations. Nonetheless, all the respondents agreed on the importance of active interactions with their students in order to determine whether their students understood what was taught in the classrooms. This corresponded with Huba and Freed (2000), and Wright (2011), who claimed that successful learning and knowledge sharing can be achieved through active students' engagement, participation, and collaborative activities. The respondents' emphasis on their students' understanding to ensure their academic success were also opined by Moulding (2010), where higher satisfaction and better grades can be achieved if educators focus on improving engagement through active discourses with their students.

The respondents interviewed in this study also cited that ensuring students' attention during lectures (13.6%), as well as ensuring that they aren't the only ones doing the talking (two-way communication) (13.6%) are important precursors for increasing student-lecturer interactions, a crucial strategy for effective learning (Hallinger & Lu, 2013; Kuh et al., 2004). The themes pertaining to the respondents' perceptions of interactions with their students during lectures are presented in table 4.4. Figure 4.1 illustrates the summarized thematic analysis results.

Table 4.4: Results of the thematic analysis of lecturers' perception on types of responsive students, interaction purposes, barriers and techniques

Thematic area	Second-order theme	First-order theme	Theme description	*n*	(%)
Types of responsive students	Eloquent	Talkative	Students who frequently and actively engages in conversations amongst each other and with the lecturers.	5	16.7
		Converses well	Students who possess a certain degree of language fluency for conversing.		
	Front seated	Front seated	Students who are seated in the first few rows in the lecture classrooms or halls.	12	40.0
	Academically motivated	Hardworking	Students who are diligent.	11	36.7
		Good students	Students who exhibit interest towards their studies and are driven to excel academically.		
	Work experience	Work experience	Students who are currently working full time or part time while pursuing their education concurrently, or had working experience prior to studying.	2	6.6
Importance of interaction	Subject comprehension	Get feedback	To derive responses from students on subject content and lecture delivery.	16	72.7
		Ensure understanding	To determine whether the students comprehended or grasp the subject content delivered.		
	Two-way interactions	Two-way interactions	To ensure that students and lecturers actively interact to foster active learning in the classrooms.	3	13.6
	Ensure attention	Ensure attention	To ensure that students are paying attention during lectures.	3	13.6

Table 4.4 continued

Thematic area	Second-order theme	First-order theme	Theme description	*n*	(%)
Students' interaction barriers	Introversion	Shyness	Students who do not feel comfortable or are afraid in voicing their opinions.	10	26.3
		Inferiority	Students who feel not up to par with their peers who achieve better results or are deemed better than them.		
		Lack of confidence	Students who do not possess confidence in themselves to excel academically.		
	Time constraint	Time constraint	The need to complete the required syllabus within the semester.	7	18.4
	Poor language skills	Poor language skills	Students who cannot converse well due to low language fluency.	3	7.9
	Indifference attitude	Not prepared	Students who come to classes unprepared.	15	39.5
		Lack understanding	Students who do not understand the subject content.		
		Unresponsiveness	Students who do not care to engage or participate during lectures or communicate with their lecturers.		
	Culture	Culture	Students' background, i.e. local students tends to be less responsive and interactive compared to international students.	3	7.9
Lecturers' interaction techniques	Class activities	Group discussions	Assigning topics to students and encouraging them to form groups and conduct discussions amongst themselves.	13	28.3
		Presentations	Students' presentations in front of their lecturers or peers in the classrooms.		
	Q&A sessions	Ask questions directly	Allocating and conducting question and answer sessions with their students.	33	71.7
		Constant prompt	Constantly prompt students for their understanding and feedbacks.		

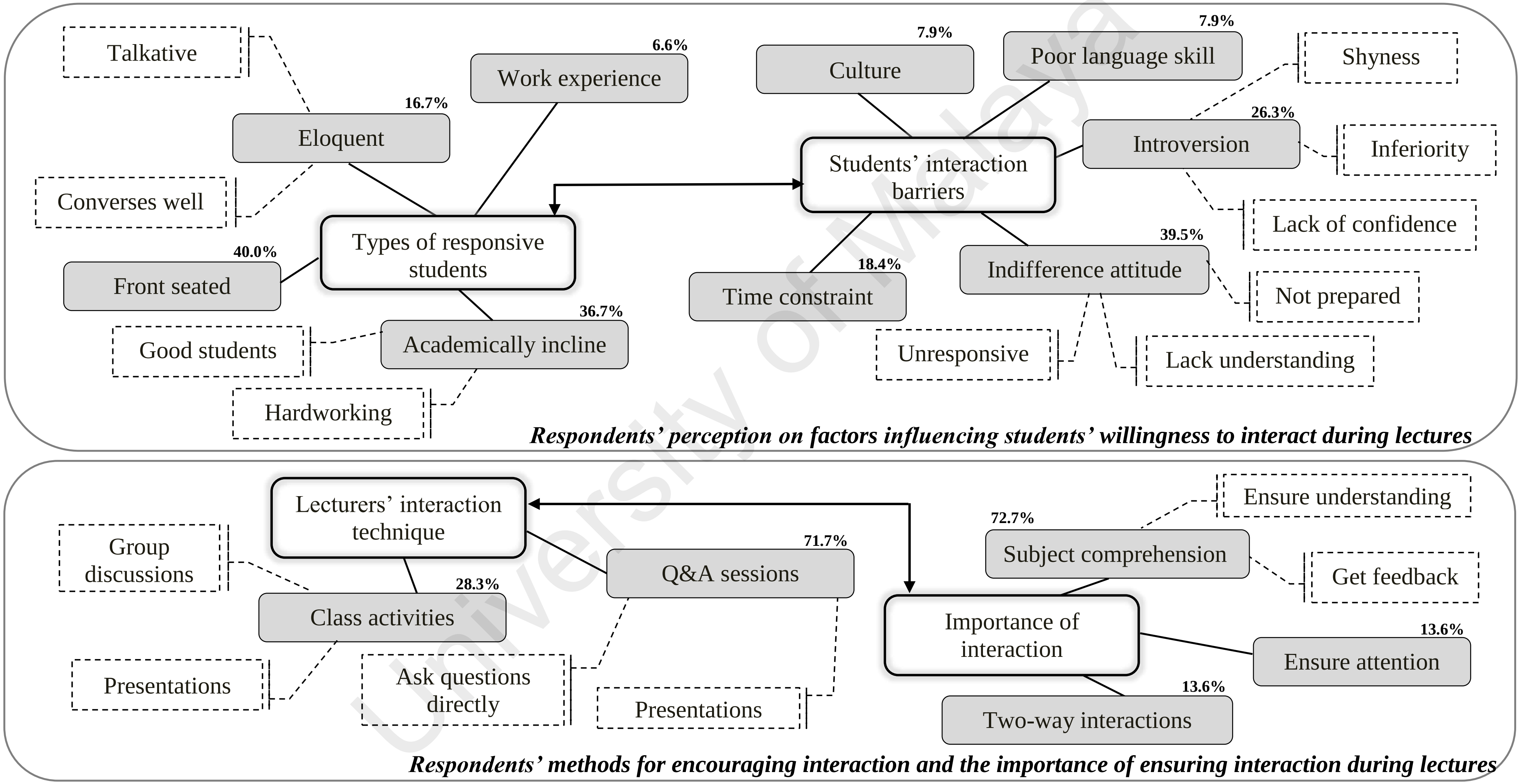

Figure 4.1: Respondents' perception of student-lecturer interactions

(b) ***Interactions in Large Lecture Classes***

The majority of the respondents also stated that they preferred a smaller number of students in each lecture group (90.9%). Only one respondent contended that students' number is irrelevant, whereas another respondent opined that lecturers' ability to communicate with all the students effectively during lectures matters the most, regardless of the number of students. Table 4.5 presents the responses on the effects of large lecture classes with more than 50 students on interactivity between lecturer and students. Twenty-one valid responses were recorded from 18 respondents, with the remaining four respondents giving neutral answers. Data analysis revealed two main effects of large classes (themes): (a) low interactivity (40.0%), and (b) lecturers' inability to provide equal attention to all the students (32.0%). Lastly, large classes also resulted in students seated towards the back of the lecture halls or classrooms to be unresponsive (12.0%).

These results concurred with the research problem of the lack of quality student-lecturer interactions in large classes (Moulding, 2010). In addition, Exeter et al. (2010) also asserted the negative effects of large class on students' engagement, due to the inability to promote active learning and in-class discussions. Among others, Bachman and Bachman (2011), and Lane and Harris (2015) reiterated that large classes suffers from lack of interactive not only due to unequal attention paid to all students, but also unresponsive students who sit at the back of the classroom. As such, findings obtained are crucial, and allows for the corroboration of the research problem.

Table 4.5: Results of the thematic analysis of large lecture classes (> 50 students) on student-lecturer interactions

Main themes	Theme description	*n*	(%)
Low interactivity	Lecturers feel that interactions with their students are more challenging and difficult in large classes (more than 50 students).	10	40.0
Inability to provide attention to all students	Lecturers are unable to provide attention to all students.	8	32.0
Unresponsive back-benchers	Middle to back row students generally are unresponsive and does not respond to lecturers' encouragements to engage in class interactions.	3	12.0
Neutral	The perceptions that the number of students in a class does not affect interactions between students and lecturers.	4	16.0
	Total events recorded	25	100.0

(c) ***Perceptions of Mobile Technology for Aiding Interactions***

Lecturers' intentions to use mobile technology for educational purposes were queried. Two major thematic areas emerged: (i) perceived advantages, and (ii) perceived disadvantages of educational mobile technologies. Mobile technology was perceived to be most advantageous for being useful for educational purposes (34.8%), enabling instant messaging between students and lecturers (30.4%), followed by its potential to assist introvert students to interact (17.4%), students' mobile technology savviness (10.9%), potential to reduce students' boredom in the classrooms (4.3%) and enabling collaborations among the students (2.2%).

Concerns relating to mobile technology for educational usage were mainly the potential of students' misusing it for non-learning reasons (58.4%), followed by being perceived as redundant and unsuitable for student-lecturer interactions (19.4%), potential for decreasing students' real-life communication skills (technology dependence) (16.6%), and concerns of unstable and slow wireless Internet connection (5.6%). Other suggestions elicited voluntarily by the respondents on the suitability of mobile technology as an interaction tool with their students were to incorporate features whereby lecturers will be able to control the timing and duration for the students to send queries (4 responses); a save option that allows the lecturers to save students' queries into the mobile devices and thus allowing the lecturers to respond after class at their own convenience (3 responses); and also to incorporate options that allow the lecturers to ask the students to provide feedback in the form of structured questions (1 response). Table 4.6 and figure 4.2 present the results of respondents' intention to use mobile technology during lectures for interacting with their students in the future.

Table 4.6: Results of the thematic analysis of mobile technology adoption intention

Main themes	**Main themes** **Sub-themes**	**Theme description**	***n***	**(%)**
Educational advantages	Real-time interaction	Enable students and lecturers to interact freely anytime and anywhere instantly.	14	30.4
	Collaboration	Provide collaboration opportunities amongst students.	1	2.2
	Reduce boredom	Able to reduce boredom especially for theoretical courses by incorporating mobile technology into the learning activities.	2	4.3
	Technology savviness	Students today are perceived to be adept at using mobile technology and might spark their interest if mobile technology is used as part to support learning in the classrooms.	5	10.9
	Useful tool	Mobile technology is perceived as being useful in teaching and learning for both students and lecturers, and for accessing learning materials and resources anytime, anywhere.	16	34.8
	Overcome students' introversion	Mobile technology is perceived to be able to help students to overcome their shyness, lack of confidence, or language barriers to interact with their peers and lecturers.	8	17.4

Table 4.6 continued

Main themes	Main themes Sub-themes	Theme description	*n*	(%)
Educational concerns	Technology misuse	Students losing concentration during lecture due to use of mobile technology in the classrooms, and thus disrupts the teaching and learning process. Students may send nonsensical questions. Allowing students to use mobile technology may cause students to secretly use mobile technology for non-learning purposes.	21	58.4
	Redundancy	Perceptions of mobile technology not being suitable for interacting with students during lectures.	7	19.4
	Intermittent wireless connection	Concerns regarding the reliability of Internet connection, e.g. the occurrences of intermittent connection breaks.	2	5.6
	Dependence	Use of mobile technology for interactions may result in students being dependent on it, and decreases opportunities for them to develop their communication skills which are perceived as important.	6	16.6

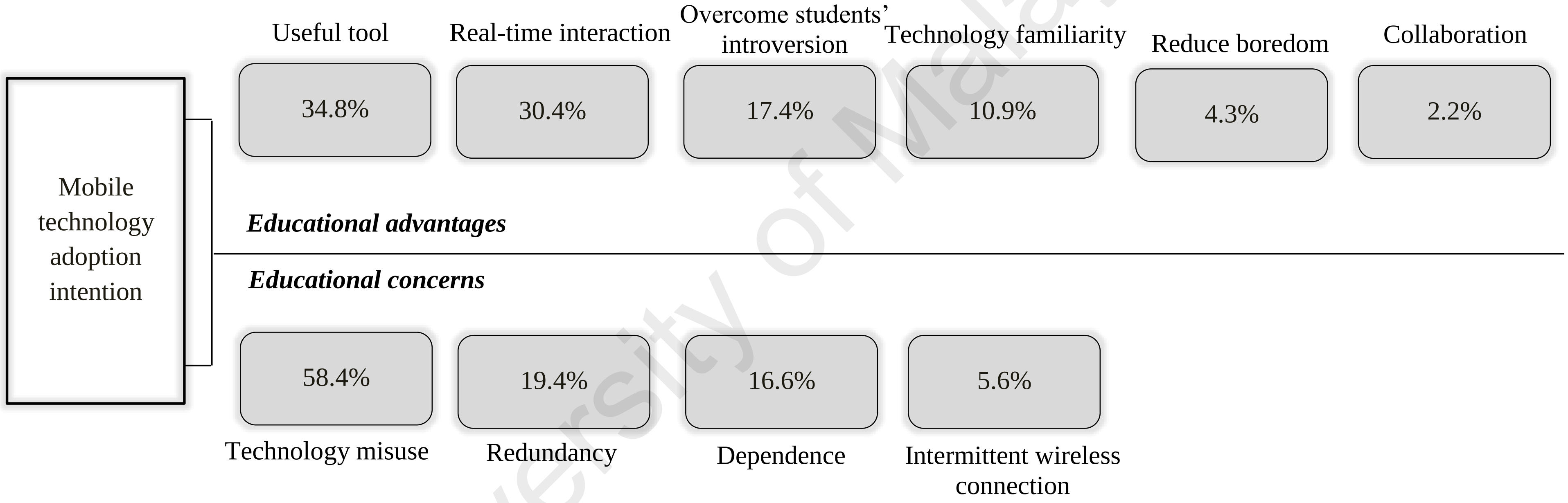

Figure 4.2: Results of the thematic analysis of mobile technology adoption intention

The perceived advantages and disadvantages of mobile technology usage in education were analysed and their associations to the IMMA framework's exogenous constructs were surmised. The following sections describe the implications of these finding.

(d) Features of Mobile Technology

Perceived usefulness and system quality were supported by the perceptions of mobile technology being useful for educational purposes, enabling instant messaging between students and lecturers, and enabling collaborations among the students. The findings theoretically established the importance of the qualities and usefulness of mobile technology, in particular the many popular mobile messaging applications today. Furthermore, the use of mobile messaging applications such as WhatsApp to enable users to interact with ease was deemed crucial and supportive of the applications' input-output processes and quality interface design (information quality). This includes the ability to send text messages, multimedia files (graphics and videos), and share documents. In addition, mobile messaging applications are built with creative emoticons that allow users to express their emotions when communicating. The contact list of popular messaging applications are also convenient to be updated and tracked. Taken together, features of mobile technology (perceptions of usefulness, system quality, and information quality) were conjectured to be important predictors of intentions, acceptance and usage of mobile technology, which were proven significant in studies of IS and technology acceptance (Hsu et al., 2014; Lin & Wang, 2012; Tsai et al., 2012).

(e) Intrinsic Motivations

Other advantages voiced by the respondents on the educational use of mobile technology focused on the tertiary students. The respondents believed that mobile technology can help students to overcome their shyness, lack of confidence, or language barriers and encourage them to interact with their peers and lecturers. Davidson, Gillies, and Pelletier (2015) argued students who are introverts face more challenges, and educators need to devise teaching strategies to encourage introvert students to actively participate in discussions and learning activities conducted. Voorn and Kommers (2013) put forth the benefits of using social media as the platform for introvert students to collaborate and engages in active discussions with their peers. Mobile learning was also found to facilitate learning among students with different personalities or characters (Shariffudin et al., 2012).

In addition, it was also thought that tertiary students today are adept at using mobile technology, and deviating from traditional teacher-centred teaching and learning approach may increase their interest and engagement behaviours in their studies. Coupled with the potential to reduce students' boredom in the classrooms and make learning fun, these findings supported the inclusion of the enjoyment construct. The popularity of mobile games, social networks and messaging services suggest that mobile users today place a lot of emphasis on the experience of joy or enjoyment when using mobile technology for leisure of communication purposes (Balakrishnan, Liew, & Pourgholaminejad, 2015; Deater-Deckard, Chang, & Evans, 2013; Giannakos, 2013). Students' mobile technology proficiency also reflects mobile users' confidence in their ability to learn and use new mobile technology, thus lending credence to the self-efficacy construct.

(f) ***Cultural Influence***

The potential for misuse of mobile technology among the students for non-learning purposes was perceived as the central disadvantage of promoting the use of the technology in the classrooms. The respondents also felt that mobile technology are not a suitable platform for student-lecturer interactions on serious academic matters. Another important concern voiced was the use of mobile technology for interactions may result students' dependency on the technology, and thus decreases opportunities for them to develop their communication skills which are perceived as important real-life skills to acquire during their tertiary years. Bearing in mind that none of the respondents were using mobile technology for teaching, and interacting with their students, the disadvantages voiced were the respondents' opinions, and did not come from actual experiences. Therefore, uncertainties relating to the feasibility of mobile technology for educational use were found prevalent among the respondents. Therefore, deep uncertainties was surmised to negatively impact mobile technology adoption intentions.

In sum, the respondents concurred that lack of interactions are common and the norm of large lecture classes, and this was surmised to reflect the practices of higher education in Malaysia. However, the majority of respondents did agree that mobile technology may help them to interact with their students more effective, and were open to the idea of using the technology. However, adoption concerns were voiced relating to the suitability of the technology to benefit teaching and learning endeavours, reflective of deep rooted uncertainties and reservations of the respondents toward mobile technology.

To summarize, observations of the selected large lecture classes revealed a clear finding: the lack of interactions between students and their lecturers. Respondents from the interviews concurred that lack of interactions during large lecture classes are typical and common, and thus accepted as the norm of large classes.

The majority of respondents did agree that mobile technology might increase student-lecturer interactions, and were open to the idea of using mobile technology to interact with their students. However, concerns were voiced by the respondents regarding use of mobile technology in the classrooms for enabling student-lecturer interaction, specifically the fear that students may misuse the technology for non-learning purposes and also cause the loss of concentration among the students.

The educational advantages of mobile technology support the IMMA framework's constructs of system quality, information quality, enjoyment, perceived usefulness, perceived ease of use, and self-efficacy. Perceptions of mobile technology as being useful for aiding teaching and learning, as well as for supporting student-lecturer interactions and collaborative works justify the inclusion of system quality and perceived usefulness. Furthermore, mobile technology such as mobile messaging applications enables real-time communication and the sharing of information (attributes of information quality). Students' technology savviness also lends credence to the enjoyment, perceived ease of use, and self-efficacy constructs. The potential of the technology for alleviating boredom in the classrooms, as well as enabling introverted students to interact are supportive of the enjoyment construct.

The concerns voiced by the respondents relating to mobile technology use yielded a strong support for the uncertainty avoidance construct. Major concerns or uncertainties regarding the suitability and effectiveness of using the technology in the classrooms were voiced. Generally, it is feared that using mobile technology in the classrooms may cause serious repercussions towards the students. Figure 4.3 shows the mapping of each supporting factor and concern of mobile technology adoption to the framework's constructs.

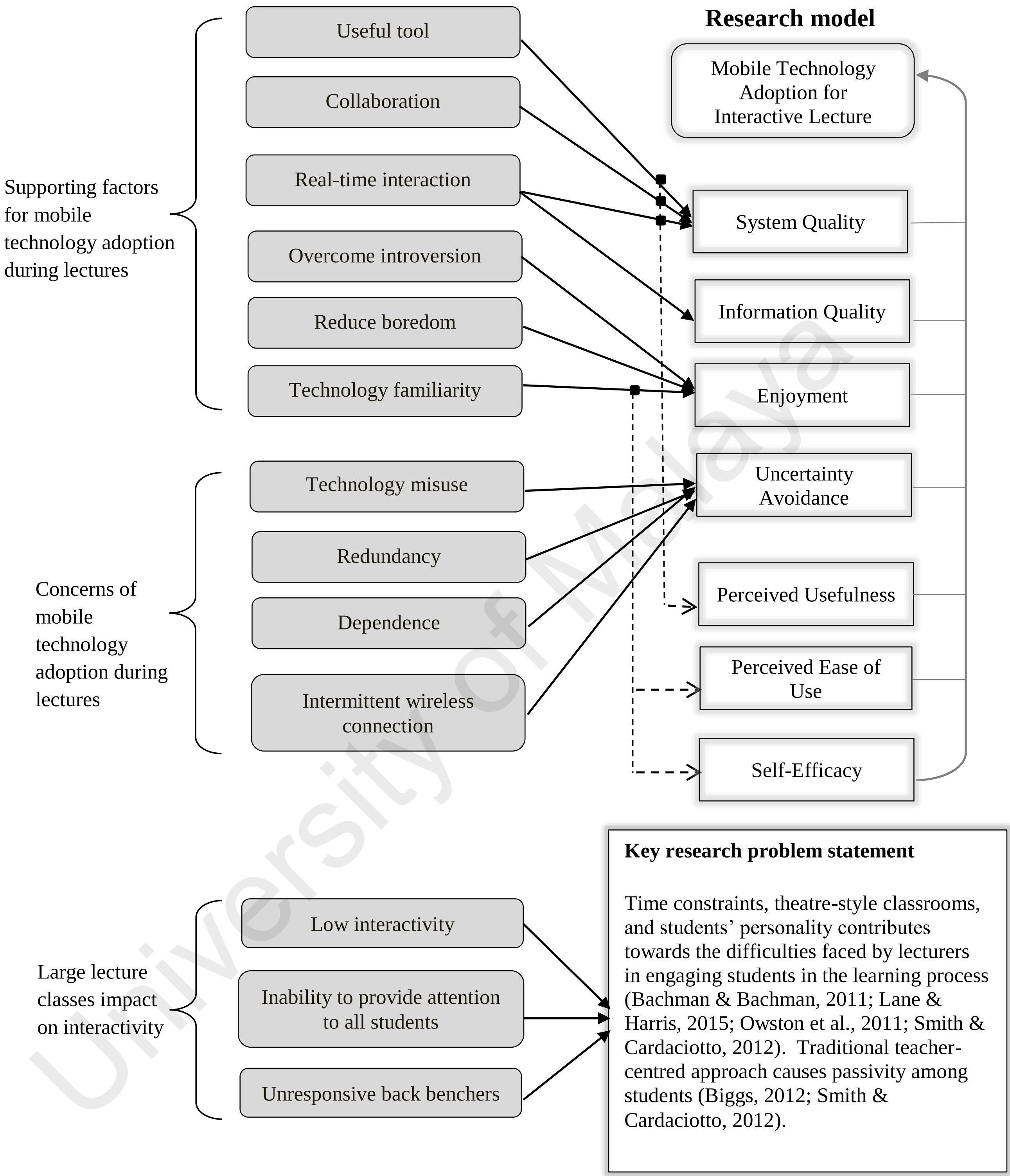

Figure 4.3: Mapping of supporting factors and concerns of mobile technology adoption to IMMA framework constructs

4.2 Quantitative Research

Following the qualitative research, a survey was distributed to tertiary students in Malaysia, designed to extract their perceptions of mobile technology based on the framework's constructs. Mainly, data collected were subjected to statistical analyses in order to measure the framework's consistency, reliability, and validity. Next, the study's theorized hypotheses were assessed and confirmed. Additional data analyses were conducted to examine the framework's predictive power, and the effect size and performance of significant exogenous constructs. The following sections describe the quantitative data analyses used.

4.2.1 Data Examination

Issues of missing data, suspicious response patterns, outliers, and data normality were addressed prior to descriptive and inferential analyses.

4.2.1.1 Missing Data

The study's data was collected via an online survey. Parameters were programmed to prevent respondents from skipping questions due to oversight. This ensured that respondents answered all the questions prior to submission. Hence, data collected from respondents have no missing values.

4.2.1.2 Suspicious Response Patterns

Each respondent's response pattern was examined to detect straight lining answers. The study's survey utilised a five-point Likert scale. As such, a response pattern of all 1s, 3s, or 5s detected is to be removed (Hair et al., 2014). A total of 396 responses were obtained at the end of the data collection period. A thorough examination of all the responses revealed a total of 68 responses with all 1s, 3s or 5s, which were subsequently removed. Answers for questions with slight variations using reflective measures were screened for consistency for the remaining 328 responses. No inconsistencies were detected.

4.2.1.3 Outliers

To determine the presence of outliers in the 328 remaining responses, the latent variable *z* scores of each response across all the latent constructs were extracted and examined, with absolute values of *z* scores above three indicating a univariate outlier (Kline, 2011). A multivariate outlier is a combination of uncommon scores on at least two variables (Kline, 2011). Both types of outliers can influence the outcome of subsequent statistical analyses. In the context of this study, the framework has eight latent constructs. Therefore, responses with scores above absolute values of three on more than 50% or above of the total constructs (four or more constructs) will be removed. Examination revealed only eleven responses with latent variable scores above absolute value three on one or two constructs only. Thus, they are retained and further examination is required.

All 328 responses were then subjected to further examination in an attempt to detect extreme responses. The indicators for each construct were measured using a Likert scale of 1 to 5. Diagnostics by means of boxplots using IBM SPSS Statistics 21 indicated the presence of outliers for each of the construct's indicators for Likert scale 1 and 2. Perceived usefulness (PU) has a total of 24 outlier cases (scale 2 – 13 cases, scale 1 – 11 cases), perceived ease of use (PEOU) has 19 outlier cases (scale 2 – 13 cases, scale 1 – 6 cases), self-efficacy (SE) has 18 outlier cases (scale 2 – 9 cases, scale 1 – 9 cases), enjoyment (EJ) has 26 outlier cases (scale 2 – 14 cases, scale 1 – 12 cases), system quality (SQ) has 15 outlier cases (scale 1), information quality (IQ) has 18 outlier cases (scale 2 – 3 cases, scale 1 – 15 cases), uncertainty avoidance (UA) has 4 outlier cases (scale 1), and lastly, adoption intention (AI) has a total of 14 outlier cases (scale 1).

However, it is inappropriate to directly discard the responses with outlier answers on the lower scale (out of norm) (Kline, 2011). To determine if the outliers will affect subsequent data analyses, the mean values and 5% trim mean values for each construct's indicators were extracted and compared, as presented in Table 4.7. The mean values and 5% trim values for all the indicators were very similar. Given this, the possibility of the outliers affecting future data analyses results are very small (Pallant, 2013). Thus, all outliers' responses were not discarded and retained.

Table 4.7: Indicators' mean and 5% of trim mean

Indicator	Mean	5% of trim mean
PU1	4.24	4.33
PU2	4.27	4.36
PU3	3.80	3.86
PU4	4.17	4.23
PU5	4.32	4.39
PEOU1	4.16	4.21
PEOU2	4.20	4.28
PEOU3	4.35	4.43
PEOU4	3.91	3.97
PEOU5	4.25	4.32
SE1	4.06	4.11
SE2	3.87	3.92
SE3	4.17	4.22
SE4	3.75	3.79
SE5	4.07	4.13
EJ1	4.24	4.32
EJ2	4.17	4.24
EJ3	3.95	4.02
EJ4	4.13	4.22
EJ5	4.22	4.29
SQ1	3.31	3.33
SQ2	3.36	3.37
SQ3	3.65	3.68
SQ4	3.89	3.95
SQ5	3.98	4.02
IQ1	3.75	3.79
IQ2	3.88	3.93
IQ3	3.82	3.87
IQ4	3.86	3.88
IQ5	4.02	4.07
UA1	2.86	2.84
UA2	2.81	2.79
UA3	3.06	3.07
UA4	3.29	3.33
UA5	3.07	3.08
AI1	3.73	3.76
AI2	3.37	3.39
AI3	3.39	3.41
AI4	3.59	3.61
AI5	3.68	3.71

4.2.1.4 Data Distribution

The framework has a total of 40 indicators. The kurtosis and skewness values of 35 of the indicators were within the -1 and +1 acceptable range (Hair et al., 2014; Kline, 2011). The exceptions were PU1 (skewness -1.3, kurtosis 2.0), PU2 (skewness -1.2, kurtosis 1.3), PEOU3 (skewness -1.2, kurtosis 1.6), EJ1 (skewness -1.2, kurtosis 1.3) and EJ4 (skewness -1.1, kurtosis 1.3), thus exhibiting a slight degree of non-normality. However, the degree of skewness and kurtosis are not severe, and the indicators are measuring the reflective constructs. The deviations from normality is not considered an issue, and as bootstrapping procedure performs fairly robustly when data are non-normal, the indicators are retained.

4.2.2 Descriptive Statistics

A total of 328 valid responses were used for descriptive and inferential analysis in this study. Table 4.8 tabulates the respondents' background details. IBM SPSS Statistics 21 was used to derive descriptive statistics of the respondents and research model's constructs.

4.2.2.1 Respondent Characteristics

The demographic details of the respondents is shown in Table 4.8. Average age of the respondents was 21 years old. Among the 328 respondents, the percentage of males (48.8%) and females (51.2%) was fairly proportional. Majority of the respondents are undergraduates (93.6%). The largest group of academic field of the respondents is information technology (30.2%), followed by management (28.0%).

Table 4.8: Demographic profile of respondents (n = 328)

		Frequency	Percentage
Gender	Male	160	48.8
	Female	168	51.2
Level of education	Postgraduate	21	6.4
	Undergraduate	307	93.6
Academic field	Information Technology	99	30.2
	Management	92	28.0
	Engineering	55	16.8
	Law	27	8.2
	Accountancy	24	7.3
	Sciences	15	4.6
	Social Science	7	2.1
	Humanities	3	0.9
	Architecture	3	0.9
	Language	2	0.6
	Education	1	0.3

Table 4.9 shows the type of mobile devices currently owned by the respondents. A large number of respondents (89.9%) owned smartphones, followed by laptops (78.0%). In terms of Internet accessibility using mobile devices, 271 (82.6%) are able to access the Internet via a cellular network. All respondents are able to access the Internet via WiFi connection on their mobile devices, and all respondents' higher learning institutions provided Wi-Fi. In terms of mobile devices usage, 309 (94.2%) of the respondents reported using their mobile devices for learning purposes (such as accessing learning materials, reading announcements or viewing timetable online).

Table 4.9: Respondents' mobile devices usage (n = 328)

			Frequency	Percentage
Type of mobile devices currently owned.	Mobile phone	Yes	154	47.0
		No	174	53.0
	Smart phone	Yes	295	89.9
		No	33	10.1
	Laptop	Yes	256	78.0
		No	72	22.0
	Netbook	Yes	85	25.9
		No	243	74.1
	Tablet	Yes	119	36.3
		No	209	63.7
	E-book reader	Yes	6	1.8
		No	322	98.2
Internet Access method using mobile devices	Via a cellular network	Yes	271	82.6
		No	57	17.4
	Via WiFi	Yes	328	100.0
		No	0	0.0
Higher learning institution provide WiFi connection		Yes	328	100
		No	0	0.0
Use mobile devices for learning purposes		Yes	309	94.2
		No	19	5.8

4.2.2.2 Construct Characteristics

Means, standard deviations and coefficient of variations of the constructs are presented in Table 4.10. Due to the nature of the data collection being self-reported, and exogenous and endogenous constructs' data were obtained from the same respondents, concerns regarding same-source bias or common method variance may arise (Podsakoff and Organ, 1986). However, each construct's coefficient of variation shows substantial variability. Further analysis to assess common method bias is described in section 4.2.3.2 (a).

Table 4.10: Descriptive of constructs

Construct	Code	Mean	Standard Deviation	Coefficient of Variation
Perceived Usefulness	PU	4.16	0.88	21%
Perceived Ease Of Use	PEOU	4.17	0.83	20%
Self-Efficacy	SE	3.99	0.86	22%
Enjoyment	EJ	4.14	0.91	22%
System Quality	SQ	3.64	0.89	24%
Information Quality	IQ	3.87	0.81	21%
Uncertainty Avoidance	UA	3.02	1.20	40%
Adoption Intention	AI	3.55	0.97	27%

4.2.3 Inferential Statistics

This study utilised the PLS-SEM approach, with the objective of maximizing the explained variance of the framework's endogenous construct (AI). SmartPLS Version 2.0.M3 was used to perform the PLS-SEM analysis. The analyses and interpretation of the results were done in three stages. In the first stage, all constructs' items were assessed using EFA to determine the underlying grouping of all the constructs' items. Though EFA is commonly used for studies when researchers have no priori hypotheses, its applicability for this study is still relevant for verifying the IMMA framework structure.

The second stage was the testing of the measurement model internal consistency and reliability, convergent validity, and discriminant validity by using CFA. The second stage was the assessment of the structural model for hypotheses testing. Structural model evaluations of the exogenous constructors' collinearity, size and significance of path coefficients, predictive power and relevance of the endogenous construct, and effect size of the significant exogenous constructs were examined.

Post hoc power analysis was conducted next to determine the power of the framework, specifically the framework's endogenous construct. Finally, advanced analysis to estimate the robustness of the results using IPMA was then conducted in order to strengthen the arguments of the findings in two dimensions of importance versus performance.

4.2.3.1 Exploratory Factor Analysis

All constructs' items were assessed by using EFA via principal component analysis (PCA) with Varimax rotation using IBM SPSS Statistics 21. The Kaiser-Meyer-Olkin measures of sampling for independent and dependent variables were 0.933 and 0.812 respectively, indicating that the sample size is adequate for factor analysis (Malhotra, 1999). The Bartlett's test of sphericity results for both independent (x^2 = 8482.66, *df* = 595, $p < 0.001$) and dependent (x^2 = 789.04, *df* = 10, $p < 0.001$) variables are significant. All items measuring the independent and dependent variables have communalities above 0.50, and are thus included in the analysis (Malhotra, 1999).

The 35 items measuring the independent variables were grouped into seven factors with eigenvalues above 1.0, and explains 71.37% of the total variance. This exactly matches the seven exogenous constructs in the IMMA framework. All five items measuring the dependent variable can be grouped into only one factor with eigenvalues greater than 1.0, and explains 64.13% of the total variance. Majority of the factor loadings of the variables' items exceeded 0.4, thus fulfilling the significant level of construct validity, with the exception of items SE4, SQ4, and SQ5 (Malhorta, 1999; Michael & Uzoka, 2008). However, minor variability in the loadings are expected for self-reported surveys (Malhorta, 1999), therefore the items were further analysed for reliability and validity, with the results presented in the following sections.

Table 4.11 tabulates the factor loadings of the variables' items.

Table 4.11: Factor analysis for independent and dependent variables

	Independent variables							**Dependent variable**
	Perceived Usefulness	Perceived Ease of Use	Information Quality	Uncertainty Avoidance	Enjoyment	Self-Efficacy	System Quality	Adoption Intention
PU1	0.794							
PU2	0.809							
PU3	0.622							
PU4	0.716							
PU5	0.728							
PEOU1		0.643						
PEOU2		0.601						
PEOU3		0.684						
PEOU4		0.474						
PEOU5		0.643						
SE1						0.618		
SE2						0.75		
SE3						0.507		
SE4						0.330		
SE5						0.582		
EJ1					0.621			
EJ2					0.674			
EJ3					0.733			
EJ4					0.748			
EJ5					0.682			

Table 4.11 continued

	Independent variables							Dependent variable
	Perceived Usefulness	Perceived Ease of Use	Information Quality	Uncertainty Avoidance	Enjoyment	Self-Efficacy	System Quality	Adoption Intention
SQ1							0.799	
SQ2							0.788	
SQ3							0.553	
SQ4							0.319	
SQ5							0.295	
IQ1			0.672					
IQ2			0.65					
IQ3			0.827					
IQ4			0.817					
IQ5			0.769					
UA1				0.817				
UA2				0.867				
UA3				0.875				
UA4				0.876				
UA5				0.911				
AI1								.717
AI2								.737
AI3								.830
AI4								.861
AI5								.847

4.2.3.2 Confirmatory Factor Analysis

All the constructs in the framework were measured by five indicators each, and are reflective in nature. The constructs were assessed for internal consistency, individual indicator reliability, and average variance extracted (AVE) to evaluate convergent validity. Fornell-Larcker criterion and cross loadings were used to assess discriminant validity. Prior to the measurement model assessments, Harman's single factor and inter-constructs' correlation were examined for evidence of common method bias.

(a) ***Common Method Bias***

Common method bias was examined using Harman's single factor (Podsakoff and Organ, 1986), and examination of inter-constructs' correlations. Unrotated principal component factor analysis, PCA with Varimax rotation, and principal axis analysis with Varimax rotation all revealed the presence of eight distinct factors with eigen values greater than 1.0, rather than a single factor. Taken together, all eight factors accounted for 71.2% of the total variance. The largest variance (first factor) is 38.2% (less than 50.0%). The results proved that neither a single factor nor a general factor accounts for the majority of the covariance in the measures.

Extremely high correlations between the constructs ($r > 0.90$) (Bagozzi, Yi, & Phillips, 1991) are indicative of common method bias. The correlation matrix (refer section 4.2.3.2 (d) and table 4.15) shows the correlations among the constructs, with the highest correlation value of 0.777 (< 0.90). While the results of both analyses do not prevent the occurrence of common method bias, they are indicative that common method bias is not a serious problem, and are unlikely to affect the interpretations of results in this study.

(b) ***Internal Consistency Reliability***

In quantitative data analyses, reliability represents the degree of consistency among the indicators of a latent construct (Hair et al., 2014). The indicators' reliability in this study were assessed by examinations of the inter-item correlations and item-to-total correlations. Inter-item correlations examined the degree to which scores on one item are related to scores on all other items in a scale. Item-to-total correlations above 0.5 and inter-item correlations above 0.3 are indicative of the reliability of the measurement (Robinson, Shaver, & Wrightsman, 1991). Table 4.12 tabulates the inter-item correlations and item-total correlation of each construct's indicators. All the inter-item correlations are above 0.3 and all item-total correlations are above 0.50, indicative of the reliability of the measurement scale.

Table 4.12: Inter-item and item-to-total correlations

Inter-Item Correlation Matrix						**Item-Total correlation**
	PU1	PU2	PU3	PU4	PU5	
PU1	1					0.720
PU2	0.685	1				0.790
PU3	0.517	0.627	1			0.634
PU4	0.570	0.658	0.501	1		0.700
PU5	0.636	0.614	0.509	0.625	1	0.711
	PEOU1	PEOU2	PEOU3	PEOU4	PEOU5	
PEOU1	1					0.739
PEOU2	0.606	1				0.703
PEOU3	0.621	0.648	1			0.749
PEOU4	0.542	0.461	0.536	1		0.609
PEOU5	0.702	0.665	0.691	0.567	1	0.795
	SE1	SE2	SE3	SE4	SE5	
SE1	1					0.710
SE2	0.595	1				0.659
SE3	0.669	0.580	1			0.767
SE4	0.443	0.401	0.563	1		0.584
SE5	0.661	0.653	0.701	0.597	1	0.806
	EJ1	EJ2	EJ3	EJ4	EJ5	
EJ1	1					0.683
EJ2	0.689	1				0.733
EJ3	0.409	0.479	1			0.595
EJ4	0.615	0.623	0.631	1		0.804
EJ5	0.624	0.682	0.535	0.774	1	0.790

Table 4.12 continued

Inter-Item Correlation Matrix						Item-Total correlation
	SQ1	SQ2	SQ3	SQ4	SQ5	
SQ1	1					0.584
SQ2	0.607	1				0.571
SQ3	0.465	0.526	1			0.697
SQ4	0.405	0.321	0.608	1		0.638
SQ5	0.357	0.336	0.550	0.683	1	0.605
	IQ1	IQ2	IQ3	IQ4	IQ5	
IQ1	1					0.686
IQ2	0.586	1				0.707
IQ3	0.595	0.582	1			0.756
IQ4	0.659	0.705	0.756	1		0.857
IQ5	0.528	0.559	0.637	0.720	1	0.711
	UA1	UA2	UA3	UA4	UA5	
UA1	1					0.744
UA2	0.806	1				0.807
UA3	0.611	0.680	1			0.800
UA4	0.582	0.633	0.761	1		0.791
UA5	0.656	0.720	0.771	0.824	1	0.852
	MTAI_IL1	MTAI_IL2	MTAI_IL3	MTAI_IL4	MTAI_IL5	
MTAI_IL1	1					0.586
MTAI_IL2	0.571	1				0.606
MTAI_IL3	0.425	0.486	1			0.706
MTAI_IL4	0.455	0.464	0.735	1		0.745
MTAI_IL5	0.493	0.488	0.634	0.732	1	0.732

To further examine the reliability of the reflective constructs, all constructs' Cronbach's alphas (CA) were screened. They provide an estimation of the reliability based on the inter-correlations of the observed indicator variables. PLS-SEM prioritizes the indicators based on their individual reliability. CA values of 0.62 to 0.95 are acceptable for exploratory studies (Nunnally, 1978). However, CA is sensitive to the number of items in the scale, and is generally viewed as a conservative measure of internal consistency reliability. Due to its limitation, composite reliability (CR) which takes into account the different outer loadings of the indicators is considered a more rigorous reliable assessment method (Fornell & Larcker, 1981; Gefen, Straub, & Boudreau, 2000).

Composite reliability values of above 0.7 are deemed desirable (Fornell & Larcker, 1981; Gefen, Straub, & Boudreau, 2000; Segars, 1997). Table 4.13 shows the CA of each construct to be between 0.62 and 0.95, and CR is above 0.70. In sum, results from correlation analysis and reliability measures affirm the reliability of all the reflective constructs in the framework.

Table 4.13: CA and CR of the constructs

Construct	CA	CR
PU	0.859	0.898
PEOU	0.885	0.916
SE	0.896	0.924
EJ	0.884	0.915
SQ	0.880	0.912
IQ	0.876	0.911
UA	0.825	0.877
AI	0.923	0.939

(c) ***Convergent Validity***

Indicators' outer loadings above 0.7 (Nunnally, 1978), and are statistically significant indicate adequate convergent validity. In addition, AVE values exceeding 0.5 suggest satisfactory convergent validity (Bagozzi & Yi, 1988; Fornell & Larcker, 1981). Table 4.14 tabulates all indicators' loadings and their respective *t*-values. Most indicators are significant and highly loaded on their proposed construct (above 7.0), with the exception of SQ1 (0.695) and SQ2 (0.688). However, weaker outer loadings in exploratory studies are frequently observed (Hulland, 1999). As SQ1 and SQ2 loadings are almost 0.70, SQ's CR and AVE were examined. Both CR (0.912) and AVE (0.589) are above the suggested threshold values. In consideration of the content contribution of SQ1 and SQ2 for the SQ construct, both SQ1 and SQ2 were retained in subsequent analyses.

Table 4.14: Item loadings and AVE of the constructs

Constructs / Indicators	Item loading	*t*-value	AVE
Perceived Usefulness			**0.676**
PU1	0.810	26.540	
PU2	0.876	59.629	
PU3	0.762	22.864	
PU4	0.824	30.770	
PU5	0.833	34.832	
Perceived Ease of Use			**0.685**
PEOU1	0.841	40.132	
PEOU2	0.825	26.748	
PEOU3	0.844	31.740	
PEOU4	0.730	20.894	
PEOU5	0.890	66.648	
Self-Efficacy			**0.672**
SE1	0.823	35.195	
SE2	0.776	24.015	
SE3	0.867	53.118	
SE4	0.729	19.846	
SE5	0.892	54.032	
Enjoyment			**0.688**
EJ1	0.804	25.449	
EJ2	0.846	37.098	
EJ3	0.726	20.448	
EJ4	0.883	59.681	
EJ5	0.879	29.862	
System Quality			**0.589**
SQ1	0.695	14.666	
SQ2	0.688	15.690	
SQ3	0.839	37.560	
SQ4	0.819	35.638	
SQ5	0.784	26.801	
Information Quality			**0.708**
IQ1	0.798	30.009	
IQ2	0.822	30.800	
IQ3	0.847	41.366	
IQ4	0.918	87.888	
IQ5	0.816	30.903	
Uncertainty Avoidance			**0.756**
UA1	0.781	8.580	
UA2	0.826	9.573	
UA3	0.901	18.878	
UA4	0.901	17.664	
UA5	0.929	18.670	

Table 4.14 continued

Constructs / Indicators	Item loading	*t*-value	AVE
Adoption Intention			**0.640**
AI1	0.733	25.437	
AI2	0.723	19.224	
AI 3	0.814	32.837	
AI4	0.861	44.302	
AI 5	0.858	52.360	

(d) ***Discriminant Validity***

Detailed inspection of the cross loadings provided evidence for the constructs' discriminant validity as each indicator has the highest value for the loading with its corresponding construct, while cross loadings with other constructs are lower.

Table 4.15 shows the final results of the Fornell-Larcker criterion assessment with the square root of the reflective constructs' AVEs on the diagonal, and the correlations between the constructs in the lower left triangle. Overall, square roots of the AVEs for the reflective constructs of AI (0.800), EJ (0.829), IQ (0.841), PEOU (0.828), PU (0.822), SE (0.820), SQ (0.767) and UA (0.869) are all higher than the correlations of these constructs with other latent variables. Cross loadings and Fornell-Larcker criterion thus confirmed the discriminant validity of the constructs.

Table 4.15 also concludes the results of the measurement model assessment using CFA. To review, all assessments' criteria were met, providing concrete evidences of the framework's reliability and validity.

Table 4.15: Correlation matrix of, CA, CR and AVE of the constructs

	Correlation of constructs										
Constructs	AI	EJ	IQ	PEOU	PU	SE	SQ	UA	**CA**	**CR**	**AVE**
AI	**0.800**								0.859	0.898	0.640
EJ	0.552	**0.829**							0.885	0.916	0.688
IQ	0.570	0.551	**0.841**						0.896	0.924	0.708
PEOU	0.475	0.727	0.534	**0.828**					0.884	0.915	0.685
PU	0.465	0.627	0.502	0.763	**0.822**				0.880	0.912	0.676
SE	0.511	0.714	0.624	0.777	0.672	**0.820**			0.876	0.911	0.672
SQ	0.569	0.541	0.700	0.517	0.448	0.571	**0.767**		0.825	0.877	0.589
UA	0.178	0.122	0.111	0.083	0.090	0.081	0.097	**0.869**	0.923	0.939	0.756

Note: Items on the diagonal (bold) are square roots of the AVEs while the off-diagonals are correlations

4.2.3.3 Structural Model Assessment

This section presents the assessment of the structural framework results. The research model's predictive capabilities and the relationships between the constructs were examined. Each exogenous construct (PU, PEOU, SE, EJ, SQ, IQ, and UA) was assessed for its influence towards the endogenous construct (AI). In other words, perceived usefulness, perceived ease of use, self-efficacy, enjoyment, system quality, information quality, and uncertainty avoidance were tested for their effects on adoption intention of mobile technology to promote student-lecturer interactions.

(a) Collinearity Assessment

Prior to structural analyses, collinearity diagnostics in the structural model needed to be examined. Path coefficients might be bias if structural estimations involve significant level of collinearities among the exogenous constructs (Hair et al., 2014). To assess the collinearities, tolerance and variance inflation factor (VIF) were determined. Tolerance value of 0.20 or lower, and VIF value of 5 or higher are suggestive of potential collinearity problems (Hair et al., 2011). A linear regression for construct EJ, IQ, PEOU, PU, SE, SQ and UA as predictors of AI was run using IBM SPSS Statistics 21. Table 4.16 shows the tolerance and VIF values of the collinearity assessment.

Table 4.16: Collinearity assessment

	Tolerance	VIF
EJ	0.406	2.466
IQ	0.438	2.286
PEOU	0.281	3.564
PU	0.411	2.435
SE	0.320	3.124
SQ	0.485	2.064
UA	0.980	1.020

The collinearity analysis shows that the collinearity indicators – tolerance levels above 0.2, and the VIF values are clearly below the threshold of 5. Therefore, collinearities among the predictor constructs are not an issue in the structural framework.

(b) ***Hypotheses Test***

Estimates for the structural model are obtained (path coefficients and *t*-values) to test the hypothesized relationships among the constructs. Table 4.17 presents the results of the hypothesis test.

Table 4.17: Results of hypothesis test

Hypothesis		Beta (β)	*t*-value	*p*-value
H1	SQ → AI***	0.243	3.728	0.000
H2	IQ → AI **	0.212	3.355	0.001
H3	PU → AI	0.114	1.765	0.078
H4	PEOU → AI	-0.053	0.569	0.570
H5	EJ→ AI ***	0.243	3.522	0.000
H6	SE → AI	0.024	0.315	0.753
H7	UA → AI *	0.094	2.099	0.037

Note: *p < 0.05, **p < 0.01, ***p<0.001

Results from the evaluations of the hypotheses revealed that all predictors, except for PEOU, are positively related to AI, explaining a total of 44.9% of the variance in AI. Constructs that significantly influence AI are SQ, IQ, EJ, and UA. However, UA is the weakest predictor (β = 0.094, *t*-value = 2.099, $p < 0.05$). Though it is significant, its coefficient value (Beta) is lower than the acceptable value of 0.1 (Lohmoller, 2013), thus contributing a very small influence towards predicting AI. SQ, IQ, and EJ on the other hand are strong predictors, with SQ (β = 0.243, *t*-value = 3.728, $p < 0.001$) emerging as the strongest significant predictor, followed by EJ (β = 0.243, *t*-value = 3.522, $p < 0.001$), and IQ (β = 0.212, *t*-value = 3.366, $p < 0.01$). Therefore, hypotheses H1, H2, H5, and H7 are supported.

(c) ***Predictive Accuracy, Relevance, and Effect Size***

To evaluate the predictive accuracy of the structural model's endogenous construct, the coefficient of determination, R^2 value was determined. The R^2 of the AI construct is 0.499, which evaluates to substantial predictive power (Cohen, 1988). Referring to stricter threshold evaluations, R^2 value of 0.499 also represents moderate predictive power (Chin, 1998; Hair et al., 2011; Henseler, 2010).

The effect sizes of SQ, IQ, and EJ are 0.049, 0.033, and 0.038 respectively. Based on Cohen's (1988) effect size assessment, individually, SQ, IQ and EJ have relatively small effect size on AI. The effect size of UA is 0.013, below the threshold of Cohen's small (1988) effect size, thus confirming the very small influence of UA on AI based on its small path coefficient value (below 0.1) despite being significant at $p < 0.05$.

The Q^2 value for the endogenous construct AI is 0.272. It is clearly above zero, and is above the medium threshold suggested by Hair et al. (2014). Thus, AI's predictive relevance is estimated to be medium in strength. Figure 4.4 depict the results from the measurement framework assessment (CFA) and the structural framework assessment using PLS-SEM.

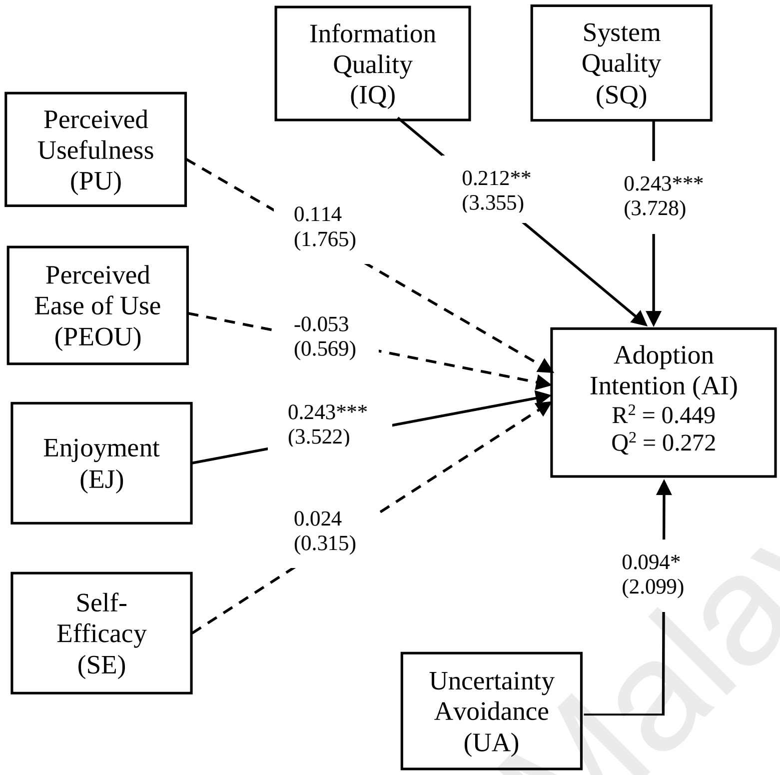

Figure 4.4: IMMA framework's measurement and structural analyses results

Note. *p < 0.05, **p < 0.01, ***p<0.001, t-values in parentheses. Dashed paths are not significant

4.2.3.4 Importance-Performance Matrix Analysis

Structural model assessment focuses on the coefficients (direct, indirect, and total effects) of each construct. IPMA, a map-based assessment is used to extend the findings of the structural model by including the actual performance of each predictor construct (Hock, Ringle, & Sarstedt, 2010; Rigdon et al., 2011; Volckner et al., 2010). The analysis adds an additional dimension that includes the constructs' average index values. Results from the structural model's total effects (importance), and the average index values (performance) of the constructs were compared to determine priority constructs and highlight significant areas of improvement. Table 4.18 presents the index values of the exogenous constructs in the structural model, as well as the total effects of the predictor constructs.

Table 4.18: Total effects and index values of AI

Constructs	Importance (Total effects)	Performance (Index values)
SQ	0.243	66.713
EJ	0.243	78.870
IQ	0.212	71.674
PU	0.114	79.469
UA	0.094	50.765
SE	0.024	75.093
PEOU	-0.053	79.788

As shown in figure 4.5, comparisons between the predictors of AI yielded a clear finding: both SQ and EJ have the highest importance and performance results. Interestingly, though SQ significant is higher (*t*-value = 3.728) than EJ (*t*-value = 3.522), EJ has the highest performance level. This underscore the equal prominence of both SQ and EJ as strong determinants of AI. Equally important is IQ, which has the second highest significant performance. UA has very little influence on AI based on its low importance and performance level, despite its significance. Notably, PU, SE, and PEOU have higher performance levels despite not being significant. In retrospect, if the PU, PEOU, and SE's importance are found significant, it will increase the predictive power of AI, and thus merits attention in future studies.

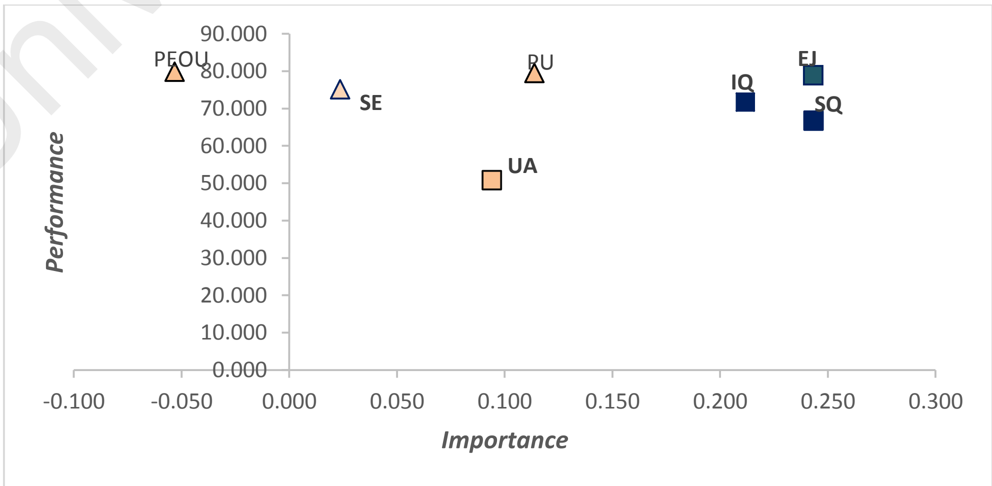

Figure 4.5: Importance-performance map for mobile technology adoption intention for interactive lecture

4.2.3.5 Discussion

The IMMA framework has seven hypotheses, developed to test the predictors of students' intentions to use mobile technology to interact with their lecturers. The hypotheses and summary of the findings obtained are depicted in table 4.19 below.

Table 4.19: Hypotheses and summary of the findings for the predictors of mobile technology adoption intention

Hypothesis		Decision
H1	System quality is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.	Supported
H2	Information quality is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.	Supported
H3	Perceived usefulness is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.	Not supported
H4	Perceived ease of use is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.	Not supported
H5	Enjoyment is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.	Supported
H6	Self-efficacy is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.	Not supported
H7	Low level of uncertainty avoidance is positively associated with adoption intention of mobile technology for aiding student-lecturer interactions.	Supported

However, contrary to the findings from past and recent literature on technology acceptances, perceived usefulness, perceived ease of use, and self-efficacy were found not significant, resulting in the rejection of hypotheses H3, H4, and H6. Taken together, the framework's predictive accuracy (and the amount of variance in adoption intention construct explained by all its exogenous constructs) was evaluated, and findings proved substantial predictive power (R^2 = 0.499). In addition, the framework was found to possess moderate predictive relevance (Q^2 = 0.272). Therefore, objective two was achieved.

Overall, the findings appeared to strongly support system quality, information quality, and enjoyment as strong predictors students' behavioural intentions, with uncertainty avoidance having a small influence, whilst TAM's perceived ease of use and perceived usefulness, and self-efficacy from social cognitive theory were found not significant. The following sections will discussed the hypotheses' findings.

4.2.3.6 Features of Mobile Technology – Perceived Usefulness, System Quality and Information Quality

Studies on technology acceptances in a multitude of fields have generally emphasized the importance of factors such as perceived ease of use, perceived usefulness, as well as intrinsic factors of self-efficacy and enjoyment in recent years. Nevertheless, DeLone and McLean's (1992) IS success model has gained prominence in recent years and widely validated in studies of IS acceptances (Hsu et al., 2014; Petter et al., 2008, 2013; Rai et al., 2002; Seddon, 1997; Wang & Liao, 2008; Wu & Wang, 2006). Two key constructs in the model are system quality and information quality, antecedents of system use and user satisfaction. Though both constructs' significance are undisputable, they are not posited as direct predictors of IS acceptance in the model. System quality and information quality were given much more focus when it comes to design and development of sophisticated information systems, for instance an enterprise resource planning and decision support system (Olson & Staley, 2012; Van Valkenhoef et al., 2013). Considerations and focus on the analysis and design efforts, bearing in mind that essential qualities such as reliability, accuracy, relevancy, flexibility and timeliness are essential.

In addition, reviews of literature failed to produce related studies examining the significance of information quality and system quality as predictors of mobile technology acceptance, particular in the field of higher education in Malaysia. Therefore, to fulfil this gap in the literature, both constructs were posited as direct antecedents to predict students' intention to use mobile technology to aid interactions with their lecturers. Considering that the present findings found both system quality and information quality to be strong predictors of tertiary students' adoption intentions, inferences can be made relating to the importance of the qualities of mobile applications.

For instance, mainstream messaging applications successfully expanded their reach across the general landscape of mobile users by integrating functionalities that go beyond merely enabling sending and receiving of messages. Attributes of superior system qualities of mobile messaging applications such as Facebook Messenger enable users to not only send text and multimedia messages, but also added functionalities from voice and video calls to games connectivity. Most importantly, messaging applications such as WeChat have integrated innovative features that goes beyond the traditional scope of messaging application, through the integrated of transport booking and mobile payment services, in addition to enabling mobile commerce and mobile banking (Yeung, 2015).

In addition, clarity of input instructions, minimal and ease of inputs with the implementation of predictive text input, coupled with the clarity and brevity of the output produced added to the appeal and mass adoption of such applications. Furthermore, mobile developers are increasingly focusing on the messaging applications' interface designs, specifically on the user input that allows user to manipulate the application, and the output to indicate the effects of the users' manipulation (Dunn, 2015). With constraints such as mobile devices' screen size, and the short attention span of mobile users (Spence & McKenzie, 2014), a user-friendly and understandable interface design are essential.

The proven significance of the system quality and information quality construct to predict tertiary students' intentions to use mobile technology to interact with their lecturers, point strongly to the importance of both construct in future studies of mobile technology acceptances. This is especially more vital, given the proliferation of various Web 2.0 and mobile applications in education. A study conducted by Adobe Systems among 102 educators from Southeast Asia, including Malaysia, found that majority of the educators surveyed believed that technological tools are important to foster students' creativity (Adobe Systems, 2013). With a multitude of educational tools to choose from, it is believed that chief selection factors will centre on the functionalities, interface designs, and input-output characteristics.

The perceived usefulness construct measures the respondents' beliefs that using mobile technology would promote and ease student-lecturer interactions. Together with perceived ease of use, numerous studies over the years have proven the importance of perceived ease of use and usefulness in determining behavioural intentions (Calisir et al., 2014; Padilla-Meléndez et al., 2013; Tarhini et al., 2014b). Contrary to findings from the literature, the present study failed to demonstrate the significance of perceived usefulness to influence students' intentions to use mobile technology to interact with their lecturers. The weak strength and insignificance of the construct indicates that despite the usefulness and convenience of mobile technology for enabling interactions, it does not increase students' intentions to use the technology to interact with their lecturer. Similar findings were reported by Woodcock, Middleton, and Nortcliffe (2012). Their study found that students generally are unaware of the potential of their smartphones and mobile applications' potential to support learning. Tossell et al. (2014) investigated the perceptions of students that have never used smartphones regarding the usefulness of iPhones to support learning. Findings revealed students perceptions that the devices actually restricted their learning abilities. Gikas and Grant (2013) found that despite the usefulness of mobile technology, students were frustrated when lecturers do not incorporate the use of mobile technology in classes. In addition, students' perceived that mobile technology was more suited for leisure purposes and unsuitable for supporting learning (Gikas & Grant, 2013). Though the majority of the respondents (94.2%) are already using mobile technology for learning purposes, the perceived uncertainties demonstrated by the respondents (students) in this study reflect a certain degree of doubt regarding the usefulness of mobile technology to enhance student-lecturer interactions. Mainstream mobile messaging applications are designed for informal conversations. Therefore, students' may not perceive such messaging applications' to be suitable for meaningful interactions on educational issues with their lecturers, compared to conventional means of communication such as email.

4.2.3.7 Personal Motivations – Enjoyment and Self-Efficacy

Gefen and Straub (2000) asserted that extrinsic motivations have a stronger impact on user acceptance of an information system than intrinsic motivations. Numerous studies have contradicted this supposition and proved the importance of enjoyment and self-efficacy in educational technologies (Giesbers et al., 2013; Sarwar et al., 2014). The significance of perceived playfulness, an intrinsic motivation to perform a behaviour for pleasure and enjoyment, was demonstrated to predict acceptance of educational technologies (Padilla-Meléndez et al., 2013; Teo & Noyes, 2011; Wu & Gao, 2011). Results obtained from the hypotheses tests affirm the vital influence of enjoyment to predict students' adoption intention, which measures the degree of pleasure or joy that comes from using mobile technology. Notably, enjoyment was noted to be a stronger predictor than information quality and system quality.

This may reflect the characteristics of the younger generation of mobile users that tend to seek instant gratification when it comes to technology use (Spence & McKenzie, 2014), and is indicative of the possibility that though mobile technology are beneficial in the classrooms as instructional tools, if it does not excite the students or contain elements that promotes enjoyment, behavioural intentions may reduce as a consequence. Popularity of mobile messaging applications also hinges on their ability to allow users to express their emotions, and provide an avenue for users to pass time in a meaningful way (Singh, 2014). The complexity of Facebook features have not deterred many from using it, and may reflect enjoyment as an influential factor. Research conducted proved that Facebook remains the most popular choice of social media platform (Balakrishnan, 2014; Balakrishnan, Liew, & Pourgholaminejad, 2015; Duggan et al., 2015). This can be attributed to the fact that the quality and variety of services bring an element of fun and excitement for its user.

The popularity of online mobile games are also testament to the importance of the enjoyment attribute for mobile users today. The advent of mobile games was positioned as one of the key factors that contributed to the exponential rate of mobile usage, and globally, the industry generated 7.8 billion U.S. dollars revenue in 2012 and the figure is expected to grow to more than 12.6 billion by 2016 in the United States (Statista, 2016), with worldwide revenue amounting to 28.2 billion U.S. dollars (SuperData, n.d.). There are also growing awareness of the potential benefits in using digital games in education. Lecturers can capitalize on various popular gaming platforms for higher education to create a learning environment that not only supports students' creativity and self-learning capabilities, but also provide opportunities for playtime during the learning process (Buck, 2013). The ability of game-based mobile applications to stimulate students' interest in their learning is huge. Researchers have conducted experimental studies to test the efficacy of game-based learning, and the benefits for the students were highlighted. Among others, Sun and Hwang (2013) incorporated a collaborative game based learning environment to facilitate the students to share and organized knowledge gained during the game-playing, and the results of their experiment pointed to the benefits of improving students' learning attitudes and motivation, and also improved their learning achievements and confidence. Similar experimental findings were also obtained by

Hwang et al. (2012), whereby personalized educational computer games promoted students' learning motivations and their academic achievements. Therefore, consistent with our prediction, enjoyment construct is vital, particularly when predicting mobile technology adoption intentions, and actual usage for teaching and learning purposes.

Another intrinsic motivator that was hypothesized to predict adoption intentions in this study is self-efficacy. It is noted that self-efficacy differs from perceived ease of use. Perceived ease of use denotes users' perceptions of how easy it will be to use mobile technology, while self-efficacy represents users' level of confidence in their capabilities to use new mobile devices and applications. Therefore, a technology may not be perceived as being easy to use, but users with confidence in their ability to learn and use complicated systems may drive behavioural intentions and actual usage. Studies on educational technologies' acceptance proved the positive influence self-efficacy (Holden & Rada, 2011; Kelly, 2014; Lee & Lehto, 2013; Tarhini et al., 2013). In spite of these studies' findings, self-efficacy was not positively associated with intentions to adopt mobile technology in this study. Though the level of self-efficacy among the respondents was above average (mean value of 3.99), findings revealed self-efficacy as the construct with the lowest strength and importance, therefore insignificant. This contradicted studies that proved the importance of self-efficacy (Holden & Rada, 2011; Kelly, 2014; Park et al., 2012; Tarhini et al., 2014b). The respondents' young age group (average age was 21 years old), and the existing use of mobile technology in their everyday life may have contributed to the irrelevance of self-efficacy. Respondents surveyed owned at least one mobile device, and a large percentage of them owned smartphones (89.9%), and were already using mobile technology for learning purposes (94.2%). Therefore, the issue of confidence in their ability to use mobile technology is conjectured to be no longer relevant to predict adoption intentions of mobile technology for interaction purposes. Instead, rather than self-efficacy, more emphasis were shown towards other intrinsic factors, such as enjoyment.

4.2.3.8 Cultural Influence - Uncertainty Avoidance

Malaysian society in general scores a 36 on this dimension in their study, indicating that members of the society at large has a low uncertainty level (Hofstede et al., 2010). This denotes a tolerance for ambiguities, and deviations from accepted norms are more easily tolerated. Low level of uncertainties toward mobile technology are therefore surmised among mobile users in Malaysia. Evidence supporting this assumption was based on the findings from the Malaysian Communications and Multimedia Commission (MCMC) survey in 2014. Key findings were the estimation of at least 10 million smartphone users in Malaysia (total population in 2014 was approximately 30 million), with the majority of them in the aged group of 20 – 24 years old (24.5%) (MCMC, 2014). MCMC's (2014) survey also showed that the number of smartphone users are projected to increase in the coming years, whilst traditional feature phones ownership decreases.

Tertiary students that participated in the survey exhibited low level of uncertainty avoidance level, thus reflecting Hofstede et al.'s (2010) findings. Various studies have proven that low uncertainty avoidance significantly influence users' perceptions and predict behavioural intentions pertaining to technology adoption and usage (Al-Hujran et al., 2015; Cyr, 2013, Kim et al., 2013; Park et al., 2014b). However, reviews of literature also provided empirical evidence of the insignificance of uncertainty avoidance as predictor of technology acceptance (Capece et al., 2013). Results obtained in this study on uncertainty avoidance also proved to be inconclusive. Despite being significant, the strength of the uncertainty avoidance construct was found weak. Therefore, it is conjectured that low levels of uncertainties may increase students' intentions to use mobile technology, and further empirical analyses are required in the future to confirm the significance of uncertainty avoidance to predict acceptance of educational technologies in higher education.

4.2.3.9 Technology's Perceived Ease of Use

Findings from the hypothesis test on the influence of perceived ease of use on adoption intentions was found not significant, contrary to the findings of many studies reviewed in the literature (Abu-Al-Aish & Love, 2013; Briz-Ponce & García-Peñalvo, 2015; Chow et al., 2012; Teo et al., 2012). As such, the insignificance of perceive ease of use suggests that resistance towards new technology may not be as pivotal as it once was, and factors such as ease of use may no longer play a crucial role towards predicting behavioural intentions. For instance, Wang and Wang (2009) revealed weak significance of ease of use in predicting acceptance of web-based learning approaches. Ease of use was also a weak predictor of attitude for determining users' repurchase intentions (Jang & Noh, 2011), and students' behavioural intentions to use YouTube for procedural learning (Lee & Lehto, 2013). Popularity of mobile messaging applications such as WhatsApp and Facebook Messenger in Malaysia (Osman et al.; Saad, 2015) are indicative of existing use, thus suggesting that students' possess adequate computing technological expertise. Therefore, perception towards system usability and ease of use may not contribute to explaining a significant portion of behavioural intention variances of mobile technology among adolescents and young adults. Thus, rejection of hypotheses H4 may signify a shift in the mind-set of adolescents and young adults who are adept and savvy with Web 2.0 tools and mobile devices.

4.3 Summary

Qualitative research approach was utilised to verify the study's research problem theorized from reviews of literature, as well as to establish arguments for supporting the IMMA framework's exogenous constructs prior to the framework assessment and hypotheses testing. Observations of large lecture classes, and findings from the analysis on the interview data, points to the lack of student-lecturer interactions. Notably, favourable perceptions were elicited for using mobile technology to encourage student-lecturer interactions. However, concerns were also raised as to the suitability of using mobile technology in the classrooms for academic purposes.

Moving on from the qualitative research, the framework assessment was conducted using PLS-SEM statistical analysis. However, prior to PLS-SEM, EFA was first conducted, and the underlying framework grouping of the survey instrument's items in the respective constructs was confirmed. The first stage in PLS-SEM is to assess the framework for its reliability and validity. Using CFA, the framework fulfilled the reliability and validity evaluations. Hypotheses testing ensued, with the predictor constructs of system quality, information quality, and enjoyment proven as strong predictors of mobile technology adoption intention to aid student-lecturer interactions. The influence of the cultural dimension of uncertainty avoidance however was very small though it is significant. Notably, perceived ease of use, perceived usefulness, and self-efficacy were found insignificant. This contradicts the findings obtained from previous studies in the literature. Overall, the significant constructs provided the endogenous construct in the framework with adequate predictive accuracy and relevance. Further discussions relating to the findings of both the qualitative and quantitative research are presented in chapter six.

Based on the results of the quantitative analysis, Interactive Mobile Messaging Application (IMMAP) was developed. The next chapter describes the development and implementation of IMMAP, and also the results of the experimental procedure.

CHAPTER 5: IMMAP IMPLEMENTATION, RESULTS AND DISCUSSION

Following the results obtained from the quantitative research, predictor constructs in the IMMA framework were used to guide the development of the Interactive Mobile Messaging Application (IMMAP) to ascertain tertiary students' intentions to use mobile technology to interact with their lecturers. The following sections describe the development of IMMAP, and data analyses. Findings and discussion of the findings are described next.

5.1 IMMAP Development

It is theorized that mainstream mobile messaging applications, such as Whatsapp, are not appropriate to be used in the pretest-posttest research for a number of reasons. For instance, familiarity or unfamiliarity with WhatsApp may skew perceptions of key constructs, i.e. students who are using WhatsApp actively may score highly on constructs such as perceived ease of use, self-efficacy and enjoyment, whilst students who dislike WhatsApp may give lower scores. Furthermore, popular messaging applications are designed with features meant for casual conversations and are considered unsuitable for supporting teaching and learning endeavours. Lecturers on the other hand, will be burdened with the tasks of saving their students' mobile numbers, and creating group chats. Though there are several existing noteworthy Web 2.0 tools and mobile educational applications that can facilitate student-lecturer interactions, such as Padlet and Remind, they were also deemed unsuitable in this study as the functional requirements of system quality, information quality, uncertainty avoidance, and enjoyment (i.e. the IMMA's significant adoption factors identified), are not fully represented. This is particular more so for the enjoyment and uncertainty avoidance factors. Therefore, development of a new mobile messaging application for students and lecturers to interact on academic issues is justified.

The IMMA framework was used to guide the development of IMMAP, a mobile messaging application designed specifically to enable students and lecturers to communicate on matters relating to the academic courses undertaken by the students in the semester. The supposition that mobile technology can aid and promote student-lecturer interactions in this study was demonstrated through the observation and assessment of IMMAP usage by students and their lecturers in an experimental manipulation. After the experimental manipulation, participants' intentions to use IMMAP were evaluated.

Seven exogenous constructs were posited to influence tertiary students' intentions to use mobile technology in the classrooms for student-lecturer interactions in the IMMA framework. They are perceived ease of use, perceived usefulness, self-efficacy, enjoyment, system quality, information quality, and uncertainty avoidance. Results from the thematic analysis on the qualitative data gathered from the interviews with selected academics of higher education points to the importance of all the exogenous constructs, in particular system quality, perceived usefulness, enjoyment, and uncertainty avoidance. Analyses on the quantitative data gathered from tertiary students verified system quality ($p < 0.001$), information quality ($p < 0.01$), enjoyment ($p < 0.001$), and uncertainty avoidance ($p < 0.05$) as significant, and positively influence the adoption intention of mobile technology.

Essential mobile messaging application attributes of system quality, information quality, enjoyment, and uncertainty avoidance were researched and used to design and develop IMMAP. Definitions of the significant exogenous and endogenous constructs relative to IMMAP are given below:

1. System quality – Quality of IMMAP functional requirements valued by users of mobile devices (functionality, reliability, response time and error recovery).

2. Information quality – Quality of IMMAP input, output, interface design and clarity of instructions.
3. Enjoyment – The degree to which an individual experience joy when using IMMAP.
4. Uncertainty avoidance – The degree to which an individual is comfortable with uncertainties about IMMAP prior to using the app to interact with their lecturer.
5. Adoption intention – An individual decision to use IMMAP in future classes for student and lecturer interactions.

The exogenous constructs were mapped to essential functional requirements in the development of IMMAP, as described in the following section.

5.1.1 Functional Requirements

Prior to IMMAP's development, essential functional requirements related to each exogenous construct mapped out, and integrated in IMMAP. Table 5.1 summarizes the mapping of IMMAP's functional requirements and their association with the constructs.

Table 5.1: Mapping of IMMA with IMMAP specifications

Constructs	IMMAP
System quality	– Flexibility and ease of maintenance to ensure capacity to accommodate new requirements or features. – Minimum storage and memory, thus ensuring fast responsiveness and high throughput. – Tolerant of errors committed by users. – Easy installation and minimum storage and memory needs. – Fast start-up and shut-down. – Messages transmitted in real-time.
Information quality	– Intuitive, consistent, and simple interface design. – Clear visuals of instructions and commands. – Clear and concise labelling for the commands and buttons – Accuracy of input and output processes. – Messages displayed to confirm submission. – Organized arrangement of input and output to ensure clarity. – Feedback (error messages) provided when user executes the wrong actions (for instance error during login).
Enjoyment	– The interfaces of IMMAP need to be aesthetically pleasing. – Pleasant colour combination scheme of white (background), blue (header and button) and orange (swipe button). – Minimal design patterns for each interface.
Uncertainty avoidance	– Clear, concise instructions to be posted online to guide students during installation. – Allowing students the option to send private messages that only the lecturers can view (lecturers' reply to the students' private messages are also kept private).

Feedback via confirmation or error messages, and ordered arrangements of input and output display are crucial to ensure quality of the content of IMMAP. For overall system quality, fundamental features such as ease of installation and error handling are vital. It is hoped that aesthetically pleasing interfaces using suitable colour combinations can increase user enjoyment when using IMMAP. Lastly, to reduce uncertainties prior to using IMMAP, clear installation instructions were drafted and posted online, and students also have the option of sending private messages to their lecturers should they choose to do so.

IMMAP was developed for two groups of users - students and lecturers of higher education. The fundamental reason for developing IMMAP is to allow students and lecturers to interact, whether it’s in the classrooms, or outside of the classrooms. It is designed for academic use, therefore the functionalities differ from current mainstream mobile messaging applications. For students, they first have to register by providing details of their student ID, password, name, mobile number and email address. After registration, they then proceed to login using their student ID and password. IMMAP can be accessed and used from different Android mobile devices as long as the application is installed. Data updates from student-lecturer communications are automatically synchronized, i.e. real-time updates to the database.

A list of courses registered for the particular semester is displayed, and upon selecting a course, they would be able to view the specific lecture sessions. Figure 5.1 illustrates a sample course and its lecture sessions.

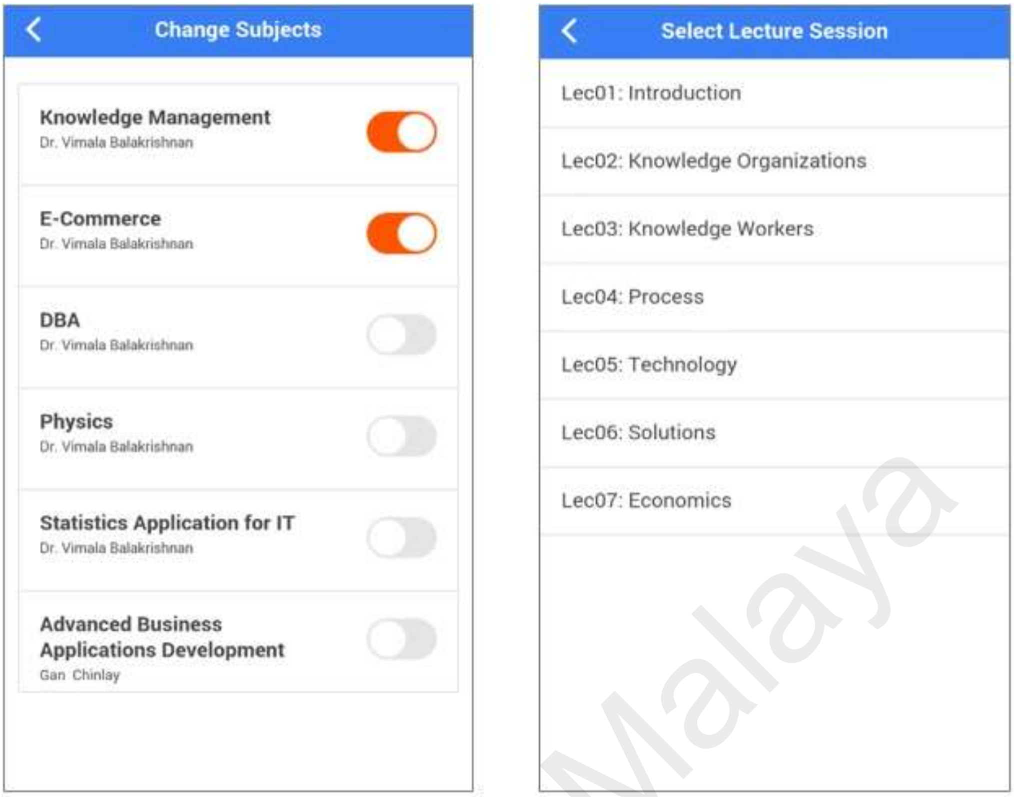

Figure 5.1: A sample of courses selection screen and its chapters

If a student wishes to send a query related to the class, it is then selected and a compose message screen will appear. An important feature implemented is that students can set their messages to either private or public mode. If the student wishes for their messages to be read only by the lecturer, the private mode needed to be selected by swiping the orange swipe button as shown in Figure 5.2.

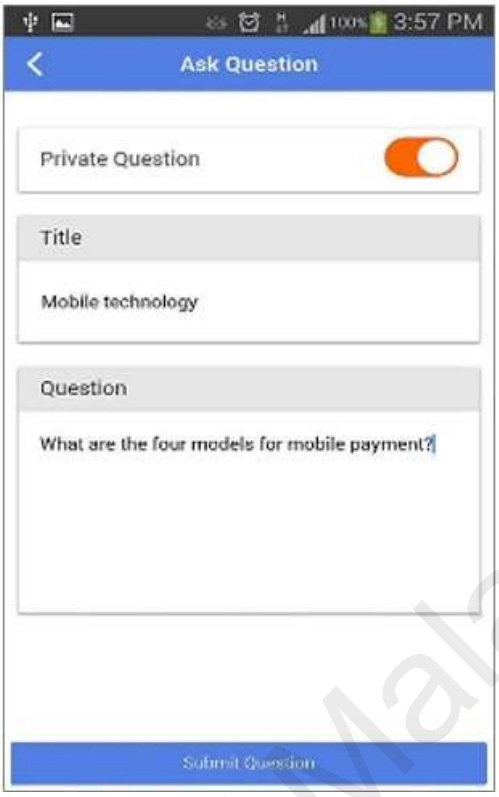

Figure 5.2: Sample of a student's message

When the lecturer replies a private message, only the sender (student) can view the reply. Figure 5.3 shows an example of a lecturer's reply screen. On the other hand, public messages can be read by all registered students. By default, all the messages are public. Lecturers on the other hand can login and are given the authority to create or delete lecture sessions for all the courses they are currently teaching. Lecturers have the authority to view all public and private messages submitted by their students, and reply accordingly.

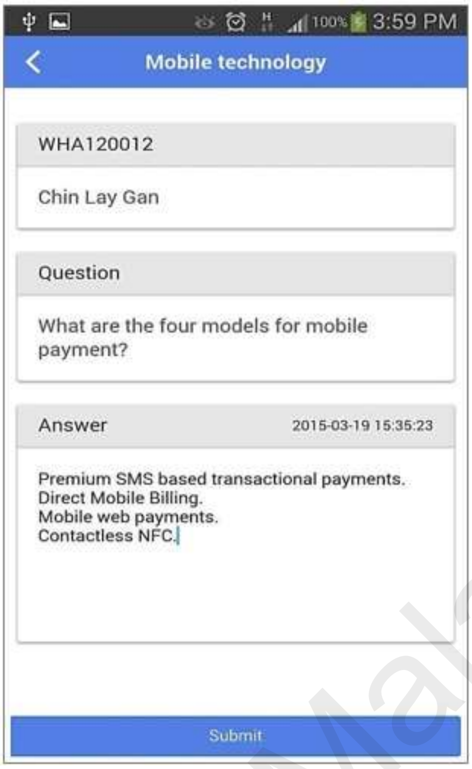

Figure 5.3: Sample of a lecturer's reply to a student's query

5.1.2 Development Requirements

IMMAP was developed using Apache Cordova, with HTML5, JavaScript and PHP language. The database was created using phpMyAdmin. Rigorous testing of IMMAP was conducted next, and defects detected were corrected. IMMAP was then deployed to a Nginx web server. Figure 5.4 illustrates the IMMAP development framework.

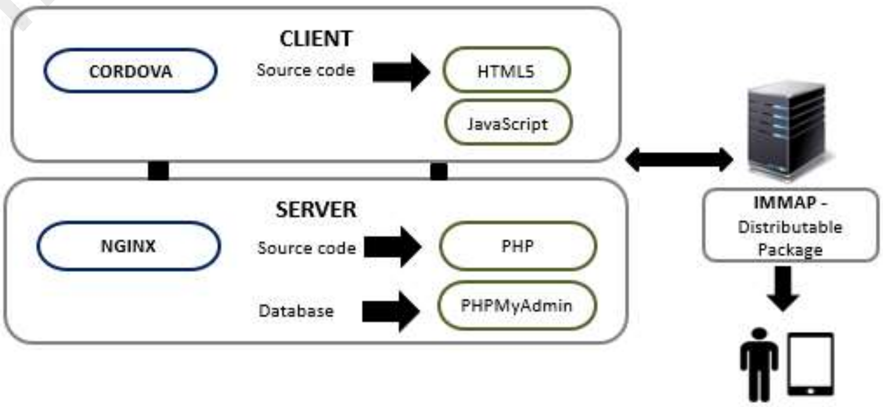

Figure 5.4: IMMAP development framework

5.1.3 Pilot Test

A pilot test involving the researcher and four students were conducted next to evaluate the feasibility of IMMAP to aid student-lecturer interactions, and identify modifications needed before the final assessment. The students installed IMMAP based on instructions uploaded online. They were then requested to register and use the application to interact with the researcher.

An informal group interview with all four students to gauge perceptions of IMMAP were conducted. The group interview session lasted approximately 40 minutes. They were queried regarding IMMAP's ease of installation, and quality of system features for aiding student-lecturer interactions. Comments and suggestions were recorded verbatim. Key suggestions obtained were related to the courses and chapters' graphical interface, i.e. use bigger font size and wider spacing between the courses and chapters. The original colour of the swipe buttons was dark grey, and a suggestion was put forth to use a brighter colour. Using the color palate of Microsoft Word 2013, suitable colours were discussed. At the end of the discussion, colour choices were narrowed down to bright reddish or orange shades. Changes were then made to improve IMMAP features based on the comments elicited.

5.1.4 IMMAP and Mainstream Mobile Messaging Application – Similarities and Differences

IMMAP and mainstream mobile messaging applications share similar practical attributes, for instance minimal storage and memory requirements, low data bandwidth consumption, and also ease of installation. However, contrary to the features of mainstream messaging applications, IMMAP functional attributes differ. If mainstream messaging applications are used for student-lecturer interactions, the following characteristics will be observed: (i) Lecturer are required to add students' contact, (ii) lecturers need to create a public chat group for each course, (iii) group messages are public, (iv) each message is not tied to a specific chapter, unless students specify explicitly, (v) able to send text, voice or audio messages, and (vi) user account in mobile messaging application such as WhatsApp is tied to a mobile number on a mobile device.

IMMAP differs from mainstream messaging applications when it comes to supporting student-lecturer interactions in higher education in these main areas : (i) Students' self-registration and login using their ID number and selected password, (ii) self-selection of current courses by the students, (iii) public group automatically created for each course, and messages can be set to private or public viewing, (iv) each message is tied to a chapter in the course syllabus, (v) able to send only text messages, and (vi) one single account (ID and password) to login on multiple mobile devices that installed IMMAP.

5.2 Experimental Manipulation

Students who participated in this study were recruited from two courses taught at the researcher's university. The first group were year two Information Technology course students, and the second group were year three Business Administration course students (N_{group1} = 8, N_{group2} = 30). Both groups of participants were chosen to represent students from the business management, and the science and technology academic disciplines. A total of 38 undergraduate students aged 20 to 24 years old (N_{male} = 16, N_{female} = 22) participated in the IMMAP experiments. Further participants' demographic details obtained from the pretest survey are presented in the following section. The experimental manipulation consisted of three stages, described in the following sections.

5.2.1 Pretest

Prior to using IMMAP in the lecture classes, participants were given a pretest survey at the beginning of the class. The survey consisted of three sections: Section A, B, and C. Section A contained statements to derive participants' personal (gender and age) and academic details (education level and field). In section B, participants reported their Internet access methods (cellular network, Wi-Fi), the availability of Wi-Fi at their campus, and whether they are using mobile technology for interacting with their lecturers in the classrooms. Out of the 38 participants, four of them did not use their mobile devices for learning purposes. In regards to Internet access using their mobile devices, 84.2% of the participants were able to access the Internet via a cellular network, and 97.4% of the participants were able to connect to the Internet through a Wi-Fi connection ($N_{cecullar\ network}$ = 32, $N_{Wi\text{-}Fi}$ = 37). None of the participants were using mobile technology to interact with their lecturers during classes.

Section C consisted of statements to obtain participants' perceptions on current use of mobile messaging applications based on the IMMA framework's constructs. Each construct consisted of five statements to be rated based on a five-point Likert scale (1: strongly disagree to 5: strongly agree). Participants from both groups completed the pretest survey in the first class.

5.2.2 Use of IMMAP

After the pretest survey, participants were given a brief demonstration of IMMAP and its key features. They were instructed to register, login, and select the right courses. Participants were encouraged to use IMMAP to send queries pertaining to the courses' syllabus. During the short break in the middle of the classes, the lecturers looked at the queries sent, and replied to some of them. Some of the communications also took place after class, probably due to constraints such as limitation of time. Both groups of participants used IMMAP for the first half of a semester, which translates to approximately seven weeks.

5.2.3 Posttest

The posttest survey was drafted to determine participants' perceptions of IMMAP. Section C from the pretest survey were modified to assess perceptions of IMMAP's enjoyment, system quality, information quality, uncertainty avoidance, and adoption intention. After the participants have used IMMAP for half a semester, the posttest surveys were distributed to them. Please refer to Appendix D to view the pretest and posttest survey instruments.

5.3 Results and Discussion

Using IBM SPSS Statistics 21, data were first examined to ensure that they do not violate assumptions for conducting paired *t*-test analysis. The crucial assumptions that needed to be verified to prevent misleading or incorrect results in *t*-test analysis are: (i) data must be continuous, (ii) there are no significant outliers in the pretest's and posttest's mean differences, and (iii) data are approximately normal (Mooi & Sarstedt, 2011; Pallant, 2013). All constructs' means can be measured on a scale in both pretest and posttest assessments, therefore the data are continuous. To determine the presence of outliers, the *z*-scores of the mean differences were extracted and examined, with an absolute value of above three indicating a univariate outlier (Mooi & Sarstedt, 2011). All absolute values of the *z*-scores are less than three with the exception of one *z*-score for the mean difference of the adoption intention construct. However, given that only one *z*-score is out of range, the probability that it will affect the results of the subsequent analysis is very small (Pallant, 2013). Skewness (measure of the symmetry of a construct's distribution) is selected to assess the normality of the data. The skewness values of all constructs' pretest and posttest scores are within the −1 and +1 acceptable range, indicating that the sample data are approximately normal.

After ensuring that no assumptions have been violated, the descriptive statistics of all constructs' prestest and posttest means and standard deviations were determined, presented in Section 5.3.1. The constructs' means were then subjected to paired sample *t*-test analysis to determine significant differences between the pretest and posttest assessments. Mean differences are considered significant at $p < 0.05$.

When examining significant effects using small sample size, results obtained can be misleading (Cohen, 1988). Although the *p*-values obtained indicate that the mean differences were unlikely to occur by chance, it doesn't reflect the magnitude of the intervention's effect, i.e. use of IMMAP to aid student-lecturer interactions. Therefore, the magnitude of the differences between the pretest's and posttest's constructs were determined using Cohen's *d*, one of the most common acceptable measure for determining effect sizes when comparing means in *t*-test analyses (Baguley, 2009). Results were then interpreted using the guidelines proposed by Cohen (1988): 0.2 = small effect, 0.5 = moderate effect, 0.8 = large effect.

The means of the constructs in the prestest and posttest surveys, and significance of the means' differences provided the fundamentals for conjectures to be made in this study.

5.3.1 Descriptive Statistics

Table 5.2 illustrates the results of the constructs' means and standard deviations from the evaluations of pretest and posttest. Standard deviations of constructs are less than one for both pretest and posttest surveys, indicating participants' consistency in rating the constructs' items. From pretest to posttest, means of uncertainty avoidance, system quality, information quality, and adoption intention are higher, while the mean of enjoyment are lower.

Table 5.2: Means and standard deviations of the constructs from the pretest and posttest surveys

Construct	Mean		Standard deviation	
	Pretest	Posttest	Pretest	Posttest
Enjoyment	4.147	3.905	0.500	0.494
Uncertainty avoidance	3.379	3.589	0.530	0.392
System quality	3.663	3.953	0.526	0.580
Information quality	3.768	3.963	0.582	0.511
Adoption intention	3.579	3.879	0.641	0.462

5.3.2 Paired Sample *T*-Test

To compare the constructs' pretest and posttest means, paired sample *t*-test was conducted with results shown in Table 5.3.

Table 5.3: Paired sample t-test results

Construct	*t*-value	*p*-value	Effect Size
EJ**	2.846	0.007	0.180
UA**	3.224	0.003	0.219
SQ*	2.538	0.016	0.148
IQ ^{ns}	1.911	0.064	0.090
AI*	2.502	0.017	0.145

Note: $*p < 0.05$, $** p < 0.01$

The results revealed participants mixed perceptions of IMMAP. Among the constructs with higher means in the posttest evaluations, paired sample *t*-tests revealed the mean differences to be significant for uncertainty avoidance (*t-value* = 3.224; $p < 0.01$). Higher mean values for uncertainty avoidance indicated participants' lower levels of uncertainties after using IMMAP. The mean increase in uncertainty avoidance is 0.211 with a 95% confidence ranging from 0.078 to 0.343. Given the Cohen's *d* value of 0.52 with a 95% confidence interval of 0.18 and 0.86, and statistical power of 87%, it can be concluded that there is a moderate difference in the uncertainty avoidance score before and after using IMMAP.

Therefore, the significant lower level of uncertainty avoidance is crucial in this study, and reflects the participants' willingness and readiness to use mobile technology in future classes for interacting with their lecturers on academic matters. Similar results were also reflected in recent studies that examined the significance of uncertainty avoidance as predictor of system and technology acceptance (Belkhamza & Wafa, 2014; Matusitz & Musambira, 2013). Interestingly, uncertainty avoidance had a small impact on users' adoption intentions based on findings from the hypotheses test. It was therefore surmised that actual use IMMAP for student-lecturer interactions, even though in a controlled experimental procedure, may have lower students' uncertainties, especially when they are allowed to send private messages and when their lecturer replied to their queries.

The differences for system quality is also significant ($t = 2.538$; $p < 0.05$). Higher mean score was observed for system quality in the posttest evaluations, with a mean increase of 0.289 at 95% confidence range of 0.058 to 0.521. Cohen's *d* effect size is 0.41, with a 95% confidence interval of 0.08 and 0.74, and statistical power of 71%. Though the effect size is categorized as small, it is near Cohen's (1988) moderate effect threshold. Therefore, the significant higher score of the system quality construct confirmed the essential functional qualities of IMMAP, for instance its ease of installation, minimal storage and memory needs, fast responsiveness, and real-time database updates.

Enjoyment have lower mean values in the posttest evaluations. However, paired *t*-test results revealed the mean difference to be significant ($t\text{-}value = 2.846$; $p < 0.01$). The mean decrease for enjoyment is 0.242 with a 95% confidence interval ranging from -0.414 to -0.070. The Cohen's *d* effect size value is 0.46 (small effect with 95% confidence range of 0.12 to 0.79). The effect size is almost at the medium level, and with a statistical power of 79%, it points to a considerable decrease of enjoyment when using IMMAP.

Taken together, the results indicate that using IMMAP is not as enjoyable compared with other mobile messaging applications. The significant decrease of enjoyment for IMMAP points to a lack of functional specifications implemented for promoting enjoyment, such as multimedia features. For instance, IMMAP does not support graphics or voice data, compared to WhatsApp. Lower enjoyment level for IMMAP may also be attributed to the app's intended use for supporting student-lecturer interactions, and not for leisure purposes. Thus, the decreased enjoyment after using IMMAP can adversely affect adoption intention, and deserves in-depth revisions of key functionalities in future enhancements. Therefore, functional features that can increase user enjoyment when using IMMAP must be given careful consideration and attention in future enhancements.

Adoption Intention

Lastly, intentions to use mobile technology in future classes were higher after the participants have used IMMAP for approximately half a semester. In other words, results point to the participants' willingness to use IMMAP to interact with their lecturers on academic matters in the classrooms. This is reflected from the significant difference for adoption intention ($t = 2.502$; $p < 0.05$), with a mean increase of 0.300 at 95% confidence range of 0.057 to 0.543. With Cohen's *d* value of 0.41 at 95% confidence interval (0.07, 0.73) and statistical power of 69%, the significant increase of adoption intention in the posttest assessment of IMMAP has a small effect. Though the effect size is small, it is near the threshold of the moderate effect level.

Therefore, participants' positive experience when using IMMAP was supported. For these reasons, higher education institutions should further explore the potential of using mobile technologies in the classrooms to support the teaching and learning undertakings of the students and lecturers.

Though information quality is not significant, it has a higher score in the posttest evaluations with $p = 0.064$ and moderate effect size of 0.09. The results are noteworthy, and merits attention in future studies. Limited conjectures can be made relating to these findings. Thus, additional studies utilising other experimental procedures, with a bigger sample size and longer duration are thus warranted.

5.4 Summary

A total of 38 students from two different courses evaluated IMMAP. Findings revealed significant changes on a number of indicators, specifically for enjoyment, uncertainty avoidance and system quality. Uncertainty avoidance and system quality have higher mean scores for the posttest assessment. In other words, participants exhibited lower level of uncertainties after using IMMAP, and are generally satisfied with IMMAP's functional and system qualities. In addition, the mean score for IMMAP adoption intention is higher compared to pretest, and found to be significant. Therefore, participants' positive experiences when using IMMAP is supported. Enjoyment on the other hand exhibited lower score, pointing to lower level of pleasure or joy when using IMMAP for interaction purposes in the classrooms. It reflects the participants' perceptions that using IMMAP in comparison with other types of mainstream mobile messaging applications is not as enjoyable. Therefore, functional features that can increase user enjoyment when using IMMAP must be given careful consideration and attention in future enhancement endeavours.

The next chapter discusses theoretical and practical implications of the findings. It also discusses the limitations of this study, and draw conclusions and recommendations for future researches.

CHAPTER 6: IMPLICATIONS, LIMITATIONS, RECOMMENDATIONS, AND CONCLUSION

This final chapter discusses the implications, limitations of this research, recommendations for future studies, and conclusions formed. This chapter is divided into three sections. The first section consists of theoretical, methodological and educational implications of this doctoral research. Section two outlines the limitations of this study and recommendations for future research. The conclusion ends this chapter.

6.1 Implications of the Study

The findings from this study furthers the understanding on the use of mobile technology in higher education from the viewpoints of both tertiary students and academics in Malaysia. The implications of the findings, with regard to theoretical, methodological, and higher education were explored, and presented in the following sections.

6.1.1 Theoretical Implications

This study provided several implications for theory. The most important theoretical contribution is the conceptual IMMA framework that improves our knowledge regarding mobile technology adoption for aiding the teaching and learning undertakings of students and lecturers, with the main focus for supporting interactions between them. Large classes in higher education reduce the quality student-lecturer interactions (Bachman & Bachman, 2011; Lane & Harris, 2015; Owston et al., 2011), and causes the prevalence of teacher-centred approach to learning (Smith & Cardaciotto, 2012; Soler-Dominguez et al., 2014. Though the use of mobile technology by students and academics of higher education is pervasive and its benefits documented in recent studies (Blasco-Arcas et al., 2013; Roopa et al., 2013; Sarwar et al., 2014), little is known about the impact of using mobile technology to enable students and lecturers to interact on academic matters.

Therefore, inspired by the works of researchers in recent years on mobile technology usage in higher education, and in light of the literature gap to examine the efficacy of mobile technology to aid student-lecturer interactions, this study seeks to contribute to the body of knowledge on the use of mobile technology in Malaysia's higher education institutions.

Little is also known about the influence of culture in mobile technology adoption in higher education for teaching and learning purposes. Yoo and Huang (2011) investigated the differences of perceptions between two groups of students (Americans and Koreans), and found that the Koreans students exhibited higher level of hesitation when it comes to adopting new Web 2.0 tools. In pursuant to this, Malaysia is a country with multi-cultural society. Therefore, this study attempted to discover whether Malaysian students will exhibit similar level of apprehension towards new technology through the integration of uncertainty avoidance as one of the exogenous constructs in the IMMA framework. Based on the construct's mean value, it can be surmised that overall uncertainties low when it comes to new innovations in the mobile industry. Furthermore, hypotheses test results on uncertainty avoidance points to the significance of lower level of uncertainty avoidance being positively associated with adoption intention of mobile technology for aiding student-lecturer interactions. However, the strength of the association between uncertainty avoidance and adoption intention is very small, and highlighted the fact that the students in general did not place much importance towards the uncertainties of using new mobile tools.

In addition, results obtained from the quantitative research and the pretest-posttest experiments yielded a clear finding: the importance of the system quality and information quality constructs that encapsulates attributes of the mobile applications' functionalities, the ease of input, and clarity and usefulness of output generated for mobile users. To date, and to the best knowledge of the researcher, this is the first study to empirically link system quality and information quality (antecedents of system use and user satisfaction in the D&M IS success model) as determinants of mobile technology adoption intention to aid higher education's student-lecturer interactions. Previous empirical works on system quality and information quality clustered within the context of examining the indirect effects of both constructs toward IS acceptance in organizations as well as for individual users (Detlor et al., 2013; Lin & Wang, 2012; Zhou, 2011). However, Lee and Wang (2012) proved the importance of information quality to predict e-learning acceptance. Therefore, application of system quality and information quality as predictors of mobile technology adoption have so far been neglected in higher education. Furthermore, based on the significance of both constructs in this study from the IMMA framework's quantitative findings, and from the findings of the experimentation conducted on IMMAP, the significant applicability of the system and information quality as predictors of mobile technology in higher education were asserted.

To date, there is also no conclusive evidence on the influence of enjoyment to predict mobile technology adoption in Malaysia's higher education, though many studies have verified the significance of the construct to predict technology usage. For instance, students' adoption of e-textbook (Hsiao et al., 2015), employees' intention to share tacit and explicit knowledge (Hau et al., 2013), and consumers' intentions to adopt mobile commerce (Zhang et al., 2012). In a similar vein, Hong et al. (2013) asserted enjoyment was significant to predict adoption of mobile data services among the younger respondents, whilst the enjoyment construct was found not significant for older respondents. The average age of the respondents that participated in the survey distribution in this study was 21 years old, and the significant results of enjoyment provided further empirical proof of today's generation emphasis on experiencing joy when using mobile technology.

6.1.2 Methodological Implications

A review of literature failed to detect a study that integrated constructs from prominent technology acceptance models, motivational and cultural dimension theories, with IS success factors that clusters on the users' technology perceived ease of use, features of mobile technology (perceived usefulness, system quality, information quality), cultural influence (uncertainty avoidance), personal motivations (enjoyment, self-efficacy). Integrating these constructs in the IMMA framework provided the researcher with the opportunity to investigate tertiary students' intentions to use mobile technology to interact with their lecturers from multiple perspectives. Critically, findings obtained revealed constructs of perceived ease of use and perceived usefulness as insignificant from the perspectives of the students in Malaysia, despite supporting qualitative findings from the perspectives of the academics interviewed. In a similar vein, though the students professed higher than average mobile technology savviness, self-efficacy was also found insignificant. Instead, system quality and information quality, together with enjoyment, emerged as strong predictors, underlining the importance of the features and information attributes of mobile applications by the younger generation.

Another significant methodological implication involves research methodology and the choice of statistical analysis in this study. This study is among the very few researches that utilised qualitative means, i.e. observations of large lecture classes, and semi-structured interviews with academics of higher education, to corroborate the research problems and gaps. In addition, this study also utilised supplementary analysis, i.e. thematic analysis support the inclusion of the exogenous constructs in the IMMA framework. Furthermore, taking into consideration the exploratory nature of this study based on the integration of prominent technology model and theories to ascertain users' adoption intentions, PLS-SEM was utilised to validate the framework and test the hypotheses. In short, PLS-SEM provides a way to not only test the relationships in the hypothesized model simultaneously, but it also maximizes the explained variance of the endogenous construct. Given that little is known about the influence of culture, as well as system quality and information quality towards predicting the intentions to use mobile technology in higher education to promote student-lecturer interactions, the use of PLS-SEM is appropriately justified.

This study utilized an experiment procedure to demonstrate the empirical findings derived. The experiment procedures subscribed to the pretest-posttest research design, whereby IMMAP was developed based on the framework's constructs. The application of an experiment where IMMAP was introduced, and used by the group of selected students and their lecturers helped to generate more valid findings, and could reduce ambiguities pertaining to the limitations of quantitative data analyses from self-reported surveys. In addition, to date and to the best knowledge of the researcher, there is a lack of studies that applied qualitative and quantitative analyses, followed by experimental assessments. Having said this, and guided by the findings obtained, a more rigorous methodology and analyses could be used to further assess for the meaning and acceptability of the results within higher education institutional context.

6.1.3 Educational Implications

The prevalence large lecture classes in higher education institutions necessitate the use of mobile technology to enable student-lecturer interactions. Obtaining adequate feedback from the students are not possible given the constraints faced by lecturers in large classes. In addition, students' cultural background and personalities, coupled with their language proficiency, can hinder them from providing feedback. However, it is vital for students to provide feedback and interact with their lecturers in order to aid their understanding (Afzal & Kamran, 2013; Sarwar et al., 2014; Ledford et al., 2015). In this aspect, using IMMAP to aid student-lecturer interactions in future classes is posited to bring numerous benefits to both students and lecturers alike. Beside enabling and encouraging interactions to take place, whether it's in the classrooms or outside of the classrooms, it may stimulate students' interest and engagement behaviours in the long run.

6.2 Limitations and Recommendations for Future Studies

This study is not without its limitations. First, this study is liable to non-response bias, when the answers of respondents differ from the potential answers of those who did not answer. Social desirability bias, or a desire to respond favourably in light of social norms or standards is also common in self-reported surveys (Armstrong & Overton, 1977; King & Bruner, 2000). Assumptions on the honesty of the respondents, and their knowledge pertaining to mobile technology and the Internet were also made. It was also assumed that the respondents completed the survey under no pretext, peer or social pressure, or possessing ulterior motives for participating in the study other than to gained knowledge and contribute to the research.

However, the research scope of this study is not considered a sensitive matter in Malaysia, thus the probability of biases are considered to be low. In addition, several preventative steps such as guaranteeing the anonymity and confidentiality of the respondents' responses, and using carefully worded and phrased sentences in the survey, and subjecting the survey instrument to expert reviews and pilot testing, followed by revisions based on feedback gathered. Unambiguous or incoherent phrases and words were removed to minimise non-response and social desirability biases.

Another limitation is where participants may rate themselves higher or lower at the posttest evaluation compared to their pretest evaluation due to a shift in the frame of reference, particularly for studies that attempt to gather participants' perception rather than factual knowledge (Howard, 1980). For instance, participants who felt that they have overrated or underrated their perceptions' during pretest may then shift their responses in the opposite direction in the posttest. As with the self-reported survey, the same preventative steps were undertaken to minimize the occurrence of response-shift bias.

A minimum of two years of teaching experience was adhered to when selecting lecturers to be interviewed. In retrospect, this requirement may be insufficient as lecturers' skills and experiences in teaching small and large classes are factors that needed to be considered. Future studies may want to employ a more rigorous sampling method that takes into consideration the lecturers' teaching abilities, such as strategic sampling through self nomination or peer nomation of lecturers that are skilled, or lecturers who are strungling with lecture-based teaching. Due to the qualitative means used in this study to determine lecturers' perceptions regarding the efficacy of mobile technology to aid interactions with their students, quantitative methods via the distribution of survey to a larger sample size of tertiary lecturers are strongly recommended.

Notwithstanding, this study is limited to the use of a pretest and posttest research, a form of quasi-experimental approach that lacks the elements of random assignment and use of a control group for true experimental researches. In addition, the experiment was conducted in two separate classes involving a year two Information Technology course students and year three Business Adminsitration course students. Data collected were combined and analysed collectively. Future studies may want to consider analysing different groups of students separately and elicit significant differences, as factors such as the nature of the course, the teaching style of the lecturer, the lecturer's readiness to use IMMAP, and students' backgrounds may result in differing usage effects.

The relatively small number of participants also points to the difficulty to generalize the experiment findings across the student population. Future studies should include larger sample size, and longer observations of IMMAP usage in lecture classes prior to posttest assessments. In addition, this study measured the impact of IMMAP, i.e. whether IMMAP has better functional and input-output features, lowers uncertainties regarding its usefulness for enhancing interactions with lecturers, increases usage enjoyment, and ultimately leads to an increase of adoption intentions among the students via a direct pretest-posttest asessments on the same group of respondents. Future studies should include a control group, a set of respondents that were not exposed to the interventions introduced by the researcher to measure the effects of technology usage. In addition, the long term effects of using IMMAP, for instance will respondents who scored poorly in the posttest's enjoyment factor reject the use of IMMAP, and the impact of students' and lecturers' readiness to use IMMAP on the students' learning achievements.

The IMMA framework does not test for mediating or moderating effects. Therefore, an important recommendation for future research is to apply background factors, i.e. gender and academic disciplines and examine their moderation roles. Significant gender differences among tertiary students in mobile technology acceptances may reveal significant differences of perceptions relating to behavioural intentions and usage of mobile technology in education. Furthermore, the influence of students' academic major on their adoption decisions may yield notable findings. For instance, to answer the research question of whether students from disciplines of information technology or computer sciences are more incline to accept mobile technology use in their learning journey compare to their business or engineering peers. In addition, since hypotheses test proved that perceived usefulness, perceived ease of use, and self-efficacy were not significant predictors of adoption intention, future studies may wish to examine whether enjoyment, system quality, information quality and uncertainty avoidance mediates the relationship between perceived usefulness, perceived ease of use, and self-efficacy with mobile technology adoption intentions.

Contradictory findings in this study was the negative association of perceived ease of use (although not significant), and the insignificance of perceived usefulness, and self-efficacy. However, all three constructs achieved high performance based on the findings from the importance-performance map analysis (IPMA). Additional investigations are therefore warranted to verify the insignificance of perceived ease of use, perceived usefulness and self-efficacy found in this study. In addition, only one cultural dimension (uncertainty avoidance) was tested in this study. The applicability of Hofstede's (2001) cultural dimensions of power index, individualism, masculinity, long term orientation and indulgence may yield notable results, and are strongly recommended in future studies.

This study was conducted in Malaysia. To determine the applicability of the framework to predict mobile technology acceptance in higher education, it is recommended that researchers apply and verify the predictive capabilities of the IMMA framework within the context of higher education in their respective countries. The finding derived from these studies are beneficial for confirming the generalizability and predictor power of the IMMA framework across geographical boundaries. In other words, comparative studies to discern differences of students' perceptions from different nationalities could yield interesting results, for instance Western versus Asian countries, or developing versus developed countries.

Lastly, the generalizability of the framework can be further expanded to include other fields or areas of technology application, such as mobile payment and wearable technology that are gaining a lot of attention recently in the technology industry.

6.3 Conclusion

This doctoral research was undertaken to investigate the viability of using mobile technology in Malaysia's higher education to support and promote student-lecturer interactions. It presented a detailed investigation on the antecedents and outcomes of the educational use of mobile technology among students and lecturers in higher education. Although mobile technology in education has been widely research, most of the previous studies focused on the use of educational technologies such as Clickers and Kahoot to aid teaching and learning endeavours (Blasco-Arcas et al., 2013; Elavsky, Mislan, & Elavsky, 2011; Wu & Gao, 2011). Little is known about the use of mobile technology to aid student-lecturer interactions, in light of the constraints of large lecture classes which are prevalent in many higher learning institutions in Malaysia (Biggs, 2012; Moulding, 2010; Lane & Harris, 2015; Ragan et al., 2014). Observations of actual classes, and interviews with academics of higher education corroborated the prevalence of teacher-centred approached to teaching, and the lack of student-lecturer interactions in large lecture classes.

To achieve this, the IMMA framework was conceptualized to analyse the significance of posited predictors of intentions to use mobile technology to aid student-lecturer interactions. To establish the theoretical framework, prominent technology acceptance models and their contributions were reviewed thoroughly. Davis's (1989) TAM is the most commonly applied model of users' behavioural intentions, acceptance and usage of technology due to the significance of the model's behavioural intention to use's antecedents (perceived ease of use and perceived usefulness). Current studies have also stressed the importance of intrinsic motivators of self-efficacy from SCT (Bandura, 1977, 2011), and enjoyment from motivational models (Scott et al., 1988; Vallerand, 1997). Delone and McLean's (1992) IS success model has also been widely researched to determine acceptance of IS based on system functionalities (system quality), and the ease and clarity of the input-output processes (information quality). Though system quality and information quality have been examined and verified for their ability to predict users' intentions and acceptance of IS, their relevance in the field of mobile technology and mobile applications' acceptance are under researched. Given the extensive adoption of mobile applications today, both constructs were conjectured to predict the use of mobile technology in higher education. Lastly, this study was conducted in Malaysia, therefore cultural norms of Malaysian tertiary students was speculated to be an influential factor. Tertiary students' level of comfort with the uncertainties of using new mobile applications was also investigated through uncertain avoidance, one of Hofstede's (2001) cultural dimensions (Hofstede et al., 2010).

Therefore, perceived ease of use, perceived usefulness, self-efficacy, enjoyment, system quality, information quality, and uncertainty avoidance were examined for their influence on mobile technology adoption intention. The findings confirmed that system quality, information quality, enjoyment and uncertainty avoidance did impact students' adoption intention. Enjoyment was found to be the strong predictor, whilst uncertainty avoidance has a small effect. This has paved the way for future investigations of constructs that relates to mobile applications' features, and the conceptualization of new constructs. System quality and information quality broadly encompass qualities of the mobile applications' features. Therefore, detailed investigation into specific key features as constructs such as reliability and responsiveness to impact mobile users' perceptions of the technology could contribute significant findings to the body of knowledge. In addition, the strong emphasis to incorporate enjoyment into educational technologies is notably, and strongly point to the need effective teaching and learning strategies to make learning much easier and enjoyable for the students. The advantages of these strategies include the increase of students' motivation, interest, engagement and academic achievement (Berns, Gonzalez-Pardo, & Camacho, 2013; Domínguez et al., 2013). The small effect of uncertainty avoidance also paved the way for future research into strategies for reducing feelings of uncertainties toward the effectives of mobile technology to support teaching and learning endeavours. In pursuant of this, the low uncertainty of the respondents that participated in the quantitative research was surmised to stem from the respondents ownership and current usage of mobile technology for learning purposes. Therefore, future studies to investigate the differences of rural and urban students' perceptions could yield significant findings. The findings also paved the way for further study on using other cultural dimensions as antecedents of behavioural intention and usage of educational technologies.

Despite findings from the literature, perhaps for the first time, perceived ease of use, perceived usefulness, and self-efficacy were found not to be positively significantly associated with technology's adoption intention. Nevertheless, the insignificance of these constructs in this study is noteworthy for future studies on educational technologies use in higher education. With the majority of the respondents surveyed owning more than one mobile devices and were already using them for learning purposes, the role of self-efficacy and perceived ease of use in predicting intentions to use educational technologies in higher education may no longer be relevant. Low awareness by higher education institutions on how mobile technology can be used to support teaching and learning, and the ensuing potential educational benefits (Tossell et al., 2014; Woodcock et al., 2012) may have reduce perceptions usefulness. Findings from the interviews with academics to ascertain their intentions to use mobile technology in the classrooms revealed deep concerns of potential technology misuse among the students. Therefore, higher education institutions who are serious about incorporating mobile technology in face to face classes, or implement mobile successfully, be more conscious of the potential benefits and strategies for effective implementation.

To answer the research question of the likelihood of tertiary students to use mobile technology to interact with their lecturers, IMMAP, a mobile messaging application, was developed and experimented in actual face to face classes to demonstrate the significance of the framework's exogenous and endogenous constructs. Pretest assessment gauged perceptions of mobile technology in general, and posttest assessment measured perceptions of IMMAP. Students that participated in the experimentation expressed a more favourable view towards IMMAP's usefulness to aid interactions, as well as functional and information qualities, and overall intentions to use IMMAP in future classes. In addition, uncertainties relating to the use of mobile technology for aiding student-lecturer interactions were lower after using IMMAP. Significance difference of pretest and posttest assessments were found for uncertainty avoidance, system quality, and overall intentions to use IMMAP. Therefore, this IMMAP's features to aid student-lecturer interactions were successfully implemented. In addition, it is theorized that allowing students to send private messages to their lecturers may have lowered their level of uncertainties and overall intentions to continue using IMMAP.

Lower perceptions of IMMA's ease of use and respondents' self-efficacy are cause for concerns. This paved the way for further investigation of the importance of assuring the mobile technology's ease of use and ways to increase mobile users' confidence in the efficacy of the mobile technology, shown to be an important factor in studies of technology acceptance (Alalwan et al., 2015; Hillier, Beauchamp & Whyte, 2013; Lee & Lehto, 2013; Shroff et al., 2011; Visinescu et al., 2015). Notably, IMMAP did not increase respondents' enjoyment, and was found to be significant. This is a cause of concern as enjoyment has been widely researched and proven an important determinant of the acceptance of educational technologies (Chen, Shih, & Yu, 2012; Padilla-Meléndez et al., 2013; Teo & Noyes, 2011). The lack multimedia features, such as voice of audio messages, and also fun emoticons were theorized to have contributed to the decreased level of enjoyment. Therefore, future enhancements of IMMAP are warranted, specifically on features deemed important to make student-lecturer interactions enjoyable.

To conclude, by testing the hypothesized relationships in the framework, and demonstrating the findings in an experimentat, this research helps to extend the body of knowledge on the antecedents and outcomes of mobile technology use to aid student-lecturer interactions. In addition, a more inclusive findings relating to mobile technology use in higher education are achieved as the study was conducted in Malaysia, a non-western country. Besides adding new knowledge to the literature of mobile technology, and its applicability to support teaching and learning in higher education, the findings are useful for educators who wish to develop and use educational mobile messaging applications to interact with their students.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

Article in Academic Journals

Gan Chin Lay & Vimala Balakrishnan (2017). Enhancing classroom interaction via IMMAP–An Interactive Mobile Messaging App, Telematics and Informatics, 34(1), 230-243 (ISI Cited Publication)

Vimala Balakrishnan & Gan Chin Lay (2016). Students learning styles and their effects on the use of social media technology for learning, Telematics and Informatics, 33(3), pp. 808-821 (ISI Cited Publication)

Gan Chin Lay & Vimala Balakrishnan (2016). An empirical study of factors affecting mobile wireless technology adoption for promoting interactive lectures in higher education, The International Review of Research in Open and Distributed Learning, 17(1): 214 - 239 (ISI Cited Publication)

Gan Chin Lay & Vimala Balakrishnan (2014). Determinants of mobile wireless technology for promoting interactivity in lecture sessions: An empirical analysis, Journal of Computing in Higher Education, 26, pp. 159 - 181 (ISI Cited Publication)

Vimala Balakrishnan & Gan Chin Lay (2014). A Framework to Promote Interactivity Using Mobile Wireless Technology in Universities Lecture Environment, Journal of Teaching and Education, 2(3):193 - 198 (Non-ISI/Non-SCOPUS Cited Publication)

Vimala Balakrishnan & Gan Chin Lay (2013). Mobile Wireless Technology and Its Use in Lecture Room Environment: An Observation in Malaysian Institutes of Higher Learning, International Journal of Information and Education Technology, 3(6), 634-637 (Non-ISI/Non-SCOPUS Cited Publication)

Proceeding

Vimala Balakrishnan & Gan Chin Lay (2015). Mobile Technology and Interactive Lectures: The Key Adoption Factors, In Churchill, D., Chiu, T.K.F. & Gu, N. (Eds.) Proceedings of the International Mobile Learning Festival 2015: Mobile Learning , MOOCs and 21st Century Learning, pp. 94 - 114

Vimala Balakrishnan & Gan Chin Lay (2013). An Exploratory Study of Lecturers Perceptions on the Use of Mobile Wireless Technology to Improve Lecture Interactivity, Joint International Conference on Engineering Education and Research and International Conference Information Technology, pp. 415 - 422 (*Non-ISI/Non-SCOPUS Cited Publication*)

Chapter in Book

Vimala Balakrishnan & Gan Chin Lay (accepted) Mobile Technology and Interactive Lectures: The Key Adoption Factors, Lecture Notes Educational Technology, In Churchill, D. et al. (Eds.) Mobile Learning Design, Chapter 7

Awards and Recognition

International Engineering Invention & Innovation Exhibition (i-ENVEX) 2015 - IMMAP, UniMap, 2015, (NATIONAL)

MyAppsTech 2015 - IMMAP, University of Malaya, 2015, (NATIONAL)