STATUS OF THESIS

Title of thesis	STUDY OF MOBILE LEARNING COURSE CONTENT APPLICATION AS A REVISION TOOL

I AHMAD SOBRI BIN HASHIM

hereby allow my thesis to be placed at the Information Resource Center (IRC) of Universiti Teknologi PETRONAS (UTP) with the following conditions:

1. The thesis becomes the property of UTP
2. The IRC of UTP may make copies of the thesis for academic purposes only.
3. This thesis is classified as

☐ Confidential

☐ Non-confidential

If this thesis is confidential, please state the reason:

_____

_____

The contents of the thesis will remain confidential for _____ years.

Remarks on disclosure:

_____

_____

Endorsed by

_____ _____

Signature of Author | Signature of Supervisor

Permanent address: | Name of Supervisor

4076-D, Jalan Raja Dewa Hilir, | Assoc. Prof. Dr. Wan Fatimah Wan Ahmad

15150 Kota Bharu,

Kelantan, Malaysia.

Date : _____ | Date : _____

UNIVERSITI TEKNOLOGI PETRONAS

STUDY OF MOBILE LEARNING COURSE CONTENT APPLICATION AS A REVISION TOOL

by

AHMAD SOBRI BIN HASHIM

The undersigned certify that they have read, and recommend to the Postgraduate Studies Programme for acceptance this thesis for the fulfilment of the requirements for the degree stated.

Signature: _____

Main Supervisor: ASSOC. PROF. DR. WAN FATIMAH WAN AHMAD

Signature: _____

Co-Supervisor: DR. ROHIZA AHMAD

Signature: _____

Head of Department: DR. MOHD FADZIL HASSAN

Date: _____

STUDY OF MOBILE LEARNING COURSE CONTENT APPLICATION AS A REVISION TOOL

by

AHMAD SOBRI BIN HASHIM

A Thesis

Submitted to the Postgraduate Studies Programme

as a Requirement for the Degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY

COMPUTER AND INFORMATION SCIENCES DEPARTMENT

UNIVERSITI TEKNOLOGI PETRONAS

BANDAR SERI ISKANDAR,

PERAK

JUNE 2011

DECLARATION OF THESIS

Title of thesis	STUDY OF MOBILE LEARNING COURSE CONTENT APPLICATION AS A REVISION TOOL

I AHMAD SOBRI BIN HASHIM

hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTP or other institutions.

Witnessed by

_____ _____

Signature of Author Signature of Supervisor

Permanent address:

4076-D, Jalan Raja Dewa Hilir,
15150 Kota Bharu,
Kelantan, Malaysia.

Name of Supervisor
Assoc. Prof. Dr. Wan Fatimah Wan Ahmad

Date : _____ Date : _____

ABSTRACT

Nowadays, mobile phones technologies are being utilized in the education field as a new electronic learning (e-learning) in transferring the knowledge to the learners. The combination of mobile phones technologies' elements has influenced the way students learn, increase their performance and change the study environment. Mobile learning (m-learning) can overcome the limitation of the locations and times taken place for learners' learning activities. This study aims to fulfil three main objectives; to design a suitable model that can be used to develop mobile learning course content application as a revision tool; to develop mobile learning course content application as a revision tool for System Analysis and Design (SAD) course called Mobile System Analysis and Design (MOSAD); to evaluate the effectiveness and usability of the developed application. The development of MOSAD application has taken several aspects into considerations such as learning theories, elements of mobile technologies and mobile learning development principles. This will ease the learners in using the developed application and giving the learners understanding of the topic discussed in the application. The developed application adopted ADDIE methodology into the MOSAD Life Cycle, as the Instructional Design Method. The MOSAD application has been developed using Java JCreator LE, Sun Java Wireless Toolkit version 2.5.2 and Microsoft Paint. The application contains several sections which include Objectives, Introduction, Course Contents, Summary, Quiz, References and Help. The MOSAD application is developed as a tool for second year Business and Information System (BIS) students of Universiti Teknologi PETRONAS (UTP) to do the revision as a preparation for any assessments such as tests and examinations. Quasi Experimental Design was conducted to 116 second year UTP BIS SAD course students. Various instruments such as heuristic evaluation, post test, questionnaires and observation have been designed to measure the effectiveness and usability of the developed application. The effectiveness and usability of the application were evaluated based on qualitative and quantitative analysis using SPSS

software. Overall, the results show that MOSAD application is effective as a revision tool for SAD students and it fulfilled the usability needs.

ABSTRAK

Pada masa ini, teknologi telefon bimbit telah digunakan dalam bidang pendidikan sebagai medium baru bagi pembelajaran elektronik (e-learning) untuk menyebarkan pengetahuan kepada pelajar. Kombinasi unsur teknologi telefon bimbit telah mempengaruhi kaedah pembelajaran pelajar, meningkatkan prestasi mereka dan menukar persekitaran pembelajaran. Pembelajaran mobile (m-learning) dapat mengatasi keterbatasan tempat dan masa yang digunakan pelajar untuk kegiatan pembelajaran. Penyelidikan ini bertujuan untuk memenuhi tiga objektif utama; untuk merekabentuk model yang sesuai yang boleh digunakan untuk membangunkan kandungan pelajaran bagi aplikasi m-learning; untuk membangunkan kandungan pelajaran bagi aplikasi m-learning sebagai alat ulangkaji matapelajaran System Analysis and Design (SAD) yang dinamakan sebagai Mobile System Analysis and Design (MOSAD); untuk menilai keberkesanan dan kebolehgunaan aplikasi yang telah dibangunkan. Pembangunan aplikasi MOSAD mempertimbangkan beberapa aspek termasuk teori pembelajaran, unsur-unsur teknologi telefon bimbit dan prinsip-prinsip pembangunan teknologi pembelajaran mobile. Hal ini akan memudahkan pelajar dalam menggunakan aplikasi yang dibangunkan dan memberikan pemahaman kepada pelajar tentang topik yang dibincangkan di dalam aplikasi. Aplikasi yangg dibina telah mengadaptasikan metodologi ADDIE ke dalam Kitaran Hidup MOSAD yang mana ianya berperanan sebagai model Instructional Design. Aplikasi MOSAD telah dibangunkan menggunakan Java JCreator LE, Sun Java Wireless Toolkit versi 2.5.2 dan Microsoft Paint. Aplikasi ini mengandungi beberapa bahagian yang meliputi Objektif, Pengenalan, Kandungan Topik, Rumusan, Kuiz, Rujukan dan Bantuan. Aplikasi MOSAD dibangunkan sebagai alat yang boleh digunakan oleh para pelajar tahun kedua jurusan Perniagaan dan Sistem Maklumat (BIS) di Universiti Teknologi PETRONAS (UTP) untuk melakukan ulangkaji sebagai persiapan bagi menghadapi penilaian-penilaian seperti peperiksaan. Eksperimen Quasi dilakukan melibatkan 116 pelajar tahun kedua yang mempelajari SAD dalam bidang BIS di UTP. Pelbagai instrumen seperti penilaian heuristik, pasca ujian, soal selidik dan pemerhatian telah

digunakan untuk menilai keberkesanan dan kebolehgunaan aplikasi yang dibangunkan. Keberkesanan dan kebolehgunaan aplikasi dinilai berdasarkan analisis kualitatif dan kuantitatif menggunakan aplikasi SPSS. Secara keseluruhannya, analisis menunjukkan aplikasi MOSAD berkesan sebagai alat mengulangkaji untuk pelajar dan memenuhi kehendak kebolehgunaan.

ACKNOWLEDGEMENT

I would like to take this opportunity to express my gratitude to everyone involved in making this project a success. First and foremost, all praises to Allah for His guidance and for giving me strength from the start until the completion of this project.

I would also like to give my upmost appreciation especially to my supervisor, A.P. Dr. Wan Fatimah Wan Ahmad and co-supervisor, Dr. Rohiza Ahmad for their support and advices throughout the project period. This project is quite a challenge for me; therefore, it would be harder to finish the project without them guiding me along the way.

My greatest gratitude is also dedicated to UTP second year, first semester students in July 2009 and January 2010 semesters from Business and Information System (BIS) programme. They had willingly participated in the preliminary studies and testing phase of this project and helped me by giving their feedbacks. Their opinions and suggestions have provided me with a lot of ideas to improve the quality of the project.

Last but not least, I would also like to give my special thanks to my parents, family members, and friends for their endless support for my endeavour. I am very fortunate to have them, supporting me through whatever difficulties I have encountered.

There are no words that I can use to show how thankful I am to the individuals and parties who were directly or indirectly involved in this project. My hope is that, one day all of you will be rewarded for your kind effort with a lot of successes in life.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I
INTRODUCTION

1.1 Background of Study

The field of education has been significantly impacted by the revolution of Information and Communication Technology (ICT). The conduct of distance learning in particular, has been transformed by the technology from independent study with once in a while face-to-face contact of learners with their educators to convenient anytime online learning or better known as electronic or e-learning. The concept of distance education which has been adopted around the world began to shift to the electronic learning in the 1980's which also marked as the beginning of a personal computer usage era. With the rapid development of technology such as the World Wide Web (WWW) and the Internet around the 1990's, online learning is becoming even more attractive due to the ample amount of learning resources available online (Demiray, 2011).

Recently, the development of communication technologies in the form of mobile technology and wireless technology has further provided the opportunity to introduce a new mode of learning into the education system. As a result, mobile learning method has been introduced to the society. Mobile learning is a step forward in the development of electronic learning. With the production of mobile communication devices, educational experts try to take the initiative to utilize the tools for the teaching and learning processes. Some mobile learning researchers such as (Siraj, 2004) said that mobile devices allow the students to share the information, coordinate their tasks efficiently and to function more effectively in the situations that require cooperation among them. Based on the above statement it can be said that mobile learning is not meant to replace e-learning but rather it can be used to complement the process of learning especially in situations where collaboration is highly needed.

Besides developing mobile learning applications for the acquirement of knowledge, mobile learning application can also be used as an effective revision tool for the students. According to ("Encarta® World English Dictionary," 2009), revision is a study that involves looking at over notes and other course materials in preparation for a test, assessment or examination. Currently, the conventional revision style is pretty much still dependant on books and notes. Students need to read the thick books and flip through their lecture notes in order to get prepared for an assessment. However, this method consumes more time for students who are given only a short period of time for revision. For examples, most universities provide only one week for study week before sitting for the final examination. Of course, during the one week period, the students will need to revise multiple subjects with multiple books and notes. For the smart students, they will come out with short notes based on the studied topics as the revision method. This approach reduces the time used for the students to do the revision as the purpose of the revision which is to refresh the student's memory on the studied topics. However, this approach does have its fallback. Like any other paper-based methods, there is a tendency for the students to lose the revision materials due to the unorganized way of keeping the materials themselves. Hence, the introduced electronic learning can overcome this problem in which the learning materials are kept in the system's database. However, there is still a limitation to electronic learning. Students need to find a location which is equipped with the Internet access in order to get the revision materials. Due to this limitation, mobile learning application which supports "at anytime and anyplace" mode of learning will be a better solution. Students only need to bring their mobile phones in order to perform the revision activities. Due to the mobility of a mobile learning application, it gives bigger freedom for the students to do the revision at any location and at anytime.

As mentioned before, revision is used to refresh the student's memory on the studied topics. For descriptive type of courses which deal with many concepts that need to be understood by the students throughout the topics learned (Hashim, Ahmad, & Ahmad, 2010b), students need to read the whole content of a concept before they can grasp and understand its major ideas. This issue becomes a big challenge to the mobile learning developers. This is due to the physical limitations of the targeted

devices themselves such as small screen size and limited storage space which make it hard to almost impossible to insert all information into the mobile learning applications. Thus, this research is aimed to propose a method for developing an effective mobile application content for revision of descriptive type courses. For the purpose of proving that the method works, a mobile application was developed for the System Analysis and Design (SAD) course. The course is one of the descriptive courses which are currently taught to second year Business and Information System (BIS) students in Universiti Teknologi PETRONAS (UTP). This course requires the students to understand the concepts that are related to the analysis of a system and the various system designs available. To further narrow down the focus of the work, the topic of Project Initiation which is taught during the early semester was chosen to be the content of the application. The choice was made due to the topic being a fundamental topic for the course. It involves many basic concepts that act as platforms for other topics throughout the semester.

1.2 Problem Statement

As the focus of this research is to look into the revision component of mobile learning application, few existing loopholes or problems have been identified to support the worthiness of the research. The identified problems can be divided into two issues which are the lack of research in terms of investigating the effectiveness of revision using mobile learning applications and the lack of learning theories and mobile usability guideline incorporation during the development of mobile learning applications. Details of the two problems are elaborated below.

1.2.1 Study on Effectiveness of Revision in Mobile Learning Applications

Effectiveness has been one of the metrics besides efficiency and usability which is often used by researchers and application developers to evaluate an application software (Seffah, Donyaee, Kline, & Padda, 2006) . Thus, effectiveness is often measured by giving application users some tasks to be completed by using the application evaluated. In other words, performance of users is an indicator of the effectiveness of an application. Similarly, for

learning applications, many published works can be found to have measured the effectiveness of certain applications (Ahmad, 2004; Baharom, 2000; Masri, 2009). All of them developed the learning applications for Mathematics and Literature courses. After completing the research, they found out that developed multimedia learning applications were more effective learning approach as compared to the conventional approaches. However, there is very limited evidence that a study on effectiveness had been conducted specifically on a component of the application which is the revision component. For learning applications which are developed for desktops or any other big display devices, putting all course contents for students to read will not be a problem. Hence, the function of the revision component will not be of glaring importance. However, for mobile devices, in particular the mobile phones, due to their limited screen size, the contents to be disseminated must be properly chosen and presented. Thus, this somewhat mimics what students are doing when they do revision (Evans, 2008; Hashim, Ahmad, & Ahmad, 2011). Readers might argue, if the above is the case, then why mobile learning application is needed in the first place. This can be answered by stating the advantages of mobile learning. Among others, it overcomes the barriers of time and place for learning (Siraj, 2004; Stansbury, 2009). To further support the above, a preliminary study (Hashim et al., 2010b) has been conducted early in this research to 82 students of Universiti Teknologi PETRONAS's (UTP) System Analysis and Design (SAD) course on students' perceptions about mobile learning utilization in higher education especially in UTP (see Appendix A). One of the objectives of this study is to get the students' opinions on mobile learning utilization as compared to the current learning practices in six pre-determined aspects which are freedom in learning activities, effective way of learning, time to get learning materials, revision for examination preparation, remove formality and study group practices encouragement. The results of the survey showed that mobile learning was highly perceived by the students to be an advantage to them as compared to the current learning practices. The average response for each question for mobile learning utilization is rated 4.2175 as compared to the response to the same questions for current learning practices, 3.3544. The detailed result is

presented in **Appendix B**. The result implies that the students believed mobile learning utilization can overcome the current learning practices limitations in the stated six pre-determined aspects especially for revision purposes. Therefore, a proper study is worthy to be conducted to really look into the right way of developing a mobile learning application for revision purposes.

1.2.2. Incorporation of Learning Theories and Mobile Usability Guidelines in Mobile Application Development

In line with the issue discussed in 1.2.1, development of mobile learning application for revision purposes will need to embed relevant learning theories as well as follow certain mobile usability guidelines so that an effective and usable application can be produced. Currently, as reviewed from existing published works, significant weakness which can be found in most developed mobile application is long text content with scrolling navigation. Some mobile learning applications provide long texts for the learners to read and they need to scroll either up, down, left or right in accessing the whole contents of the application (Hashim, Ahmad, & Ahmad, 2010a; Seong, 2006). The literature studies (Donnelly & Walsh, 2009) that have been conducted found that the long texts with scrolling way of navigation will make the learners very hard to read and searching the key points of the contents due to small screen size of mobile phones. Smaller screens will slow down the reading speed (Uther, 2002) by disrupting the eye movements' normal pattern (Kaikkonen & Laarni, 2002).

Furthermore, existing mobile learning applications are also found to be a bit complex for learners to use. Learners especially those who are not too familiar with the technology used in the application found it difficult to use such application (Grasso & Roselli, 2005; Seong, 2006). Complex mobile learning application here refers to the hard time taken by the learners to understand how to operate the application in doing their studies. It includes the complexity in terms of navigation, content and structure of application, content management and others (Donnelly & Walsh, 2009). The development

of complex mobile learning application can be avoided by taking the user factors into considerations (Seong, 2006). The developers should know the users' level of mobile application familiarity. Besides, different education level of studies also will have different experiences in using mobile application technologies (Sajjad, 2010). In making mobile learning application as an effective learning and revision tool, the developers need to ensure that the learners spend more time in understanding the learning content of the application rather than taking much time in assessing how the application works due to the developed complex mobile learning application (Göth, Frohberg, & Schwabe, 2006).

In developing mobile learning application as a revision tool, the developed application needs to help the students in doing revision in a simpler way as compared to the conventional revision method. Thus, the long text learning content with scrolling navigation and other complexities will need to be avoided. The stated problem can be overcome by taking the adoption of learning theories and mobile application usability practices into account (Seong, 2006).

1.3 Objective of Study

Based on the indentified problems that have been discussed in section 1.2, this research aims to study on mobile learning course content to assist the students in doing revision as preparation for the assessments such as examinations and tests. There are three specific objectives to be achieved at the completion of the study:

1. To propose a conceptual framework for development of mobile learning course content as a revision tool.
2. To develop mobile learning course content application as a revision tool by incorporating two elements which are learning theories and mobile application development guidelines.

3. To evaluate the mobile learning application as a revision tool in terms of effectiveness and usability.

1.4 Research Question

Due to the limited timeframe of the research, not all of the topics in SAD will be implemented in MOSAD. Rather, only one topic, the Project Initiation was chosen as the case study. The Project Initiation topic is one of the topics included in the syllabus of the SAD course taken by BIS students at UTP. As mentioned earlier in the Introduction, the reason for choosing this topic is due to its being the foundation of all the other topics of the course. Hence, understanding of the topic will be crucial for the students to proceed smoothly in the course. The application that will be developed is called Mobile System Analysis and Design (MOSAD). There are several research questions that have been created in order to realize the research objectives. The questions can be categorized according to three main questions, each with its own sub research questions as follows:

i. *How can a framework for mobile learning course content development be designed as an effective revision tool?*

   In order to design a suitable framework for mobile learning course content as a revision tool, two elements need to be studied and will be integrated in designing the model. The elements that will be investigated include learning theories and mobile learning development principles.

ii. *How can the usability of the mobile learning course content as a revision tool be evaluated?*

   The usability will be measured in terms of consistency, flexibility, learnability, minimal action and minimal memory load of the application. The sub research questions are stated as follows:

- Do the usability elements in MOSAD application help students in doing the revision through mobile phones?
- Do the students agree with the usability elements in MOSAD application?

iii. How can the effectiveness of the mobile learning course content as a revision tool be evaluated?

The effectiveness of mobile learning course content application will also be measured. The evaluation of the effectiveness of MOSAD application requires the answer to two sub research questions as follows:

- Does the MOSAD application increase the understanding of the Project Initiation topic among the second year BIS students of UTP as compared to the conventional revision methods?
- Is the MOSAD application is an effective tool for students to do revision?

1.5 Hypothesis

In measuring the effectiveness of MOSAD application as a revision tool, a post test will be conducted to two groups of participants namely control (X_1) and experimental (X_2) group. The X_1 will use the conventional revision methods while X_2 will use the MOSAD application to do the revision. The setup of the post test will be further explained in section 3.4.1 and 3.4.4.2. Finally, the result of this test will determine either to accept or reject the constructed null hypothesis below:

Null hypothesis, (H_0): *There is no significant difference between the post test mean score of control (X_1) and experimental (X_2) group.*

1.6 Scope of Study

The scope of this study is outlined as follows:

- The scope of study is focused on the Project Initiation topic of System Analysis and Design (SAD) course.
- The development of MOSAD application will focus on the revision aspect of course content. Content, structure and navigation mechanisms will be the elements to be investigated.
- For the effective mobile learning application development, the mobile learning development principles and learning theories have been adopted into the application. The adopted mobile learning development principles include content, natural usage, navigation, consistency and flexibility. Meanwhile, the learning theories that have been adopted in the MOSAD development are drill and feedback concept of behaviourism learning theory, short-term and long-term concept of cognitivism learning theory, learner-centered approach of humanism learning theory and, chunking and short-term memory capacity concept of information processing learning theory.
- This study is also concentrate to three types of tests which include heuristic evaluation, usability test and effectiveness test.

1.7 Research Framework

Before the research work starts, a research framework as shown in Figure 1.1 was outlined to guide the nature and scope of work the research will be focusing upon. Basically, three major outputs are expected to be produced by the research which is the conceptual framework for MOSAD, the prototype of MOSAD and the evaluation results of MOSAD. In order to achieve the targeted outputs, the development of MOSAD will take into considerations the instructional design, mobile technology, device technology as well as user and content requirements. And while doing all the above, each component must be aligned to the mobile environment.

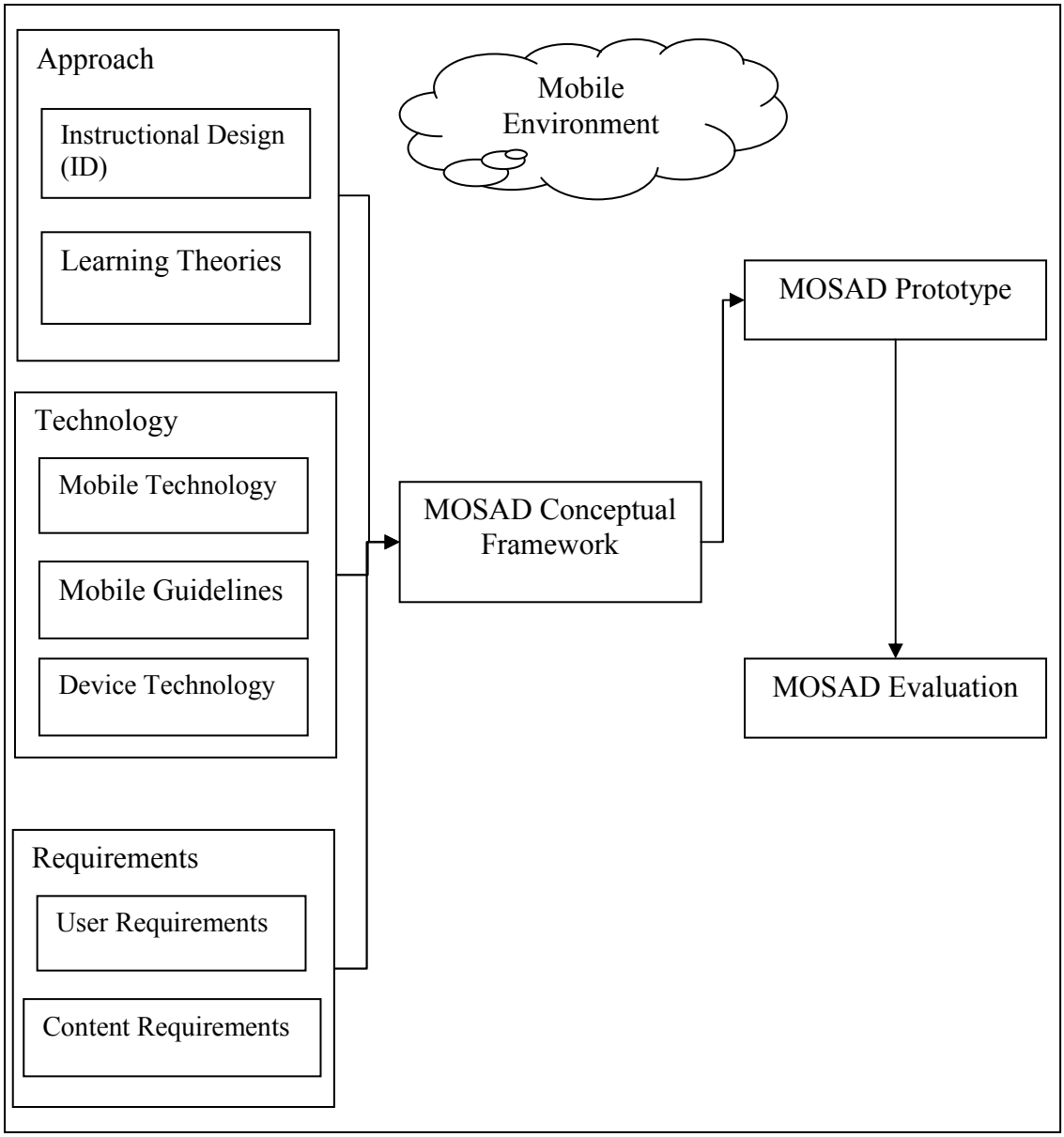


Figure 1.1: Research Framework

1.8 Organization of Thesis

This thesis is divided into five chapters. Chapter 1 discusses the background of the study, the context in which the research problems is studied, objectives and the research questions. Chapter 2 presents a review of the literature related to the topic under study. It examines various literatures on the definition of mobile learning, learning theories and mobile learning development principles that can be adapted. It also presents some of the previous work done by the developers on mobile learning application and its application usage. Chapter 3 presents the research design and

methods used in the study. In Chapter 4, development of the prototype, results and analysis of the tests conducted derived from the conceptual framework are reported. Chapter 5 concludes this study by summarizing the results of the research question identified in Chapter 1, emphasizing the contributions of the study and recommends some areas for future works.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature review on fundamental study of mobile learning (m-learning) utilization in the education sector. Some of the basic concepts that have been implemented in the reviewed research works are discussed in detail in this chapter which include definition and evolution of learning and learning styles, m-learning, in particular its definition and description, advantages and some samples of learning components supported, examples of existing m-learning applications, current issues in m-learning application practices and development, learning theories that can be adopted in m-learning course content application and m-learning course content application development principles.

2.2 Learning and Learning Approaches Evolution

Wirth & Perkins (2008) mentioned that learning is a constructive and unreceptive process of acquiring the knowledge and information. This learning definition holds that understanding comes through experiences and the surroundings interaction, and that the learner utilizes a previous knowledge foundation build a new understanding. Consequently, the learner has primary responsibility for constructing knowledge and understanding.

There have been many learning approaches being introduced by the academic practitioners and the technologists; and, the evolution of these learning approaches often time was impacted by the advancement in technology (Naidu, 2006). Figure 2.1 shows the changes of learning approaches from the very basic approach to the most advance and current, approaches of learning.

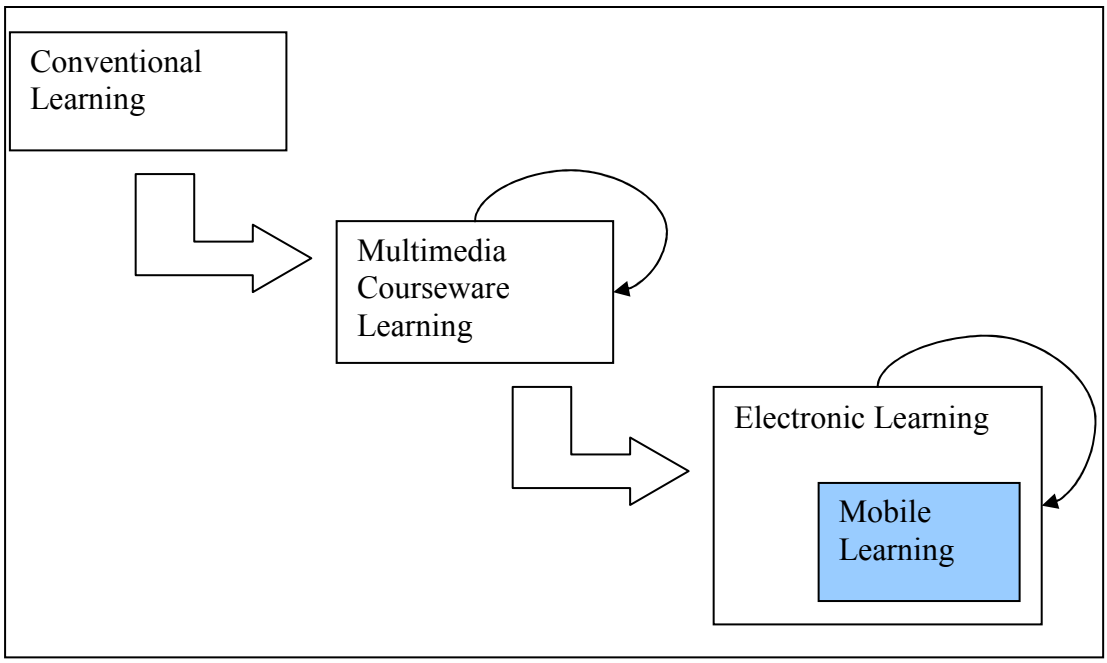


Figure 2.1: Changes in Learning Approaches

As mentioned by Al-Jabr (2006), conventional learning approach performs learning activities within the limitations of classroom and lecture hall. Classes were pre-scheduled, and the students need to attend them accordingly. Besides that, the learning approach effectiveness is usually measured by conducting written examinations for the students at specified dates and times. Other than that, oral examinations might sometimes be given to the students in order to assess their performance. Moreover, in this learning approach, instructor or teacher and the book are the main sources of information and hence, this learning approach is also known as teacher-centered and book-centered approach of learning. Students heavily rely on teachers and books, or otherwise, they cannot perform their studies. Thus, the limited sources for learning become the major weakness of this type of learning approach.

Due to the weakness of the conventional learning approach mentioned previously, the role of teachers was redefined. Teachers are no longer seen as only the source in learning, but their tasks are more of an instructor, manager and motivator in the teaching and learning process. Hence, with the new role, other sources for supporting learning were investigated. This has brought the implementation of computer and multimedia technology into education. As mentioned by Masri (2009), many academic practitioners and educators nowadays decided to utilize the computer

and multimedia technology as learning tools in order to increase the students' performance in the process of learning. Thus, multimedia courseware is one of these tools. Multimedia courseware is educational software that involves the combination of graphics, images, audio, texts and video. By implementing the interactivity concepts, learning activities using multimedia courseware become more interesting and able to achieve the expected education goal (Cereijo, 2010). The main advantage of multimedia courseware learning approach is it can overcome the students' sole dependencies on their teachers. Students can learn independently in an interactive surrounding and in a meaningful way. Moreover, in some cases, as stated by Andrade et al. (2008), multimedia courseware can help students in understanding information better than the conventional classroom learning. However, this learning approach also has some weaknesses such as it lacks interactions among the students as well as between a student and the teacher.

From the two learning approaches above, learning approach has further evolved into the electronic learning (e-learning). A simple way to define e-learning would be the use of networked information and communication technology in learning activities. The other terms that are often used to describe this kind of learning are online learning, virtual learning, distributed learning, network and web-based learning (Naidu, 2006). The fast growth in the Internet and the World Wide Web (WWW) technology influenced the utilization of e-learning in the current learning practices (Tutunea, Rus, & Toader, 2009). The main advantage of e-learning approach is it provides the flexibility in getting the learning materials and sources, and saves the costs of getting the sources as long as the Internet connection is available (Foppoli, 2010). However, like any other learning approaches, e-learning also has it weaknesses. One of it is its dependency on the Internet connection. Unavailability of the Internet network connection will disturb the learners' learning activities.

The above has brought along another new learning tool which is the m-learning. M-learning is one of the latest learning tools from e-learning approach that have been introduced to the education field nowadays. M-learning is a learning method in which a learner is given an opportunity to do learning activities using mobile devices such as cellular and smart phones (Geddes, 2004). The basic benefit of

m-learning is the freedom, power and choice. By using m-learning, learner can decide when, where and how the studies can be performed. On top of that, learning no longer needs to rely upon a fixed network connection to the Internet. The mobile technological advancement such as Wireless Application Protocol (WAP), Wireless Fidelity (WiFi) and General Packet Radio Service (GPRS) influenced the m-learning utilization in educational sector nowadays (Upadhyay, 2006). Due to the benefits of the learning approach, this research will focus on this learning approach in supporting learning activities. Hence, further discussions on concepts and issues related to the m-learning will be discussed in details in the next sections.

As a conclusion to this section, even though the learning approaches depicted in Figure 2.1 are shown to have changed from one stage to another, it does not mean the previous stages have been completely obsolete. Rather, the loops drawn at every stage means the technological-based learning approaches (multimedia courseware learning, e-learning and m-learning) are still being improved respectively until today in line with the emergence of new and more advance technologies.

2.3 M-Learning

As the definition given by Geddes (2004), m-learning is a learning approach whereby learners are given freedom to do the learning activities using the applications provided by mobile devices such as cellular and smartphones. Traxler (2009) and Quinn (2000) gave similar definition of m-learning as 'mobile e-learning' instead of 'm-learning' which means for access to the learning materials located at a remote site, mobile devices such as PDAs, palmtops, handhelds or smartphones or mobile phones will need to be used. The other m-learning definition is any kind of learning activities that occur when the students can do the learning activities at any locations, or learning that occurs when the students take the mobile technologies as the opportunities of another learning medium (O'Malley et al., 2003).

Walsh (2009) discussed five characteristics of m-learning applications. The characteristics include ubiquitous, bite sized, on demand, typically blended and can be collaborative. The term ubiquitous means m-learning content can be accessed at any

location due to the increasing coverage by mobile networks providers. Besides, m-learning also needs to be short application so that there will be no interruption in getting the application and in accessing the content of the application. Basically, m-learning applications are always on demand or pull-based. Usually, mobile devices provide access based on demand from the learners. When a specific m-learning application is needed by a learner, the application server will deliver it to the user. Other than that, the developed m-learning application needs to always blend with the existing common approach. For example, tutoring support, preparing quizzes, provides lecture materials and others must be supported like in other learning approaches. The last characteristic is that the developed m-learning application should always utilize the communication function provided by mobile devices. This characteristic allows users to communicate and discuss about learning either among the students or the teachers.

The main factor that influences the implementation of m-learning approach in the education sector is the rapid growth of mobile devices usage and its technologies in the world. United Nations (UN) (2009) reported that 60% of the world's population used mobile phones at the subscription rate of 4.1 billion per year, which showed an increase of 1 billion in number of mobile phones users since 2002. In term of technology, in 2008, 95% of new mobile phones had been found to have web browsers features (Zambonini, 2009). The other factor that has influenced the m-learning implementation is the current learning environment (Nasiri & Deng, 2009). Nowadays learning environment is changing from teacher-centered and book-centered learning to student-centered and active learning. In supporting this new trend of learning, developers have come out with the idea to develop m-learning instead of only relying on the e-learning.

2.3.1 Advantages of M-Learning

As stated earlier, the availability of mobile devices nowadays really encourages the implementation of m-learning applications. Besides that, the advantages of the learning approach also play a role in its acceptance in the education world. In a study, Siraj (2004) found out that m-learning implementation can reduce illiteracy in

developing countries. For countries that have huge number of citizens and poor, development of education requires high costs especially in infrastructure development, learning facilities and salary payment for educators. She argued that since mobile devices to be used in learning are much cheaper, this learning approach is more suitable to be applied in order to help reduce the illiteracy.

Moreover, another advantage of m-learning is its ability in supporting life time learning. Since m-learning applications can be used at anytime and anywhere, the users of m-learning applications can always use the applications to do whatever learning activity that needs to be done at their convenience. For example, tourists can use m-learning application like dictionary to search the meaning of certain words during traveling at foreign countries. Other than that, users can also use m-learning application to search for any information that they might come across while conducting their daily chores (Siraj, 2004; Stansbury, 2009). This also means there is no restrictions in terms of the place and time where and when learners need to do the learning activities (Siraj, 2004). This facility allows learners to have learning activities during free time such as while waiting for the bus or traveling or in many other different situations. Furthermore, by having no time and space restrictions problems such as lecturers need to come to class and deliver the course contents, specific period to deliver the course contents and limited contents presentation to limited number of students can be solved (Siraj, 2004). Knowledge acquirement and retention can also be improved using m-learning as stated by Jacob and Issac (2007).

Other advantage of m-learning is it can remove some of the formality from the learning experience. By implementing m-learning, learners can reduce the dependencies to the formal class period and dependencies to the lecturers. By reducing these dependencies, students can be given more freedom in choosing the way of studies. By giving freedom to students, self-esteem and confidence of the students can be increased (Attewell, 2004).

Besides that, m-learning also supports collaborative learning. Collaborative learning is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product.

Collaborative learning is based on the idea that learning is a naturally social act in which the participants communicate among themselves. It is through the communications that learning occurs (Srinivas, 2009). Quality Improvement Agency (2009) explained that collaborative learning allows learners to do the learning activities in group whereby it provides to the learners with the communication channels so that learners can discuss and share certain information during the learning activities.

Jacob and Issac (2007) stated four aspects of m-learning advantages. The aspects include easy access, options for self-study, evaluation and feedback, and access of online repository. Usually, the information is always on-demand basis. By updating the information via m-learning application, learner can always get easy access in getting updated knowledge. Besides, by implementing m-learning, students can take the opportunity to learn at their own time and pace as compared to personal computer (PC) access. As a result, it will increase the students' information or knowledge retention. Furthermore, by using m-learning, it also can provide an assessment tools to monitor students' progress or performance and come out with the reports. These reports will act as a feedback to the teachers and students. Besides that, m-learning also can be used as online repository of knowledge. Instructor can put the content of knowledge into the database and by using the application; students can always access it at anytime.

Naismith et al. (2004) also have similar point of views regarding advantages of m-learning with previous stated authors. However, Naismith et al. added that m-learning utilization will enhance the students' thinking development. By implementing m-learning, the users will not be rigid only to the developed m-learning application itself. The users always can do further studies by searching to the other wide sources. The introduced mobile network technologies of Wireless Fidelity (WiFi), General Packet Radio Services (GPRS) and Wireless Application Protocol (WAP) influenced the Internet utilization through mobile phones whereby it can help the users in accessing whatever information for the learning purposes (Upadhyay, 2006). By having this kind of learning process, students' thinking ability can be improved due to many sources of information that can be reached.

Many benefits and advantages can be grabbed from the introduction of m-learning technology in today's education world. Not only learners and teachers that can use this new learning approach, other people also can maximize the mobile phones utilization by getting the desired information in supporting the life-long learning in the society. Advanced and knowledgeable society can be produced as a result of m-learning utilization.

2.3.2 M-Learning in Education Sector

The education sector has been known to be the sector that benefits most from the utilization of m-learning. For example, in the higher education environment, m-learning has been utilized in several fields of study including medical, geosciences, traditional and culture, and many others. Generally, m-learning utilization has been practiced as a medium to spread the knowledge regarding these fields. Basically, most components of learning such as presenting lecture materials, giving quizzes and some other form of assessments, providing a platform for discussions can be supported by m-learning.

As an example, in the medical education field, Zolfo et al. (2009) introduced a mid-term evaluation of innovative approach to the healthcare workers' training with utilization of mobile technology as personal learning environment in the field of HIV and AIDS care in Peru. The training workers are given updated information on the issues of HIV and AIDS through mobile phones. It is to aid them in managing patients who get the HIV and AIDS diseases. During mid-term evaluation, the workers will be given the quizzes in order to assess the workers' understanding on the HIV and AIDS information given during training. By having this kind of continuous learning in medical education field, the students, workers and trainees will always updated with the latest medical information and knowledge.

In the geosciences field, an m-learning application called TuGeoWiki has been developed recently (Safran, Ebner, Garcia-Barrios, & Kappe, 2009). The application presents geotagged information on mobile devices. Using the application, students can get the coordinates of current location and existing places in TuGeoWiki. The

background information regarding the location will be compiled by the teacher. During the study of the subject, students can use the information compiled to better understand the relations of a location to the concepts or other locations. TuGeoWiki works as a tool in helping the teachers getting the information that can be used during students' learning sessions (Safran et al., 2009).

In the traditional and culture field, an example of m-learning applications that has been developed would be M-Tik (Ariffin & Muthan, 2010). M-Tik has been a medium of transferring information on the design of Batik in Malaysia. Basically, most of the learning Batik materials are only available in certain locations such as art gallery, library and chosen stores. The limited resource on this matter hinders the learning of Batik and also caused this field to be less appreciated by many. By having M-Tik, the Batik students and learners can learn the Batik development without going to specific places in getting the knowledge of creating Batik. As a result, m-learning application can retain the traditional and culture education so that it would not be forgotten because of the rapid modernization of today's world.

Besides for disseminating knowledge, m-learning applications can also be as one of the effective revision approaches in preparing the students for examinations. It prepares a revision space whereby users are given opportunity to get the learning materials in understanding the course and doing the quizzes in order to assess the understanding of particular course. It will be a great medium for the students to be success in the education. Evans (2008) conducted the study on the effectiveness of m-learning in the form of podcast revision lectures in higher education. Podcasting involves a series of audio or video files that can be watched or listened over and over again as a preparation before the examination. In the study, 200 first-level students were given a revision podcasts after completing a course in Information and Communications Technology as examination preparation. After using the podcasts, students were instructed to answer the survey questions. After the research conducted, students believe that podcasts are more effective learning tools than previous revision approach which using textbooks and notes. Podcast is one of the new mobile technologies that give the students an opportunity to do the systematic revision for the success during the examination.

Besides that, Bitesize Mobile developer (Bitesize, 2010) introduced a Java m-learning quiz application for secondary school students. The application prepares with two modes of usage which are online and offline. For online users, users can access through certain URL and for offline mode, the application is prepared with Java-enabled download whereby students can do the quizzes after completing the installation into the mobile phones. This application also covers three courses which are English, Mathematics and Science. Students can utilize this kind of m-learning quiz application as a preparation before sitting for the examinations.

In conclusion, m-learning can enhance the education sector through various functions. M-learning utilization is not the replacement of previous learning approaches such as computer-aided learning and e-learning. Rather, it functions as a complement of previous learning approaches whereby it is a medium that can solve the weaknesses from the previous learning approaches.

2.4 Examples of M-Learning Implementation

Recent years, many m-learning applications have been developed in order to provide students with new medium of learning. In this section, six m-learning applications will be discussed so that it produces the basic ideas of m-learning implementation usages in today's learning paradigm. The summary of m-learning applications examples are presented in Table 2.1. The explanations of the applications are describe using five parameters; usage, description, mode, the advantages and the weaknesses.

Table 2.1: Summary of Mobile Learning Application Examples

Application Name	Mobile Learning Course Manager (MLCM) (Seong, 2006)	C-Shock (News, 2007)	Mobile Museum Tours (Naismith & Smith, 2006)	Epocrates Mobile Continuing Medical Education (CME) (Crane, 2010)	Personalized Intelligent Mobile Learning System (PIMS) (Chen & Hsu, 2008)	Wireless Classroom (Singh & A.B., 2006)
Developer	Daniel Su Kuen Seong	University of Portsmouth	L. Naismith and M.P. Smith	Epocrates Inc.	Chih-Ming Chen & Shih-Hsun Hsu	Devinder Singh & Zaitun A.B.
Usage	The application is used as a portal for students in University of Nottingham	It is developed to help foreign students to manage the culture shocks of university life in Britain.	It is used for multimedia tours in traditional museum setting.	It is used as medical source of information for the medical students, medical practitioners, trainers and trainees.	It is used for supporting English language learning for non-English speakers.	It is used for class discussions and online quiz.
Description	The application consists of three main functions; "Announcements", "Assessment" and "Timetable".	It is a game-based application. The users need to complete a series of tasks that foreign students might face during their daily period in Britain.	The application delivers students-centered information to the visitors at a geology museum without taking the museum's aesthetic appeal into considerations.	The application provides clinical information and decision support tools that enable healthcare practitioners in searching for answers to medical related problems more quickly. It also equipped with series of multiple choice quiz questions.	This application prepares a list of English news and the users can choose which news to read. The application provides both modes of learning; English and Chinese to help the users to understand the meaning of the English words.	The application implements the collaboration characteristics of mobile devices whereby it provides a medium to the students in communicating and discussing about the courses taught.

					Series of new vocabularies from the news are also provided.	
Mode	Online	Offline	Offline	Online	Online	Online
Advantages	The interface design is very structured and easy to understand.	The application is very interactive and well-structured.	The application technology is easy, direct approach in explaining the contents, strong narrative, structured content and use of familiar terms.	The interfaces are very simple.	The vocabulary section is very well-structured. It can really help the non-English speakers to know the meaning of English words.	Very simple interface used.
Weaknesses	The application only can be accessed using the Internet and course materials are not provided.	Can only be accessed using smartphones, consume a lot of memory space, some interfaces are not user friendly and the instructions given in the application is too wordy.	The use of unfamiliar icon.	The use of long texts with scrolling navigation in one screen.	The use of long texts with scrolling navigation in news section.	The use of long texts with scrolling navigation and the use of unfamiliar icon.

In conclusion to this section, the m-learning applications presented above are just a few of the many other existed m-learning applications which main purpose is to contribute to the education sector with new technology of learning that can help the learners and instructors in undergoing the daily learning processes and activities using more effective and easy ways.

2.5 Issues in M-Learning

After literature studies have been conducted, it can be concluded that the idea of m-learning utilization in today's education field raised many issues. The issues include the aspects of technology, usage and the effectiveness of the application. In this section, the detail explanation will be discussed regarding the issues of availability and accessibility of the application, technological advancement, focus and pedagogical effectiveness those been adopted in the m-learning implementation.

2.5.1 Availability and Accessibility

In computer science, availability means the readiness of the developed technologies used by the target users. Usually, the availability concept is used together with accessibility concept whereby it means that the developed technologies can be used by the users through various kind of medium (Sharp, Rogers, & Preece, 2007).

M-learning implementation gives the users the opportunity to learn anytime anywhere. In accessing the learning materials at anytime and any location, users need to ensure the mobile coverage or wireless connection at the place is available or otherwise the learning activities cannot be performed. The limited mobile coverage areas and wireless connection will affect unavailability of an m-learning application (Traxler, 2009). Therefore, instead of having the m-learning application online, the developers need to consider developing an offline m-learning application. Users can get the learning materials by downloading either through mobile phones or personal computers (PC) and install it into the users' mobile phones. Thus, users can access the materials at any place without worrying the unavailability of mobile coverage and wireless connection at the current location.

2.5.2 Technological Advancement

Nowadays, the technologies are improving rapidly. In mobile application, the network and communication technologies are changing from Infrared, General Packet Radio Service (GPRS), 2G, 3G, 4G, Wireless Fidelity (WiFi), Global Positioning System (GPS) and Global System for Mobile-Telephones (GSM) (Wagner, 2005). Basically, technological advancement will give the users with more facilities in getting the information easily. However, not all mobile users are up-to-date with the latest technologies. Some of the users cannot afford to have mobile phones with all the advance facilities. Hence, it will give the users difficulties in getting the learning information since it only can be accessed using the latest communication technology of mobile phones. Because of that, it is necessary for the m-learning developers to get the target users' background before designing any application. The background might contain the types of mobile phones used by the users, the equipped communication technologies and the basic knowledge of mobile phones technologies. This information is very important so that the developed m-learning application will become useful to the target users and it can be used as a tool or medium in improving the learning activities (Bennett, 2010).

2.5.3 Focus

The basic issues when implementing m-learning include navigation, slow connection, eye strain, data transferring, storage memory, security issues and many more (Traxler, 2009). Fortunately, all the issues according to Traxler (2009) can be solved by using more advance technology of the mobile phones.

However, Goth et al. (2006) have the views regarding the usage of more advance mobile devices. Goth et al. came out with a research entitled The Focus Problem in Mobile Learning. From this research, many m-learning applications nowadays focus more on application rather than focus on the surrounding environment. The complexity of application will lead to the scenario whereby users need to use more times in studying and interacting with the application. As a result, the users will give less concentration to the surrounding. There were two

recommendations given by the author in order to decrease the focus on the application and increase the focus on the surrounding environment. The first recommendation is to focus more on Human Computer Interaction (HCI) concepts of mobile phones so that the users of the application can minimize the time used to interact with the application. The second recommendation is to avoid more advance mobile devices used for m-learning application. For example, PDAs basically are used with stylus pen. By using stylus pen, it is actually increases the focus to the application rather than the surrounding environment. In order to decrease the focus to the application, the usage of stylus needs to be avoided (Göth et al., 2006).

2.5.4 Pedagogical Effectiveness

There are two basic requirements that need to be considered for the adoption of new technology in educational systems. One of the requirements is the technology needs to be pedagogically effective and viewed as an improvement to the current technologies used (Robson, 2003). Some of the developers not even concern about the pedagogical adoption in m-learning application development. Without considering pedagogical perspectives in the development, the users will not be able to use the developed application effectively since the application is very much different from the existing developed technologies that adopted various types of pedagogies inside them.

2.6 Learning Theories

Many theories of learning pedagogy have not been implemented to support the utilization of m-learning. It happens because the developers assume that the learning theories introduced can only be implemented in the classroom environment. However, there are many learning theories that can be adopted in m-learning application development. The article of The Pedagogical Perspectives of Mobile Learning (Nie, 2006) explained five learning activities that can be utilized in m-learning. The theories are behaviorism learning, constructivism learning, situated learning, sociocultural learning and informal or life-long learning. There are also other theories that can be adopted such as cognitivism learning theory, humanism learning theory and information processing learning theory (Hashim et al., 2010a).

2.6.1 Behaviorism Learning Theory

In behaviorism learning theory, learning is coordinated via the support of a connection between a stimulus and a response or also known as drill and feedback. The implementation of this learning theory in mobile learning can be illustrated as presenting course contents' for specific question, obtain responses from the learners by answering the questions given and providing required feedbacks to the students. Presenting specific question is called stimulus, whereas obtaining responses from the learners is called response and providing feedback is called reinforcement (Naismith et al., 2004) According to Baharom (2000), reinforcement aspect will influence the learners in repeating the response on learning with the technique that gives satisfaction to the learners themselves. An example of mobile learning application that adopts this learning theory is mobile quizzes (Yuen & Wang, 2004).

2.6.2 Cognitivism Learning Theory

Cognitivism learning theory takes the ways human memory operates in term of short-term and long-term memory into consideration in promoting and supporting the learning processes. The most important aspect in the cognitive learning theory is to determine and identify what is the information the learner already knows (Grant & Gale, 1989). By counting this, the developer can develop the m-learning application that works as a new revision approach for the learners based on the past learners' achievement.

2.6.3 Humanism Learning Theory

Today, many academic practitioners consider more on learner factors or so called learner-centered. The advance educational-based technology nowadays is also implementing this learning approach rather than the system-centered approach. By utilizing this concept, the learning activities will be more effective since the learning materials are prepared to suit the learners' current ways of study (Hulse, 1992). The developed m-learning application needs to fulfill the lesson requirement, learners'

environment and learners' requirement in order to give satisfaction to the learners in helping them undergo the learning processes.

2.6.4 Information Processing Learning Theory

Miller (1956) introduced this type of learning theory. There are two concepts introduced which are chunking and the capacity of short-term memory. Actually, both theories are related to each other. Generally, human short-term memory is very limited. In order to cater this situation, the academic practitioners should always give the lessons by parts. By practicing these concepts, teachers or instructors can reduce the learners' cognitive load and overcome the weaknesses of students' short-time memory. Not only the lessons itself, the developers are also advised to design application content in chunks so that it gives to the students full control and understanding of what is being presented in the contents.

In developing m-learning course content application, all studied learning theories that have been discussed in this section will be implemented. The theories include behaviorism, cognitivism, humanism and information processing theory of learning.

2.7 M-Learning Course Content Development Principles

Besides taking into concerns some of the learning theories presented above when developing an m-learning application, there are also several principles that need to be taken into considerations when developing the content itself. This is important so that the application will be useful to the users. Grasso and Roselli (2005), and Seong (2006) categorized the principles into two categories which are users and usability. Both categories are depending to each other in providing the usable and suitable applications to the users.

2.7.1 Users

Before the developers start developing the application, the developers need to analyze users' background. Users' backgrounds are including age, level of studies and familiarity with mobile technologies (Seong, 2006). Many methods can be used in order to get the users' information and the most famous one is questionnaire method. Developers can conduct a survey in order to know target users' information. The information will help the developers in developing the application that is suitable for the target users (Hashim et al., 2010a).

2.7.1.1 Age

Age is one of the users' backgrounds that need to be taken into consideration by the m-learning application developers. Users of different group of age usually have different interests. For example, children love to play games as compared to teenagers and adults (Olson, 2010). Therefore, the developed application should suit with the children's interest. For example, the game-based m-learning application would be suitable for them. It is different to the teenagers whereby the interest is more to friendship and relationship. Teenagers love to communicate each other through social website such as MySpace and Facebook (Boyd, 2008). In order to cater to the teenagers' interest, it is suitable to equip the m-learning application with communication and conversation medium so that the teenagers can discuss about the education through the application.

2.7.1.2 Level of Studies

Same as age, level of studies is also one of the users' backgrounds that developers need to know. In Malaysian education sector, there are three levels which include primary school level, secondary school level and tertiary level. The level of studies has close relation with age whereby different level of study will implement different approach of learning. For primary school level, the approach is more to the introduction to new things and the basic knowledge of it. The syllabus is also very

objective and straight forward. The upper level which is secondary school level, the Malaysian Education Ministry put several elements of critical thinking in the syllabus and the syllabus is also little bit subjective as compared to primary school level. The highest level which is tertiary level, most of the courses require very critical thinking rather that just knowing and understanding of the basic concepts (Sajjad, 2010). Because of that, the developed applications need to be suitable with users' current level of studies so that the application helps the students in undergoing the learning processes and activities.

2.7.1.3 Familiarity with Mobile Technologies

The developed m-learning application should be an easy and simple application that helps students in understanding the taught course. The complex and advance applications will make the users suffer (Seong, 2006). Because of that, it is necessary for the developers to know users' familiarity with mobile technologies. This information will give the idea to the developers of what types of technologies that can be used in developing the application and purposely to help the users learn faster. In every application development, users play very big role in determining whether the applications achieve the target or not. The most important thing that needs to be considered when developing the application is to fulfill the users' requirements (Dennis, Wixom, & Tegarden, 2005).

2.7.2 Usability

Usability is an application quality measuring technique that experienced by the users during interface interaction (Nielsen, 1993). The advantages of usability concepts are including improve users' productivity, enhance users' quality of work, increase user satisfaction and reduce the costs for support and training program (UsabilityNet, 2006). Hence, some general design principles will need to be followed so that the m-learning application can be of acceptable usability level.

2.7.3 Mobile Usability

The mobile devices' user interfaces are often simple, but every developer comes out with the different interfaces. Current thinking suggests that elements of user-centered and usage context in mobile learning will lead to the better usability level of mobile learning applications. User-centered design means specifying the different usage contexts and the different users' requirements which include the instructors and the learners (Pehkonen & Turunen, 2003).

Another approach to improve the mobile learning usability is to make the user interface or content adaptable to the learners. Making learning content valuable to the target users in a given context, as suggested in the MOBIlearn guideline (O'Malley et al., 2003), is one way of adapting to the user. The understanding of mobile user interface limitations is vital. The limitations include small screens, limited input methods and limited battery life. Because of that, the developers need to design the user interface that meet the user's requirements without putting much complexity, slow processing and large amount of power consuming (Parsons, Ryu, & Cranshaw, 2007). All mobile phones' limitations should be considered in developing the m-learning application. The mobile usability aspects that need to be focused in designing m-learning application are including content, natural usage, navigation, consistency and flexibility.

2.7.3.1 Content

In term of the m-learning content, it is advisable for the developers to organize the content in chunks or by parts. By managing the contents in chunks, it can minimize the cognitive load of the users (Donnelly & Walsh, 2009). Usually, smaller screens will slow down the reading speed by disrupting the eye movements' normal pattern (Kaikkonen & Laarni, 2002). By designing the contents into parts, it can minimize the long texts to be put in one page screen and it will ease the users in reading the contents of the application. It also advised to find the best mechanisms in providing the learners the way to go through the content and move to the preferred page whenever learners click on it (Kaikkonen & Laarni, 2002).

Besides that, it is also necessary to avoid unneeded or unnecessary information to be put in the contents (Parsons et al., 2007). Basically, the unnecessary information will make the novice users confuse in finding the important point of the contents. Furthermore, it is also will slow down the experts' learning pace (Uther, 2002). Hence, it is advised to the developer to implement less is more rules in ensuring the contents accurate and solid (Grasso & Roselli, 2005; Kaikkonen & Laarni, 2002; Uther, 2002).

2.7.3.2 Natural Usage

The developed m-learning application must always be user friendly to the users. User-friendliness can be measured when the users just need few minutes to understand how the application works (Grasso & Roselli, 2005). In other words, when users are executing the application, they should be able to understand or become familiar with the application in only few seconds and they should know what is going to happen if certain actions are done. For example, users will always know if the "Exit" command is clicked, the application will either be closed or exit to the main page of the application. Thus, it is advisable for the developers to use the usual set of commands in the application so that users or learners will already aware of what is going to happen when the commands are clicked. The user friendliness is very important for the users in ensuring the focus is more to the contents learning rather than studying how the application operated.

2.7.3.3 Navigation

Navigation is a mechanism that is developed in helping the users move from a page or section to the desired pages or sections. In term of navigation, it is advised to avoid from using the complex navigation (Donnelly & Walsh, 2009). Complex navigation will give difficulties to the users in accessing the application. Besides, navigation must always be consistent at every page of the application (Donnelly & Walsh, 2009; Uther, 2002). Buchanan et al. (2001) found that consistent navigation will maintain the learner's pace and retaining users' learning interest, and it can also minimize the number of keystrokes in performing a task.

Donnelly and Walsh (2009) also gave the advice for navigation aspect whereby the designed application should avoid the users from scrolling frequently. Generally, by implementing scrolling mechanism into the mobile application will slow down the time for users in accessing and reading the content. Users need to scroll many times in the reading period and sometimes users need to scroll slowly to find only one key point from the contents. It really will reduce the users' learning speed. Therefore, it is advisable to find other mechanism in replacing the scrolling mechanism.

2.7.3.4 Consistency

Consistency is the most basic characteristic in usability interface design principles (Nielsen, 1993). In ensuring the consistency of the application, similar information and action need to be inserted in the similar position. Basically, consistency of the application will enhance the user friendliness of the application. It happens when the users already know that every page provides similar sets of actions. Because of that, the users can access the application from any pages or sections easily. Users need lesser time in studying the application and the focus can be used more on studying prepared learning content.

2.7.3.5 Flexibility

Flexible actions can help the users in navigating the application. Some applications provided several actions that perform the similar tasks. It is to give the users more than one method or way in accessing the application. Donnelly and Walsh (2009) defined flexibility as preparing the alternative displays to perform the same function and that additional displays can work as the shortcut functions. For example, m-learning application provides the main menu list for the users to choose the section that need to be studied. After studying that section, users need to exit to main menu list and choose another section, and then users can continue the study. By inserting the shortcut menu list in each section, it will help the users in navigating to the desired section without exiting to the main menu list. Besides, it is also can minimize keystrokes in performing one task.

In m-learning course content development, all principles that were identified above will be adopted in producing a usable application for the users.

2.8 Conclusion

The studies on m-learning and its advantages, examples of developed m-learning applications, issues in m-learning, learning theories, and development principles of m-learning course content application have been discussed in detail. All topics in this chapter will be taken into considerations and some of them will be adopted in the next study where the methodology and the development of m-learning will begin.

In developing m-learning course content application, four learning theories that have been discussed in this chapter will be implemented. The theories include behaviorism, cognitive, humanism and information processing theory of learning. In term of m-learning development principles, all identified principles will be utilized in the development process of m-learning course content prototype. In the following chapter, the implementation of the identified theories and principles in the development of m-learning course content will be discussed further.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Due to the research is product-based in nature, this chapter will elaborate on the methodology followed during the development and evaluation of the revision aspect of mobile learning course content, MOSAD. This chapter discusses the life cycle model of MOSAD development, software and tools used, and methodology of usability study adopted in the study.

3.2 Mobile System Analysis & Design (MOSAD) Life Cycle

The development of Mobile System Analysis & Design (MOSAD) application will be interpreted according to the MOSAD Life Cycle. Basically, the cycle was adopted from ADDIE methodology model. The MOSAD Life Cycle consists of Analysis, Design, Development, Implementation and Evaluation phases. Figure 3.1 illustrates the interdependency of these phases in MOSAD Life Cycle.

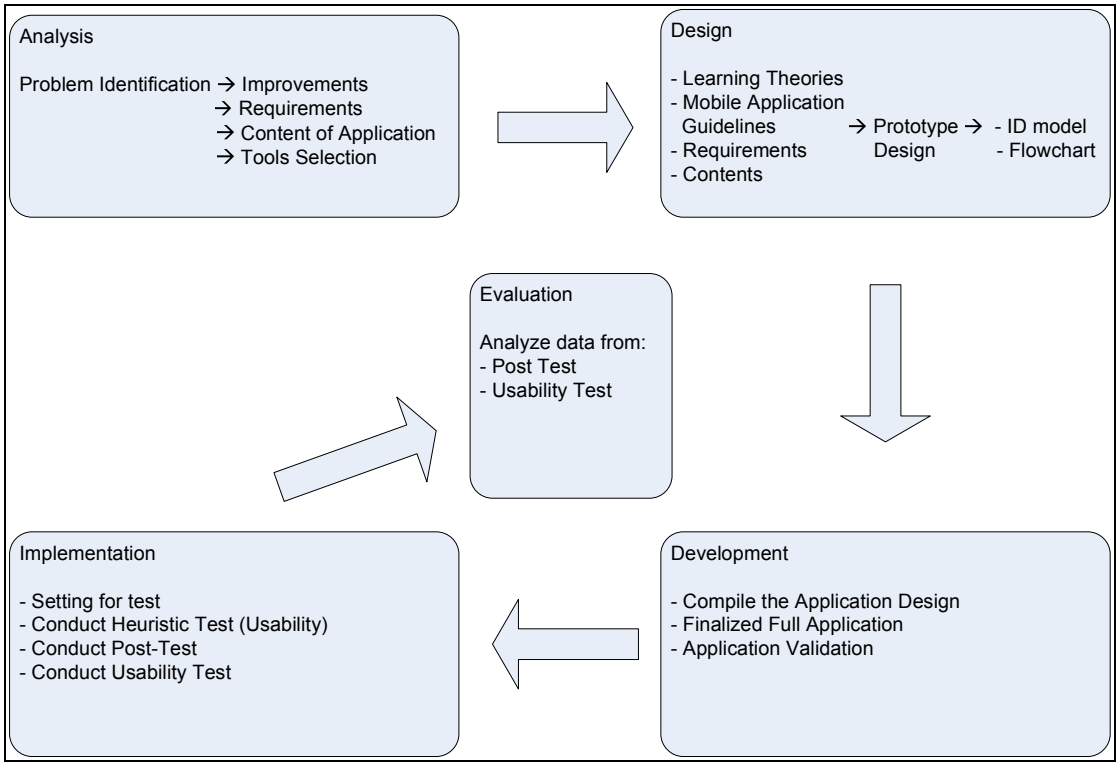


Figure 3.1: General MOSAD Life Cycle

3.2.1 Analysis Phase

Analysis is a very thorough and careful assessment of procedure in order to understand a particular topic ("Longman Dictionary of Contemporary English: The Complete Guide to Written and Spoken English," 1995). In this research, the analysis for MOSAD development has been made in accordance to suitable mobile phones technologies, students' background and the requirements of MOSAD application development. The process flow of the analysis phase is demonstrated in Figure 3.2.

For the input to the analysis phase, a survey was carried out. The survey questions as shown in Appendix A was conducted among 82 students from System Analysis and Design (SAD) course which is offered to first year first semester students at Universiti Teknologi PETRONAS (UTP). Besides collecting basic information of the students, the mobile devices which are used by them, the students' opinions on current learning practices and also their opinions regarding the m-

learning implementation in the current learning practices especially in the SAD course were identified.

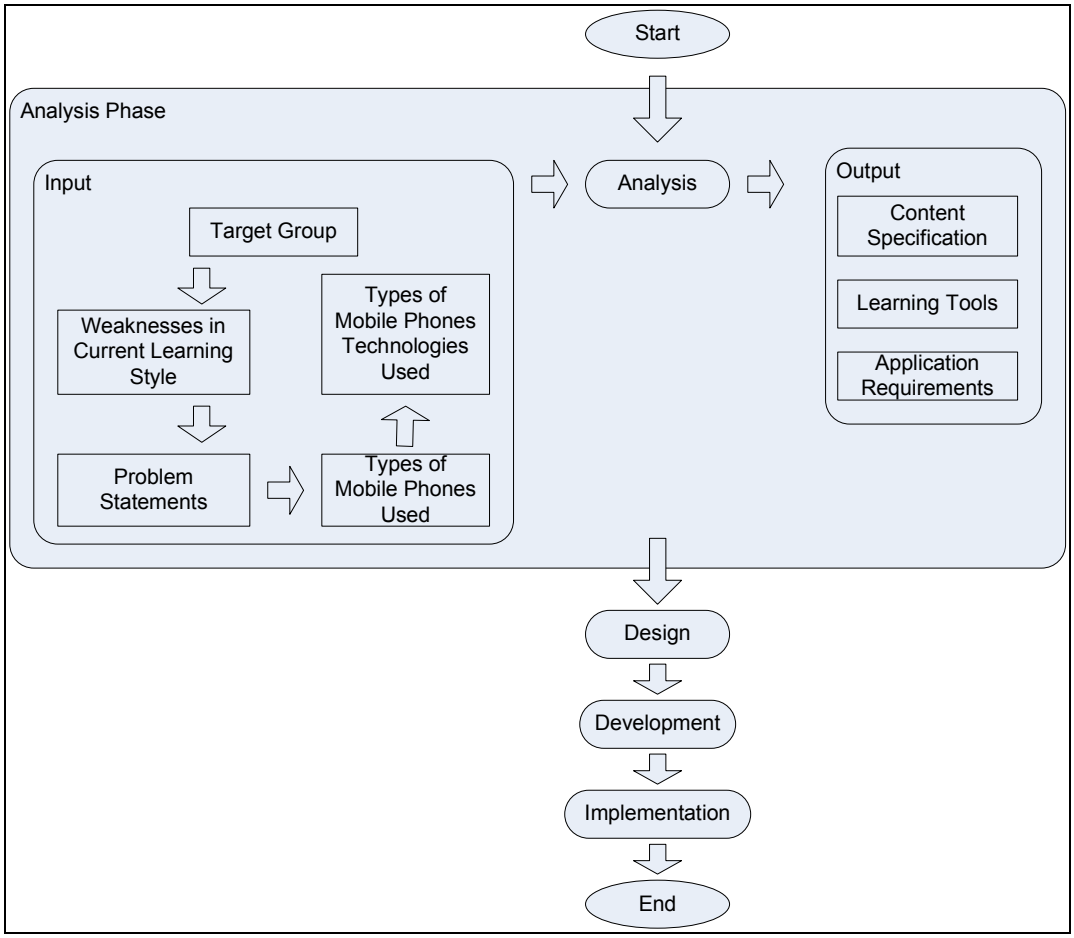


Figure 3.2: Analysis Phase in MOSAD Life Cycle

Getting the demographic information of the students as well as the mobile devices they use was necessary for this phase. Like other learning application, it is very important to know who are the users of the application in the first place. By getting the information, the developer can know the level of users' familiarity with mobile technologies (Seong, 2006). It is to ensure that the developed MOSAD application can be a very helpful tool for students to do the revision and not to get the students into trouble while using the application.

Similarly, information regarding students' mobile phones also needs to be taken into considerations when developing MOSAD. The brand of mobile phones

used by students, the features equipped by the devices and the devices operating system (OS) are all very important information. These information needs to be collected in order to develop the mobile learning application that can suit the students' mobile phones. Advance application will be useless if the students' mobile phones are not equipped with necessary tools and equipments.

Besides that, the survey also was conducted in order to get the students' opinions on current learning practices and the effects of learning if mobile learning is implemented in the current learning practices. Appendix A shows the survey questions. Here, current learning practices include the conventional learning approach, e-learning implementation, Computer-Aided Learning (CAL) and others. For this case study, students need to rate the given aspects of learning from scale one (1) to five (5) (1= strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). The questions include current learning practices and mobile learning implementation:

- Give freedom in learning activities.
- Provide more effective way of learning.
- Require less time to get learning materials.
- Helps students in doing revision as a preparation for examination.
- Remove formality of current educational system.
- Encourage study group practices.

After the survey was conducted, the problems regarding current learning practices can be identified. It is very important in order to develop the application that can overcome the problems in current learning practices.

Based on the survey, it can be concluded that there are five aspects need to be analyzed before proceeding with the design and development of MOSAD application. The aspects include target group of users, weaknesses in current learning practices,

problem statements, types of mobile phones used and types of mobile phones technologies equipped. All aspects were analyzed and the outputs are: the content of the application, selected learning tools and requirements for MOSAD application. These outputs were used for the next phase of MOSAD Life Cycle.

3.2.2 Design Phase

The design phase is the second phase in ADDIE methodology. From the evaluation of the results obtained in the analysis phase of MOSAD Life Cycle, the SAD syllabus and the content of Project Initiation topic are determined. These are used for structure, interface and prototype design, which will become the input for the MOSAD design during the designing phase. Figure 3.3 presents the flowchart of the design phase in MOSAD Life Cycle.

3.2.2.1 Input to Mobile Learning Course Content Design

There were four designs have been created during the design phase. It includes the content, structure, interface and prototype designs.

a. Content Design

The syllabus is designed according to the sub topics in the Project Initiation chapter. It includes System Request, Feasibility Analysis and Project Selection. In order to give the students better understanding regarding the topic, the application also includes Introduction and Summary sub topic. In testing the students' understanding, several quiz questions were prepared in the application. However, the focus of this project is only the contents of the course rather than quiz. The content was separated according to the sub topics provided. It is a way for students to understand the topic by partial.

- Logical Flow

Logical flow is a method of showing the relation between the content of a sub topic to another sub topic. For example, students need to explore and learn the first sub topic before going to the next sub topic. However, for MOSAD application, students can move to any desired sub topic to learn at one time. It is aimed to give the students the flexibility in accessing the contents of the application.

- Content Specification

Contents are created according to the content classifications. Contents were separated according to the sub topics in Project Initiation topic of System Analysis and Design course. Hence, the integration between sub topics is needed in the logical flow sequence.

b. Structure Design

After content design, the second step in the design phase is the Structure Design. Structure Design involves logical flow and content specification. The logical flow and module specification is the same as in the Content Design. However, module structure is about organizing the content based on the students' capabilities, the technologies, the requirements and others. For instance, the content should be structured so that it can suit the students by considering the variation of learning approaches among students, and scope of learning method that is relevant to the students.

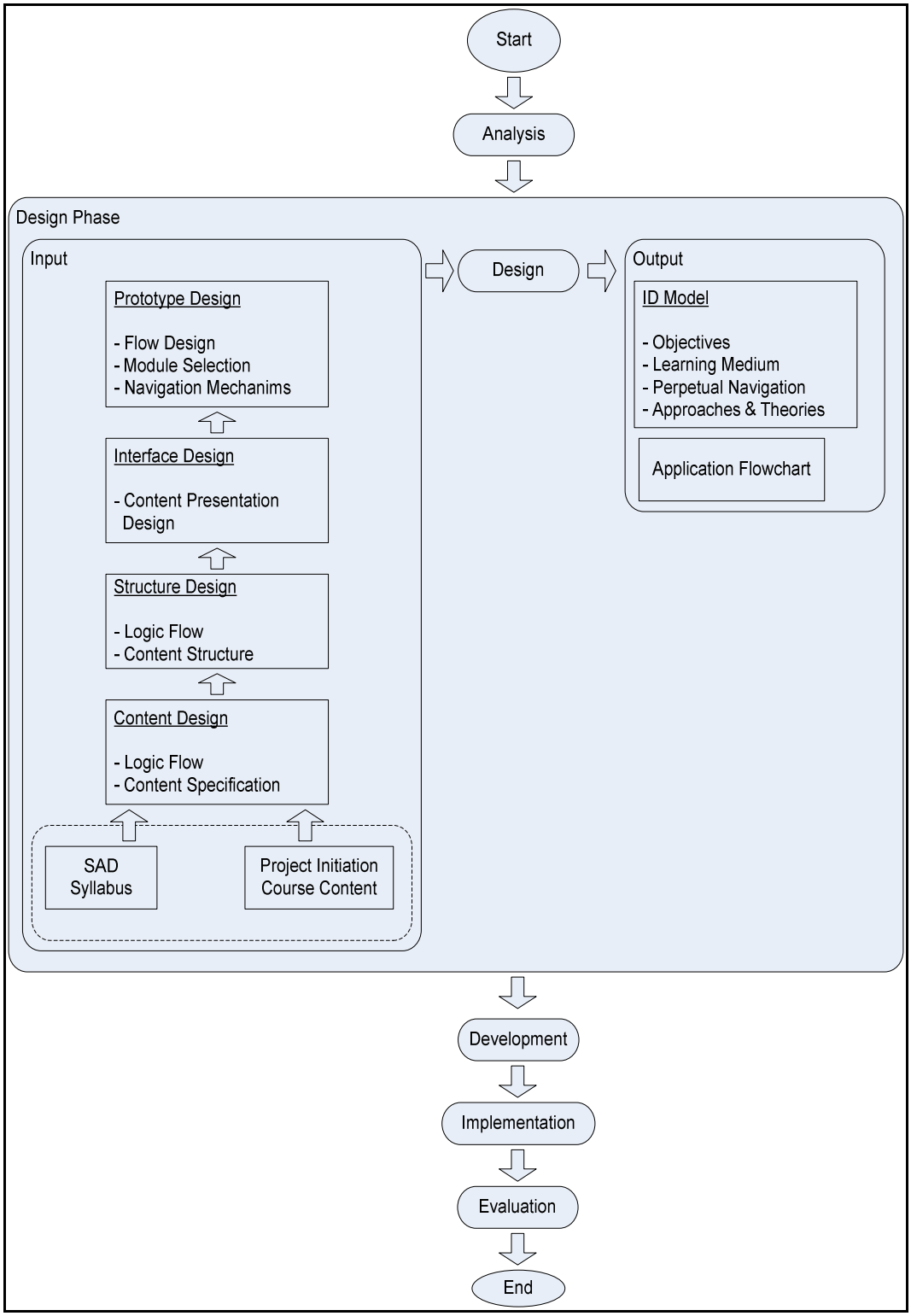


Figure 3.3: Design Phase in MOSAD Life Cycle

c. Interface Design

Designs of the mobile graphical user interface (GUI) are different from normal computer screen size GUI. However, there are several similar aspects that have been adopted into the mobile GUI. A good application is the application that is easy to use, attractive and adaptability (Hobart, 1995). Masson and Reid (2010) identified eighteen principles of good mobile GUI:

- The mobile pages need to have headers or titles. However, if the page does not have the title or header, the page needs to be designed so that it is understandable and unambiguous (P1).
- Titles need to be in capital letters. This convention visually separates content from headers (P2).
- Screen layout should work either with or without graphics.
- In a screen, avoid more than two consecutive blank lines; because the users will think that it is at the end of that page (P3).
- Lists form need to be implemented rather than table form. By using lists for page layout, it gives the designer a bit more control over text scrolling and wrapping behavior (P4).
- In mobile GUI, the font used is more restricted as compared to desktop devices. Usually for desktop devices, there over 100 types of fonts as compared to mobile devices with only two types of fonts.
- The color contrast needs to be high for fonts. The font colors and background must always be contrast. It is to ease the users in reading the content of the screen (P5).
- Different colors need to be used in stressing the different use. Sometimes, in mobile application content, there are several points or sentences that need to be highlighted. Therefore, different colors of font can represent the different degree of accentuation of each sentence (P6).

- Avoid unnecessary words. It is to avoid from frequently scrolling and minimizing the memory usage of mobile application (P7).
- Avoid redundancies.
- Avoid from breaking long character strings with dashes, commas, or other traditional separators (P8).
- Put the most important content first.
- Restrict command labels to 6 characters when the command may be displayed on a button or soft key. Command labels may be displayed in a menu, in which case they can be much longer.
- Whole words are better than abbreviations, and standard abbreviations are better than non-standard (P9).
- Images need to be in high contrast (P10).
- Avoid images with the text inside (P11).
- Use only images appropriate for users (P12).
- Use 11 items or fewer on a select list.

Out of eighteen principles guided in the mobile GUI principles as suggested by Masson and Reid (2010), twelve principles that labeled as P1 until P12 have been adopted into this research study. The adoption the principles are presented in section 4.3.3.

d. Prototype Design

All eighteen principles guided in the mobile GUI principles have been adapted into this research study. For prototype design, MOSAD application has been designed based on the flow design, module selection and navigation mechanisms.

- Flow Design

  In the MOSAD prototype, it involves many user interface designs. The interfaces need to be organized according to the priority of the flow

design. The flow is very vital in order to help users in navigating from an interface to the other interface.

- Modules Selection

  As discussed in the Content Design and Structure Design, the modules are selected according to the sub topics of the application. The application is developed in modules in order to avoid the users from mixing up the information from the application.

- Navigation Mechanisms

  The most important part of usability concept is the navigation. Navigation mechanisms are used to help the users in accessing the application. It eases the users in moving from the interface to the other interface. For this project, there are two types of navigation mechanism used. The mechanisms are "Next" and "Back" navigation, and number key-pressed navigation.

3.2.2.2 Output from the Design Phase

The output from the design phase includes the conceptual framework called Instructional Design Model (IDM) and the application flowchart which produced from the design of logical flow and flow specification. Figure 3.4 discusses the IDM of the Mobile Learning Application for System Analysis and Design Course Content (MOSAD).

The IDM involves six elements that work as the reference for the development phase. The elements are objective, source, perpetual navigation, learning approach, pedagogical approach and interactivity.

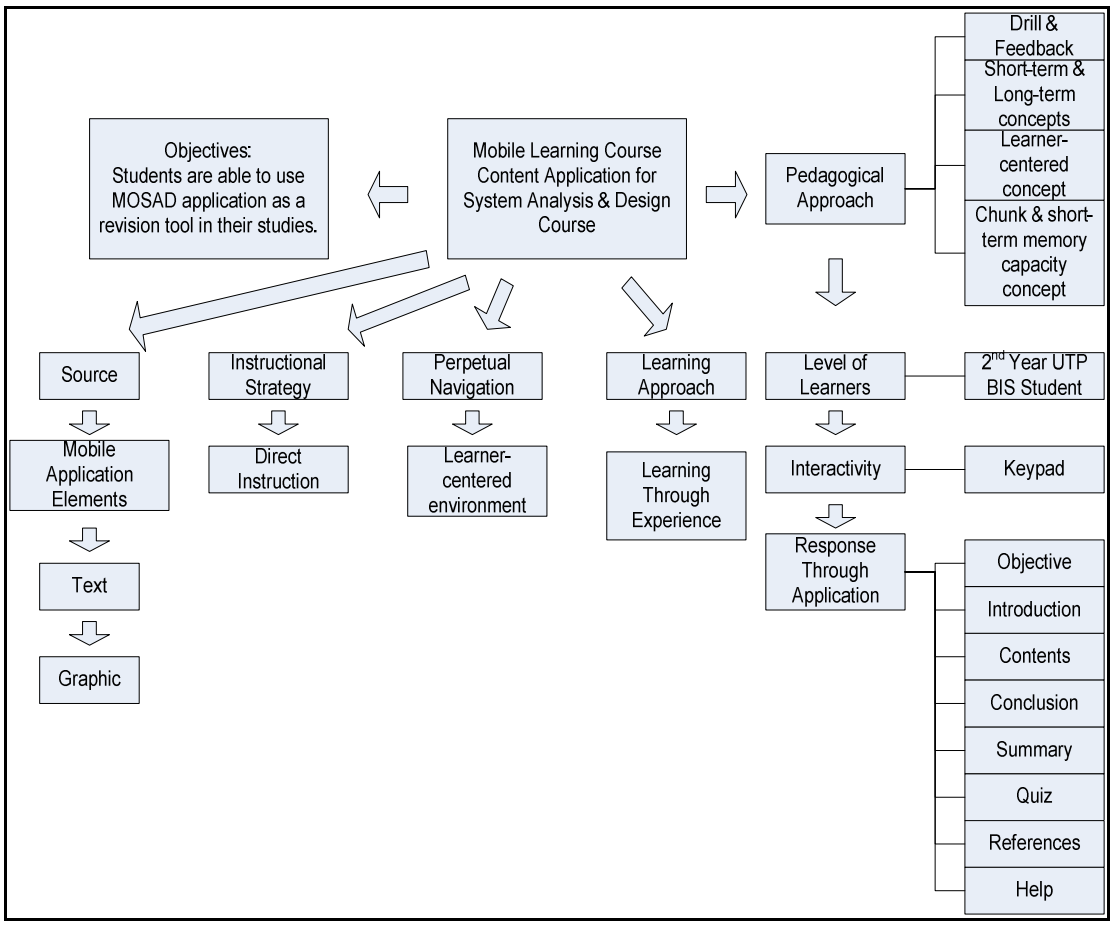


Figure 3.4: ID Model

a. Objectives

The main objective of the MOSAD development is for students to be able to use the application as a new revision tools in understanding the topic taught in the class. The other objectives include:

- MOSAD can utilize and adapt the elements of pedagogical approaches and learning theories during the development.
- MOSAD can be the alternative interactive learning way for students, inline with the technological advancement in nowadays.

b. Source

As mentioned in the previous phase, mobile application has many restrictions as compared to the desktop-size applications. Therefore, the source or learning medium is also limited. In the MOSAD application, there are only two learning sources which are text and graphics. In most of the contents in pages of the MOSAD application, texts are used to give the explanation regarding the topic. However, the texts are also limited due to the mobile phones' screen size. Therefore, the content of the application has to be designed so that it is enough to be a revision tool in giving the understanding to the users. In term of graphics, it is put as a medium to help the users in understanding the concepts explained in the application. There is also a limitation in terms of the inserted graphics. Therefore, the format of graphics that only supported by the application is in Portable Network Graphics (PNG) format.

c. Perpetual Navigation

Masri (2009) defined perpetual as continuous mode. Navigation mechanism in MOSAD prototype is designed to be a free continuous navigation. Free continuous means there is a dynamic navigation whereby users can freely jump from a section to other desired section and at the same time the application retains the usage of continuous set of navigation in performing a task. Masri (2009) also stated that, by using this kind of navigation, it encourages the learner-centered environment in learning process.

Learner-centered environment is vital to enhance students' concentration to control the learning activities based on the capabilities and need. Learner-centered application is better than learner-centered by the instructors since the developed application is a tool that is not controlled by the instructors (Baharom, 2000). Therefore, perpetual navigation will play the

very big roles in providing the learner-centered application environment to the users.

d. Learning Approach

The learning approach that has been applied in the MOSAD development is learning through experience. In the development, MOSAD application will be used as a revision method outside the class. It means the users have already learnt the details of the topic during lecture hours. Therefore, users already have the experience regarding the topic discussed in the application. The MOSAD application is just used to refresh the experience (learning) during the lecture hours.

e. Pedagogical Approach

As discussed on section 2.6, there are four pedagogical or learning theories implemented in the MOSAD application development. The theories are drill and feedback concept of behaviorism learning theory, short-term and long-term concept of cognitivism learning theory, learner-centered approach of humanism learning theory and, chunk and short-term memory capacity concept of information processing learning theory.

f. Interactivity

The interactivity of a normal desktop-size of application involves dragging, clicking, typing, up and down the mouse and so on (Masri, 2009). It is different from a mobile size application interactivity whereby it involves only keypad pressed. Nowadays, there are more advanced technologies introduced in order to interact with mobile phones such as stylus pen which is used to interact with PDA. However, based on the section 2.5.3 it is not encouraged to use the stylus pen since it will require more users' attention and time in

interacting with the application. Because of that, the Human Computer Interaction (HCI) characteristics need to be emphasized in designing the interface so that the application does not require external devices to interact with the application.

3.2.3 Development Phase

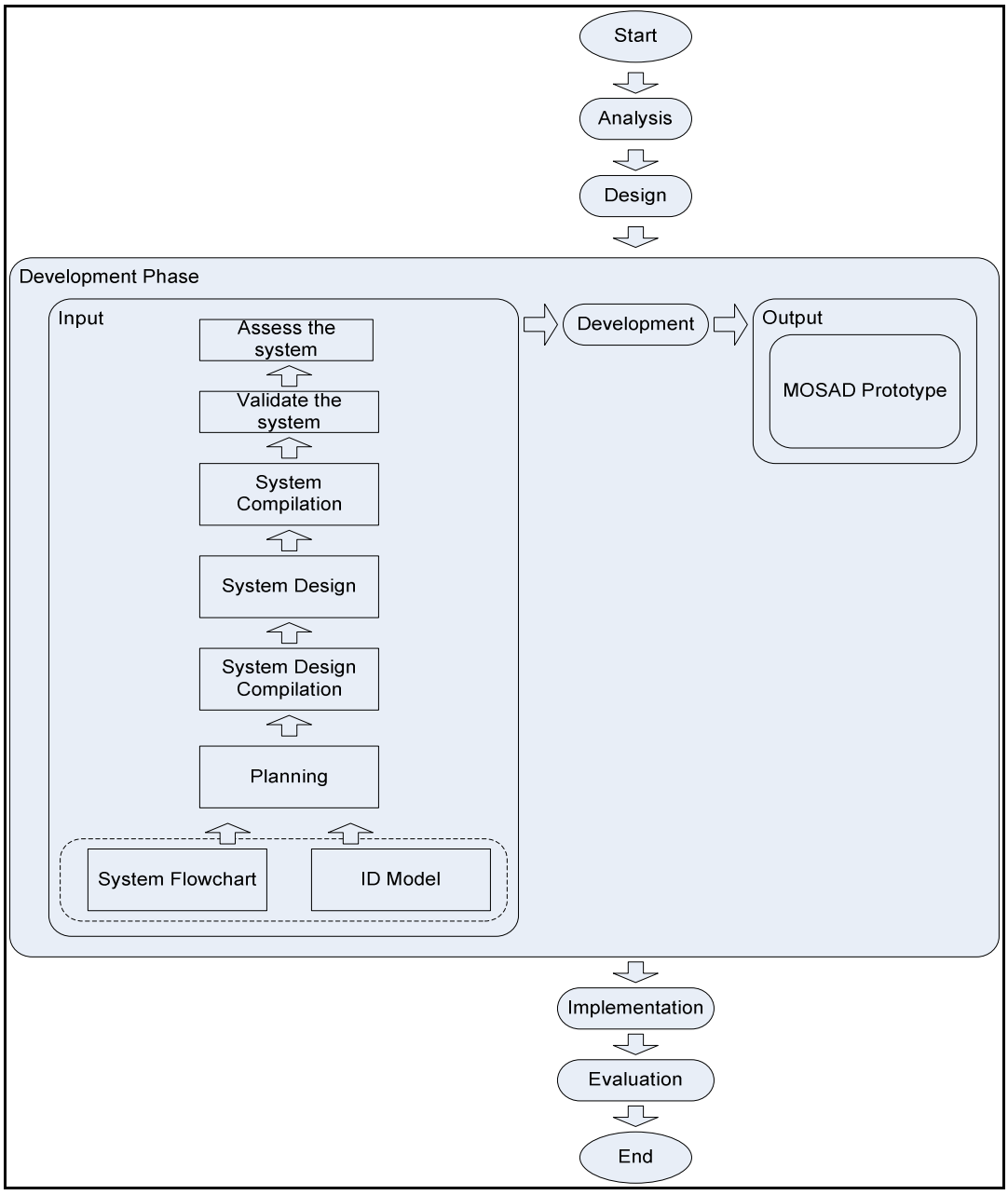


Figure 3.5: Development Phase in MOSAD Life Cycle

The step in the development phase applies the outcome from the design phase. The Instructional Design Model (IDM) and the system flowchart are used for the planning stage of the MOSAD prototype development. The IDM and system flowchart that have been designed was compiled and the system was designed based on that compiled information. After all parts of the application programmed, it will be compiled again to become a complete MOSAD prototype. The tools and equipments used in developing the MOSAD application will be discussed in the section 3.3. Then, the complete prototype will be validated based on the determined requirements, IDM and system flowchart. If the prototype does not fulfill all the aspects, the modifications and correction need to be done. Lastly, the finalized prototype can be produce and ready for the implementation phase which will be discussed in next chapter. Figure 3.5 illustrates the development phase of MOSAD Life Cycle.

3.2.4 Implementation Phase

The implementation process is presented in Figure 3.6. The process of this phase starts with Prototype Implementation Guidelines (PIG). PIG involves two groups of participants which are lecturers and students. For lecturers, it involves the work of choosing five lecturers, scheduling slot and venue and, notifying the confirmation to the chosen lecturers. Then, lecturers will proceed with the pilot testing on the prototype. The lecturers will be given sometime to go through the application and then, they are required to give comments, feedbacks or recommendations based on the identified criteria which are stated in the questionnaire in order to enhance the MOSAD prototype. The improvement of MOSAD prototype was done before the testing was performed by the students. Furthermore, for students, the tasks involve checking the lecture timetable, scheduling the slots and venues, notifying the confirmation of slot and venues, and selecting the control and experimental groups.

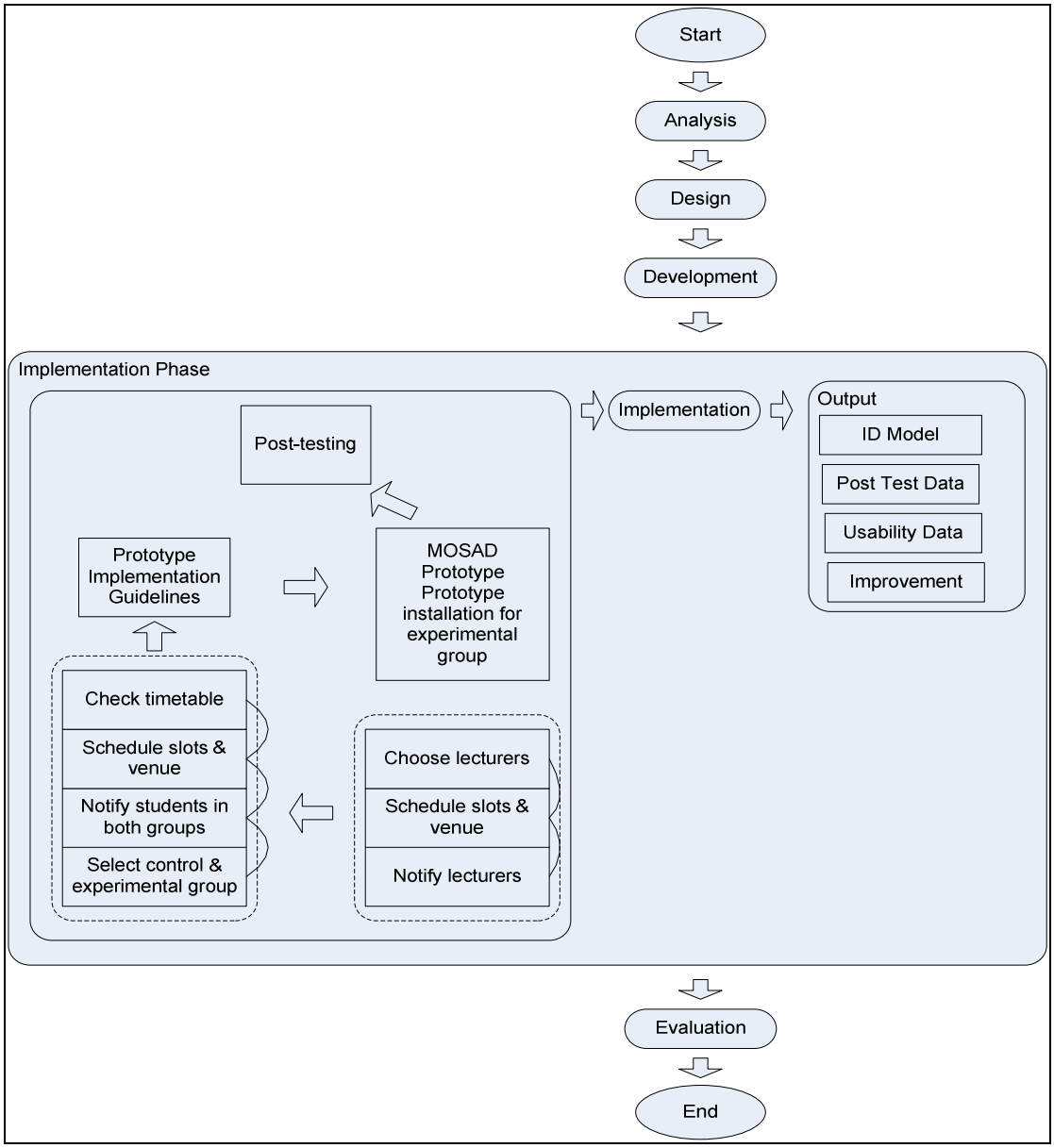


Figure 3.6: Implementation Phase in MOSAD Life Cycle

After the prototype was evaluated by the lecturers and the improvements were done for the prototype, 116 System Analysis and Design (SAD) course students will perform the post testing. The students were divided into two groups which are control and experimental groups. There are 50 students in control group and 66 students in experimental group. Table 3.1 shows the composition of each group that has participated in the experiment. As MOSAD application is used for the revision tool for students, all 116 students have already learned the Project Initiation topic in the lecture. The same quiz questions based on the topic were given to all students. The

control group will answer the questions based on any current revision tools such as getting the materials from the Internet or reading the book. Meanwhile, the experimental group will answer the question using MOSAD application as the revision tool. For the experimental group, a set of questions on the usability was been given and it will be explained in section 3.4.

Table 3.1: Sample Number for Testing

Type of group	Number of Students
Control Group (X_1)	50
Experimental Group (X_2)	66
Total:	116

3.2.5 Evaluation Phase

At the evaluation phase, all data from the implementation stage were being analyzed. Data of post test were evaluated for the effectiveness and usability of the MOSAD application. The results will be discussed in detail in section 4.3. Figure 3.7 illustrates the evaluation phase of MOSAD Life Cycle.

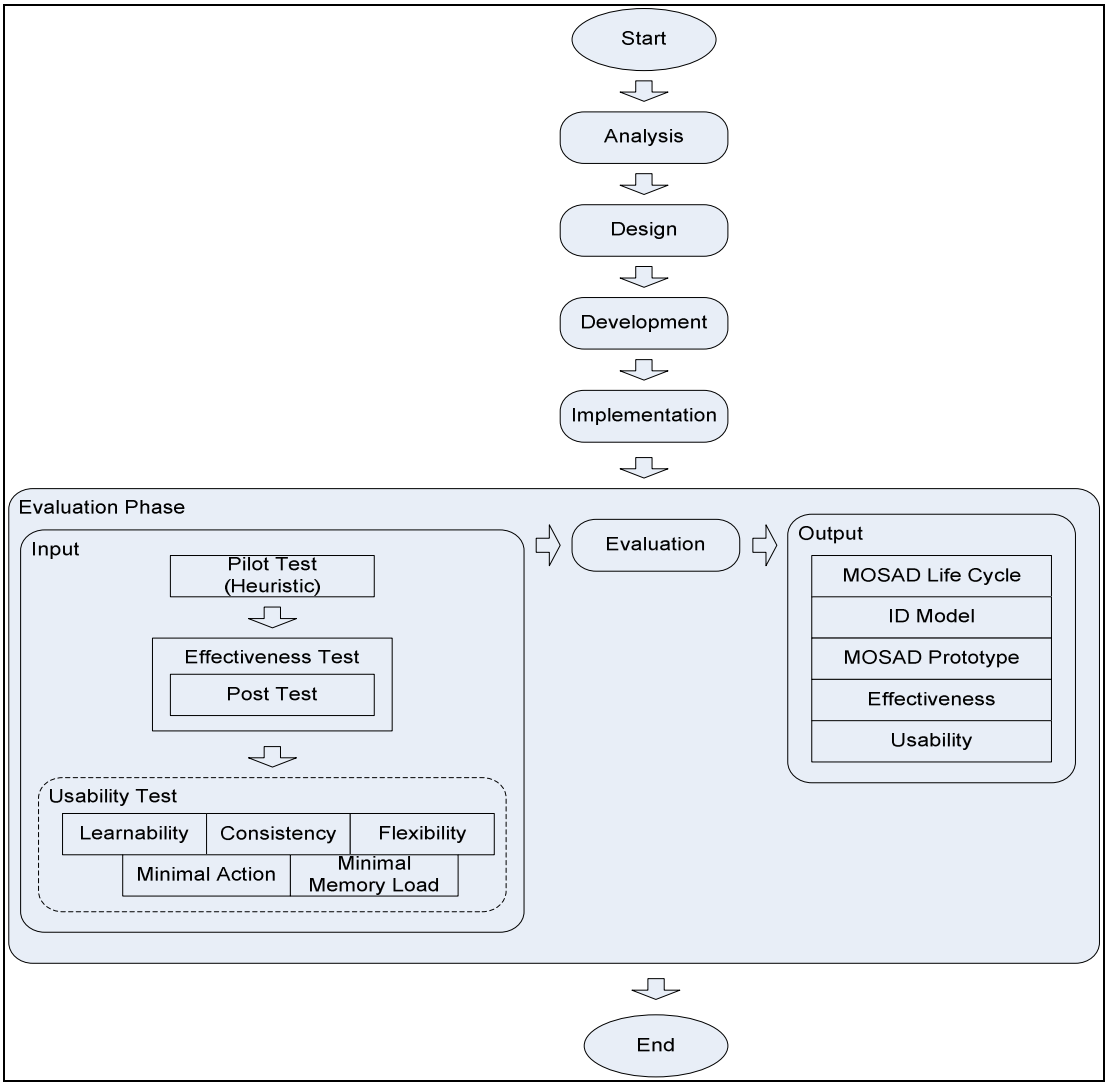


Figure 3.7: Evaluation Phase in MOSAD Life Cycle

3.3 Software and Tools for Development

The development phase of MOSAD Life Cycle involves the use of three related software equipments. Based on the preliminary study which is related to section 3.2.1, the equipped wireless communication devices and mobile operating system (OS) in the students' mobile phones influence the selection of software and the tools used in developing the application. Figure 3.8 presents the type of wireless communication devices equipped in the students' mobile phones. From the figure, top three wireless communication devices equipped are General Packet Radio Service (GPRS) (92.68%), Bluetooth (78.05%) and third generation (3G) (53.66%).

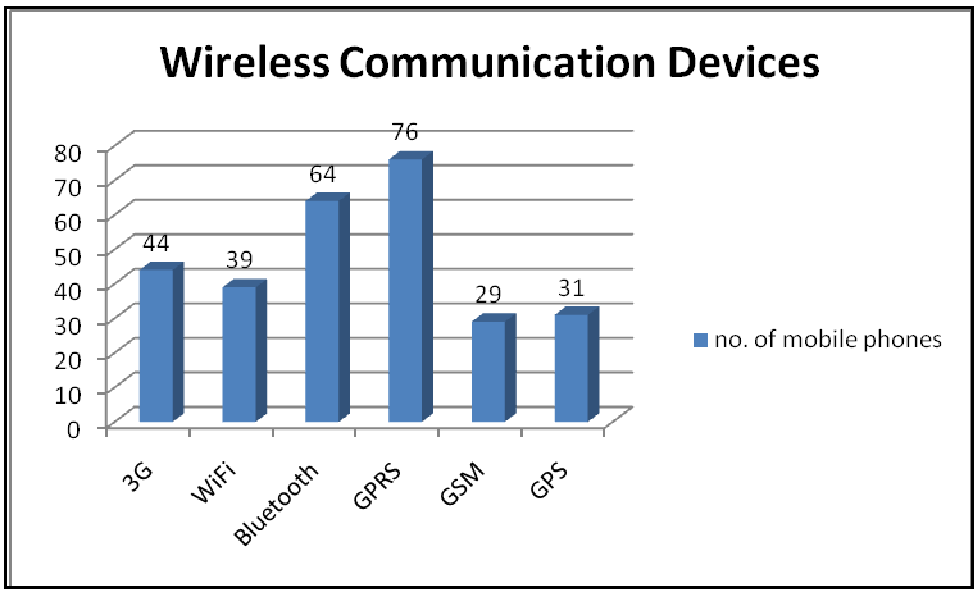


Figure 3.8: Equipped Wireless Communication Devices

Figure 3.9 shows the type of operating system supported by the students' mobile phones. From the figure, it shows that 91.46% of students' mobile phones can support Java OS and 18.29 % supports the Windows Mobile OS.

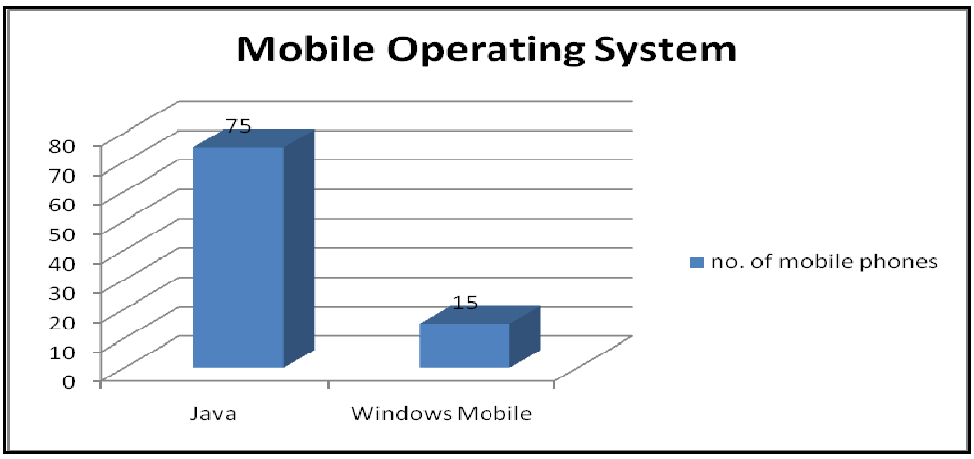


Figure 3.9: Supported Operating System (OS)

Based on the results, the suitable software and tools were chosen in order to develop the application which will suit the students' phones. The software and equipments used includes Java JCreator LE, Sun Java Wireless Toolkit version 2.5.2 and Microsoft Paint. The selection of Java programming language as a programming software was due to the survey result that showed 91.46% of students' mobile phones supported this kind of OS platform. Besides that, the MOSAD application also was

developed as offline mode application whereby users can use it without Internet. It is due to the result that shows the top three wireless communication devices equipped which are GPRS, Bluetooth and 3G.

3.3.1 JAVA JCreator LE

The MOSAD application was developed using JAVA programming language. JAVA programming language allows the programmers to implement object-oriented programming whereby it eases the programmers in doing necessary modification without modifying the whole codes. Other than that, it also allows the programmers to reuse the methods or functions those were already programmed for the application. By that case, JAVA JCreator LE was chosen in order to compose the codes in developing the prototype. The screen shot of the software is presented in the Figure 3.10.

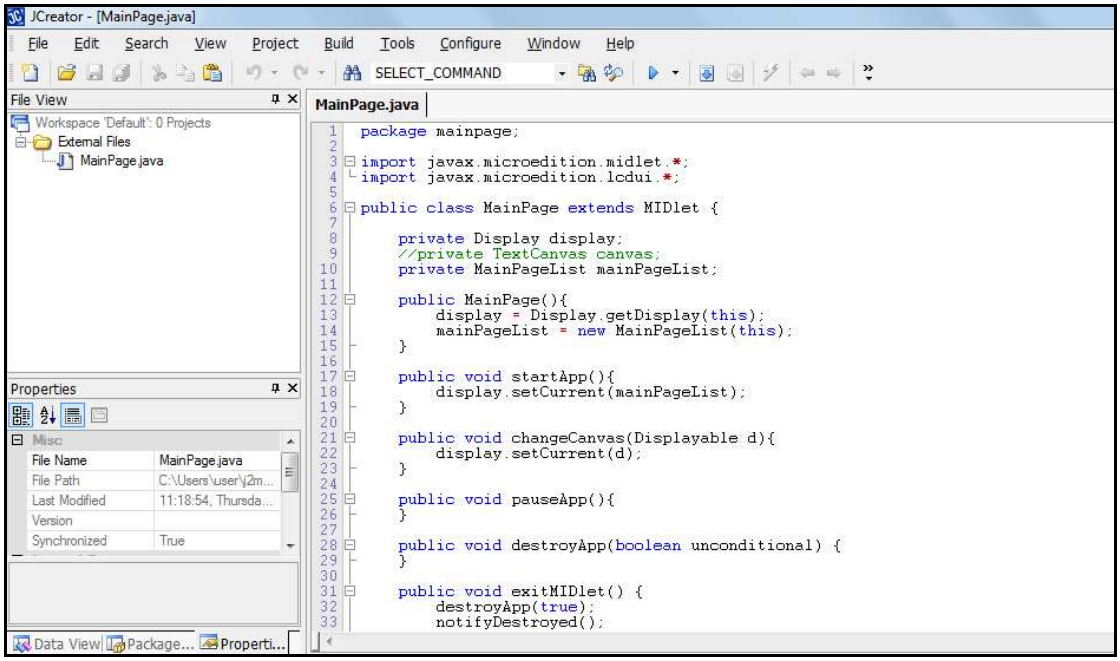


Figure 3.10: Screenshot of JAVA JCreator LE

3.3.2 Sun JAVA Wireless Toolkit Version 2.5.2

After the functions are well-coded, the programs need to be compiled. The compilation must success before the programs can be run. In compiling and running the programs, Sun JAVA Wireless Toolkit Version 2.5.2 was chosen since the program was written in JAVA programming language. Figure 3.11 shows the screen shot of the JAVA Wireless Toolkit application.

After the compilation process was success, the run button is clicked in order to see the working MOSAD application. When the run button was clicked, the Sun JAVA mobile phone emulator will appear and functioning application can be demonstrated. Figure 3.12 shows the Sun JAVA mobile phone emulator.

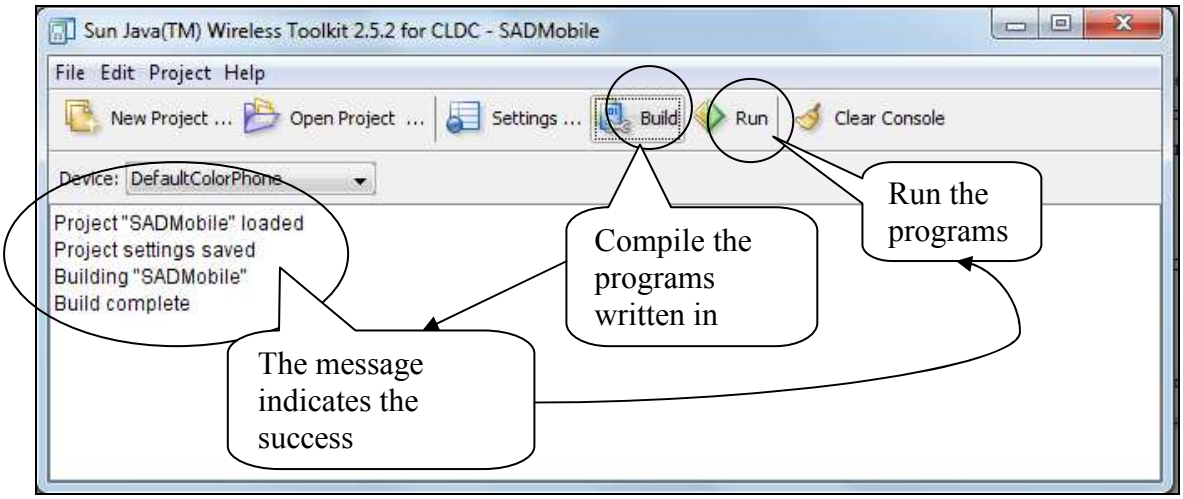


Figure 3.11: Screenshot of JAVA Wireless Toolkit Version 2.5.2

Figure 3.12: Sun JAVA Mobile Phone Emulator

3.4 Methodology for Usability Study

Usability is a technique of measuring the quality that users experience during interface interaction (Nielsen, 1993). The advantages of usability concepts are including; improve productivity, enhance quality of work, increase user satisfaction and reduce support and training costs (UsabilityNet, 2006). Hence, some general design principles will need to be followed so that an m-learning application can be of acceptable usability level.

Since mobile applications have the many limitations including small screen size, slow processing, limited memory load and others, there are some modifications done in usability aspects. Therefore, the usability aspects evaluated for MOSAD application was adopted from Purdue Usability Testing. The testing includes

consistency, flexibility, learnability or user-friendliness, minimal action and user's memory load (Lin, Choong, & Salvendy, 1997).

- Consistency: is measured based on the similar information and action are inserted in the similar position in the interfaces (Nielsen, 1993).
- Flexibility: is measured based on the preparation of more than one display to perform the same function (Donnelly & Walsh, 2009).
- Learnability / User-friendliness: is measured based on the ease of using the application and performing the tasks of the application (Masri, 2009).
- Minimal Action: is measured based on the number of keystrokes needed in performing a task. A good system design requires at most three keystrokes in performing a function (Nielsen, 1993).
- User's memory load: is used to measure the minimal usage of users' memory load in understanding the contents of the application.

The usability of MOSAD application involves testing the application on mobile phones screens. Thus, GUI principles were applied to measure the effectiveness of the developed MOSAD application interfaces.

Furthermore, there are two techniques of usability testing conducted which are pilot testing and survey questionnaire.

- Pilot study.

  This study is conducted to get the initial feedbacks regarding the MOSAD prototype based on the usability concepts and its contents. There are five UTP lecturers involved in this study. All five lecturers have a background on Human Computer Interaction (HCI), meanwhile, two of them are teaching System Analysis and Design (SAD) course. The purpose of the pilot study is to get the lecturers' comments on the developed MOSAD application in both aspects which are usability and the course content of the application. After getting all comments from the lecturers, the improvements were done before the testing is conducted to the students.

- Questionnaire.

  Questionnaire is the technique used to conduct the usability testing to the end users which are students. This technique is a type of testing that provides chance to gather more usability comments during the testing sessions.

- Observation

  Observation is another quantitative method to conduct the usability testing. The purpose of using this method is to support the quantitative data from usability test questionnaire result.

3.4.1 Design for Usability Study

The usability study for MOSAD application involves the Quasi Experimental Design by having only post test with experimental and control groups (Sekaran, 2000). This experimental design was used since the MOSAD application only works as the revision tools for the students. Before conducting the testing, the control group will go through the topic of Project Initiation using current revision method while the experimental group will use the MOSAD application to perform the revision. Because of that, there is no need to conduct the pretest since the study is just to measure the effectiveness of the mobile learning application as a revision tool compared to the current revision approaches. However, there is a threat that will decrease the validity of the results. If the two groups are not matched and randomly assigned, selection biases could infect the results. The differential selection of the persons making up the two groups would confound the cause and effect relationship (Sekaran, 2000).

Quasi Experimental Design involves two groups of participants which are control and experimental group. The process of implementing the Quasi design in MOSAD begins by choosing the control group (X_1) and experimental group (X_2). Both groups were already learnt the topic during the lecture hours. After a couple weeks, the control group will perform the test whereby the students were given the

choices of the revision tools that will be used. After 30 minutes of revision, the control group is given ten multiple choice quiz questions based on the topic within 15 minutes. For experimental group, two slots of students were chosen to do the test. Students need to use the MOSAD application as a treatment in doing the revision. After 30 minutes of revision, students need to answer the same 10 multiple choice quiz questions in 15 minutes. After completing the quiz, the experimental group was asked to evaluate the usability testing questionnaire form for the MOSAD application. Table 3.2 illustrates the summary of post test Quasi Experimental Design.

Table 3.2: Summary of Post Test Quasi Experimental Design

Group	Treatment	Outcome
Control Group (X_1)	T	O_1
Experimental Group (X_2)		O_2

3.4.2 Sample of Study

The post test Quasi Experimental Design involves two groups of students namely control and experimental groups. Both groups are students from Business Information who are currently taking System Analysis and Design (SAD) course. Besides, both groups also have already learnt the Project Initiation topic during the lecture slots. There are fifty students in control group and sixty six students in experimental groups. The numbers of students were decided based on the number of students registered the tutorial sessions for the SAD course. Table 3.1 shows the composition of each group that has participated in the testing.

The decided number of participants in each group is suitable based on several suggestions made by previous researchers. Nielsen (2000) stated that for sample of 5

participants in a study, about 75% of usability problems can be determined during the heuristic evaluation. Therefore, by choosing five lecturers for pilot testing, it is enough to get the valid data of the usability problems in MOSAD application. For usability testing among the experimental group, Ahmad (2004) has conducted the testing within 31 samples whereas Norizah @ Norazah in Ahmad (2004) has conducted the usability testing among only 27 samples. Therefore, within the decided number of samples in MOSAD application usability testing, it is more than sufficient as compared to the previous researchers' studies in getting the valid data.

3.4.3 Tools for Testing Process

In this project, there are three tools used for the testing including Pilot Testing, Usability Questionnaire and post test.

- Pilot Testing – Experts Evaluation

  Pilot testing was conducted in order to get the comments of the developed MOSAD application in terms of usability and the contents of the application. Five lecturers were selected to do the test. All five lecturers have Human Computer Interaction (HCI) background. All lecturers were shown the MOSAD application and usability comments were given by the lecturers regarding the application for the application improvement. In addition, from five lecturers, two of them are teaching System Analysis and Design (SAD) course. Based on the prototype, the comments regarding the application contents were given by the SAD lecturers. All comments were compiled and the improvements were done before the Usability Questionnaire distributed among the students. The comments are explained in details in section 4.4.1.

- Usability Questionnaire

  Usability questionnaire was conducted in getting the usability data from the end users. The data will show whether the MOSAD prototype is usable to the

users or not. The questionnaire is attached in the Appendix C (Section A). The survey questionnaire was distributed to sixty-six experimental group of students. In the questionnaire, there are five aspects involved. The aspects include consistency, flexibility, learnability or user friendly, minimal action and user's memory load. In each aspect, there are five questions presented. The users need to rate each question using a scale from 1 to 5 (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). Once the data was gathered, it will be analyzed in order to see the MOSAD prototype usability level.

- Usability Observation

Usability observation was conducted to get the data that supports the usability questionnaire result data. The observation was conducted to twelve students from second year System Analysis and Design (SAD) course. The chosen number of test participants is more than reliable according to Nielsen (2000) in which five testers are enough to conduct usability test. It is a quantitative method in which it measures the steps of actions and time taken by the users in performing the given tasks using the MOSAD prototype. All tasks performed by the students have been recorded. The parameters that have been measured include:

- ❖ Time taken to understand how the MOSAD application works.
- ❖ Time taken to complete the revision using MOSAD application.
- ❖ Number of key-presses used to move from page to other page.
- ❖ Number of key-presses used to move from section to other section.
- ❖ Number of key-presses to exit from the section.
- ❖ Frequencies of using shortcut key to move from section to other section.
- ❖ Frequencies of using main menu list to move from section to other section.

The value of each parameter has been measured by taking the average from twelve students. Finally, the observation and questionnaire usability data has been compared to proof that both data are match each other in terms of usability. The parameters and the results of usability observation will be discussed further in section 4.5.2.

- Post test

Post test is a test from Quasi Experimental Design where it is conducted in order to check the effectiveness of MOSAD prototype as a revision tool as compared to other existing revision tools. For post test, there are two groups of participants involves which are control and experimental. Both groups have already learnt the Project Initiation topic as the topic will be tested in post test. The number of 50 students in control group did the revision using existing revision methods while 66 students in experimental group did the revision using MOSAD application. Both groups were given a set of ten multiple choice quiz questions on the topic of Project Initiation. The quiz questions are attached in the Appendix C (Section B). Students were given 15 minutes to complete the quiz. After getting all the quiz results, the effectiveness of MOSAD prototype will be analyzed.

3.4.4 Usability Data Analysis

There are two types of data that have been gathered for this project which is quantitative and qualitative data. The quantitative data were analyzed using the Parametric Statistic which was divided into two styles of calculation which are descriptive and inferential statistic. In quantitative analysis, the calculation was done using Statistical Package for Social Science (SPSS) version 11.5 (Sekaran, 2000). Meanwhile, the data were analyzed from the pilot studies done to the five lecturers. Details of the collected data are explained in details in the section 4.4.1 and 4.4.2.

3.4.4.1 Qualitative Analysis

Data from the pilot studies are categorized as the qualitative data. These data will be analyzed using descriptive approach to explain the data in descriptive structure.

3.4.4.2 Quantitative Analysis

Quantitative Analysis was performed according to the hypothesis determined previously. The hypothesis is:

Null hypothesis (H_0): *There is no significant different in the post test mean scores between the Control and Experimental Group.*

The Parametric Statistic technique has been utilized in analyzing the data as Descriptive and Inferential on the 50 samples of control group and 66 samples of experimental group. The descriptive statistics is used to describe the structure of the data whereby it involves four types of calculation including Mean, Variance, Frequency and Percentage.

Meanwhile, Inferential Statistic is used to summarize the relationship between the samples that have been used in the experiment. In performing the Inferential Statistics, Independent t-test is used to see the difference between the means of experimental and control groups (Sekaran, 2000). For MOSAD application testing, the Independent t-test had been chosen since there are two different samples which are control and experimental group. The formula of calculating the difference of control and experimental means is shown below:

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$\overline{x_1}$ is the mean of the experimental group

$\overline{x_2}$ is the mean of the control group

S^2 is the variance or standard deviation square

n_1 is a sample size of the experimental group

n_2 is a sample size of the control group

3.5 Conclusion

This chapter has discussed on the details methodology of Mobile System Analysis and Design (MOSAD) application. The MOSAD Life Cycle is designed based on the ADDIE methodology which includes Analysis, Design, Development, Implementation and Evaluation. After going through all phases, the MOSAD application was completed and the testing was done in evaluation phase.

In evaluation phase there are two types of data collected which are qualitative and quantitative data. Qualitative data gathered through the pilot testing done among five lecturers whereas quantitative data collected from survey questionnaire and observation which were conducted to the students during the testing of the application. The phase also involves the post test among the experimental group of students in order to identify the effectiveness of MOSAD application as a revision tool as compared to other current revision tools. The next chapter will present the results and the analysis of the MOSAD application development and the tests which were conducted during the evaluation phase.

CHAPTER 4
RESULTS AND ANALYSIS

4.1 Introduction

This research had been conducted to achieve the three main objectives as stated in the first chapter which are: to propose a conceptual framework that can be used for the development of the course content for mobile learning as a revision tool application, to develop a mobile learning as a revision tool application prototype for System Analysis and Design (SAD) course based on the proposed conceptual framework, and to evaluate the mobile learning application prototype as a revision tool in terms of effectiveness and usability. Thus, in this chapter the results of the research will be presented according to the three objectives mentioned.

4.2 Mobile System Analysis and Design (MOSAD) Conceptual Framework

In developing the MOSAD application, four components have been incorporated in the framework so that the application will become an effective revision tool. The components include ADDIE methodology as an Instructional Design (ID) model, the technology, requirements and learning theories. All components were selected according to the preliminary (Hashim et al., 2010b) and the literature studies that have been performed. Figure 4.1 illustrates the detail conceptual framework for MOSAD development.

Based on section 3.2, the ADDIE methodology consists of five phases; Analysis, Design, Development, Implementation and Evaluation phases which functioning as the life cycle in developing the MOSAD prototype. In chapter 3, each phase has been discussed in detail.

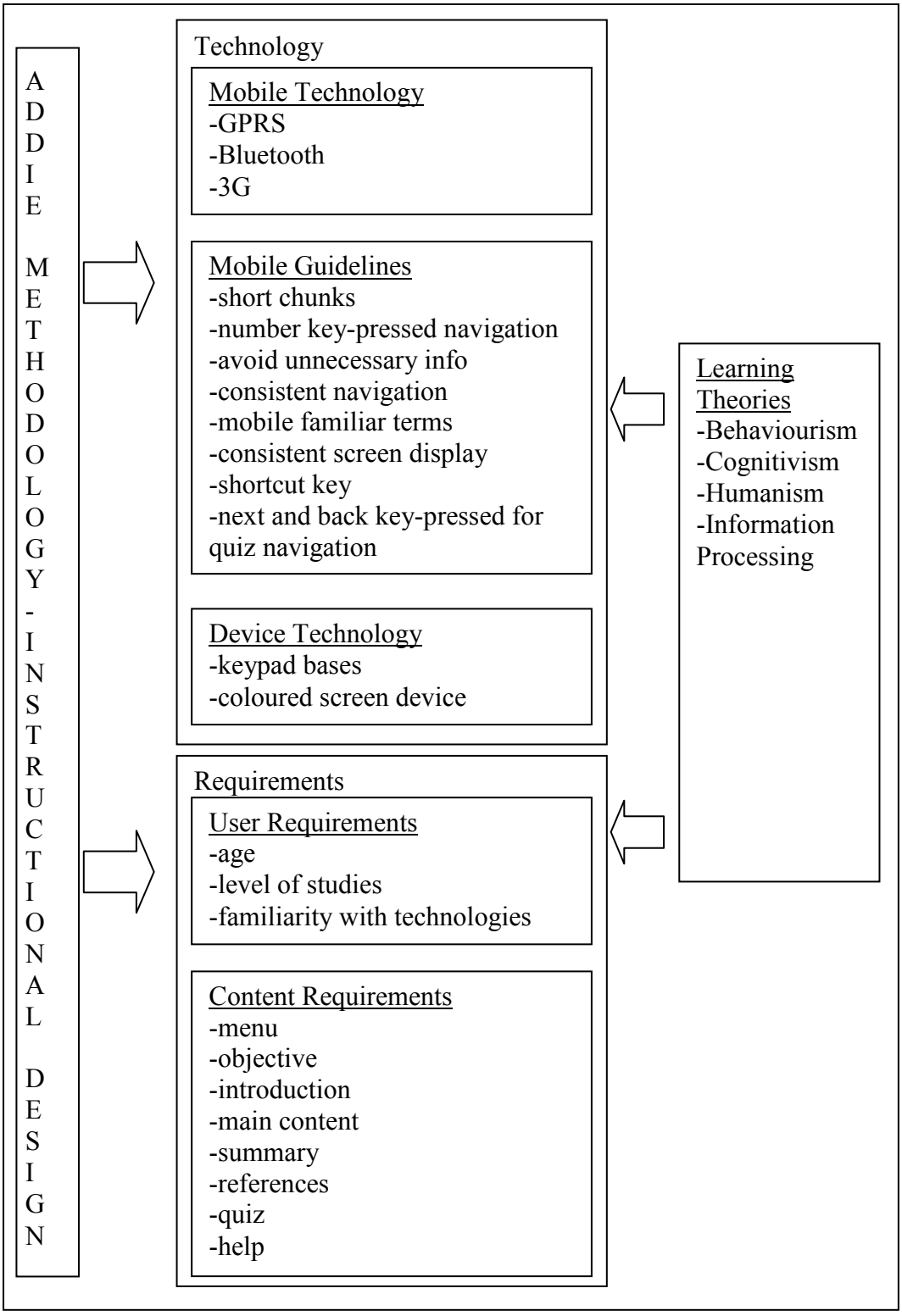


Figure 4.1 MOSAD Conceptual Framework

In technology component, it consists of three elements; mobile technology, mobile guidelines and device technology. Based on the preliminary study (Hashim et al., 2010b) that has been done, the highest three of wireless networks equipped in the

students' mobile phones are GPRS, Bluetooth and 3G. Based on this study, the MOSAD application has been developed in such a way that it can access using these three types of wireless networks. For mobile guidelines, the literature studies have been conducted to identify the best mobile guidelines for the prototype development. The guidelines include:

- Practicing the short chunks of sentences in each screen.
- Implementing number key-pressed navigation rather than "Next" and "Back" key-pressed in navigating the contents of the MOSAD application.
- Avoiding the unnecessary information to be put in the screen.
- Ensuring the navigation is always consistent in each screen.
- Using the mobile familiar terms to ease the users in understanding how the application works.
- Ensuring the consistency of screen displays.
- Preparing the shortcut key.
- Implementing "Next" and "Back" commands key-pressed navigation for Quiz section.

All guidelines have been followed in developing the prototype so that the produced application will be effective to help the users doing their revision. The final element of technology component, device technology involves the keypad-based and coloured mobile phones. According to Goth et al. (2006), it was encouraged to use the keypad-based mobile phones as compared to the touch screen mobile phones. It is due to the time taken to interact with the application. Based on the research done by Goth et al. (2006) the time taken to interact with the application in doing a single task using touch screen mobile phones are longer than keypad-based mobile phones. Hence, the keypad-based mobile phones are suitable to be used for accessing the MOSAD application as it can be used at any leisure time even a while as the time taken to interact when performing a single task is much shorter. For the second element which is coloured mobile phones, the MOSAD application has been developed for coloured-platform mobile phones as it will become me more interactive to the users in using it.

For the requirement component, the user and content requirements were taken into considerations in developing the prototype. In user requirements, the demographic information that include age, level of studies and familiarity with mobile technologies are taken into account so that the developed application will suit the target users. For this research, second year first semester Universiti Teknologi PETRONAS (UTP) Business and Information System (BIS) students were selected as the target users since the application was developed to them as they were currently taking System Analysis and Design (SAD) course. Most of them are twenty years old and very familiar with the mobile technologies. In term of content requirement, the content was decided based on the current syllabus of Project Initiation topic and some additional sections that has been chosen according to the studies that has been done. The additional sections were created in helping the students in undergoing their revision smoothly. The original syllabus includes introduction and the main contents which include system request, feasibility analysis, project selection and summary. The additional section includes menu, objective, references, quiz and help. Each content and additional section will be discussed further in this chapter.

For final component which is learning theories, the MOSAD application development has adopted four learning theories; behaviourism, cognitivism, humanism and information processing learning theory. Utilization of each learning theory will be elaborated in detail in section 4.3.

4.3 Development of Mobile System Analysis and Design (MOSAD) Prototype

The development of MOSAD prototype consists of many processes starting from planning until the evaluation of the prototype as discussed in section 3.2. MOSAD prototype development started with preliminary study in which to get the information on target users' mobile phones. The information includes brands, equipped wireless communication devices and supported operation system (OS). The elements of MOSAD prototype development include user interface design, course content structure design, learning theories and usability principles utilization.

4.3.1 User Interface Design

Section 2.4 discussed six examples of mobile learning applications. From the reviewed examples, it was found that, the interfaces of these applications were divided into several parts. For example, Mobile Museum Tours (Naismith & Smith, 2006) were divided into three parts namely title at the top, content in the middle and navigation mechanism at the bottom. Same goes to Epocrates Mobile CME application (Crane, 2010), where it implemented the same way of user interface design. This type of user interface design is very simple and it is the most suitable design due to the limitations of mobile phones' screen sizes. Figure 4.2 illustrates the user interface design for MOSAD application.

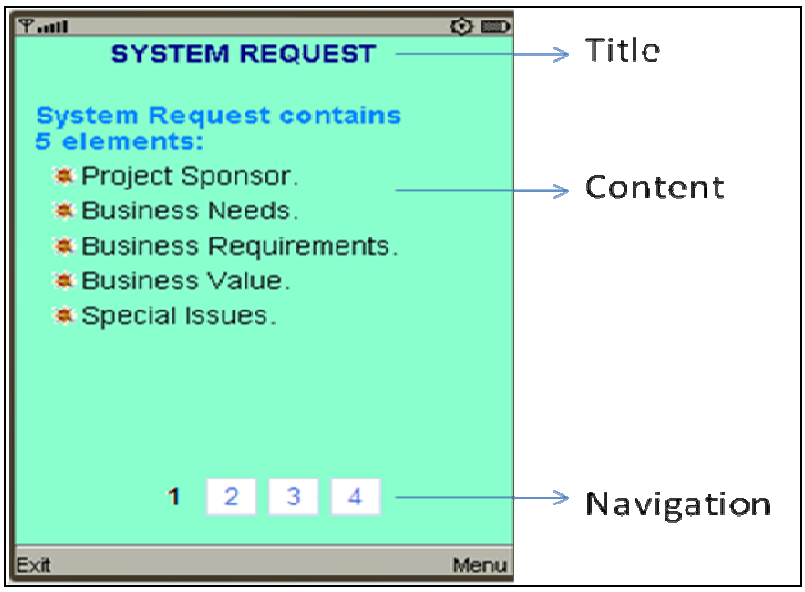


Figure 4.2: MOSAD User Interface Design

Section 3.2.2.1 (c) discussed eighteen principles of graphical user interface (GUI) design whereby it stated that background colour and font colour need to be contrast. Here, soft green colour was selected as the background for every MOSAD application pages. Then, the selection of font colours like blue and black was chosen since they contrast with the background colour. There are other principles pointed out such as the need of title name of the pages, avoid inserting image with text inside and emphasizing the level of sentences (Masson & Reid, 2010) were implemented in the

MOSAD interface design. In order to stress the level of sentences, MOSAD interface design implemented the use of different bullets.

4.3.2 Course Content Structure Design

MOSAD application was designed to a topic of System Analysis and Design (SAD) course which is Project Initiation. Therefore, the structure of the application course content was design based on the elements taught in the topic. The elements include objectives, introduction, system request, feasibility analysis, project selection, summary and quiz. However, there are three additional structure added in order to ease the students in understanding how to use the developed application. The additional elements include main content list, help section and reference section. Figure 4.3 shows the content structure of MOSAD prototype.

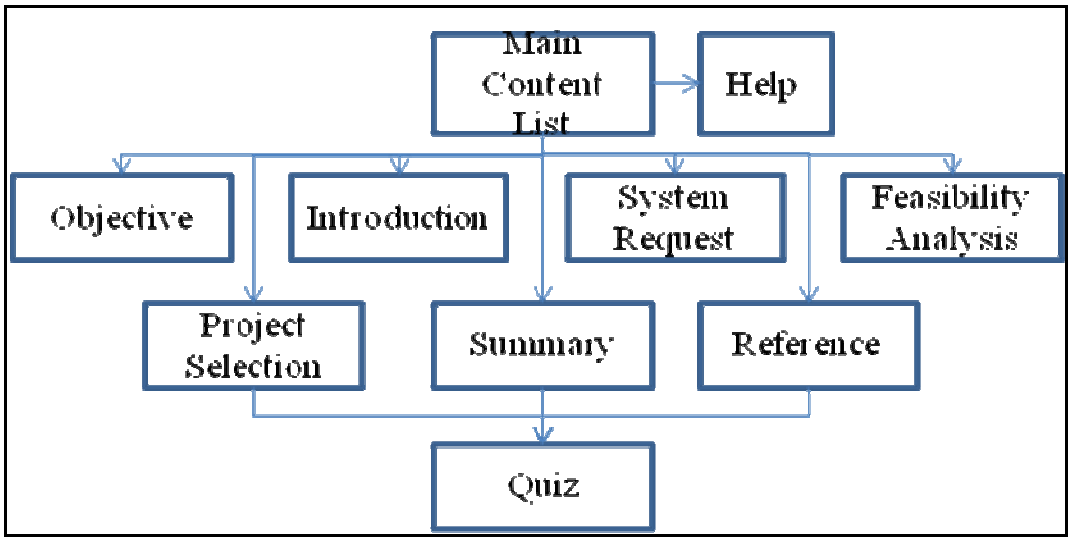


Figure 4.3: MOSAD Application Course Content Structure

In relation to the MOSAD course content structure, Figure 4.4 presents the flowchart of the application. It shows the sequence of the prepared sections of the application. It starts with the main content list whereby the users can select the section that want to be studied. Before coming to the quiz section, user needs to completely reading the learning materials from the Objective until the Reference section. Meanwhile, user can access the Help section whenever they want.

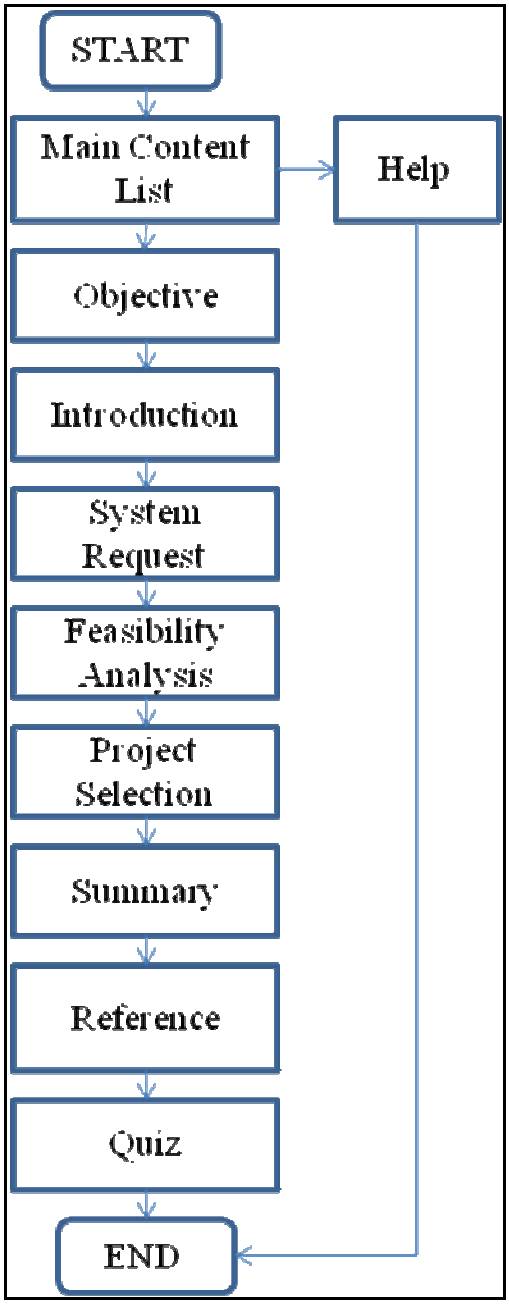


Figure 4.4: Flowchart of the MOSAD Application

4.3.3 Learning Theories and Usability Principles Utilization in MOSAD

Figure 4.5 until Figure 4.16 show the screen shots of the MOSAD application. In this section, each screen shot will be explained how the mobile GUI principles listed by Masson and Reid (2010), learning theories and mobile usability principles have been adopted in the application design.

Referring to section 3.2.2.1 (c), there are twelve out of eighteen mobile GUI principles that have been adopted in the MOSAD development. The principles are listed in Table 4.1.

Table 4.1: The Adopted Mobile GUI Principles

No.	Mobile GUI Principle	Label
1	The mobile pages need to have headers or titles.	P1
2	Titles need to be in capital letters.	P2
3	In a screen, avoid more than two consecutive blank lines.	P3
4	Lists form need to be implemented rather than table form.	P4
5	The color contrast needs to be high for fonts. The font colors and background must always be contrast.	P5
6	Different colors need to be used in stressing the different use.	P6
7	Avoid unnecessary words.	P7
8	Avoid from breaking long character strings with dashes, commas, or other traditional separators.	P8
9	Whole words are better than abbreviations, and standard abbreviations are better than non-standard.	P9
10	Images need to be in high contrast.	P10
11	Avoid images with the text inside.	P11
12	Use only images appropriate for users.	P12

In designing the application also, four learning theories were adopted which include drill and feedback of behaviorism, long-term and short-term memory capacity concept of cognitivism, learner-centered approach of humanism and, chunk and short-term memory capacity concept of information processing learning theory.

Finally, development of the application also has adopted eight mobile usability principles which were identified during the literature studies. The utilized usability principles are presented in Table 4.2.

Table 4.2: The Adopted Mobile Usability Principles

No	Mobile Usability Principles	Label
1	Short sentences with point form	U1
2	Chunking	U2
3	Short chunks	U3
4	Flexibility	U4
5	Shortcut key	U5
6	Simple Navigation	U6
7	Natural Usage	U7
8	Consistency	U8

In the Figure 4.5 until Figure 4.16, the adopted mobile GUI and usability principles are labeled as P1 until P12 and U1 until U8.

In general, MOSAD application supported behaviourism learning theory whereby both course content and short quiz were prepared. In the application, students are given the revision materials in refreshing their memories of what they were already learnt during lecture periods. After doing the revision (drill), set of multiple choice questions was prepared in testing their understanding of the concepts discussed in the application which functioning as feedback. Figure 4.5 shows the short quiz prepared in the application.

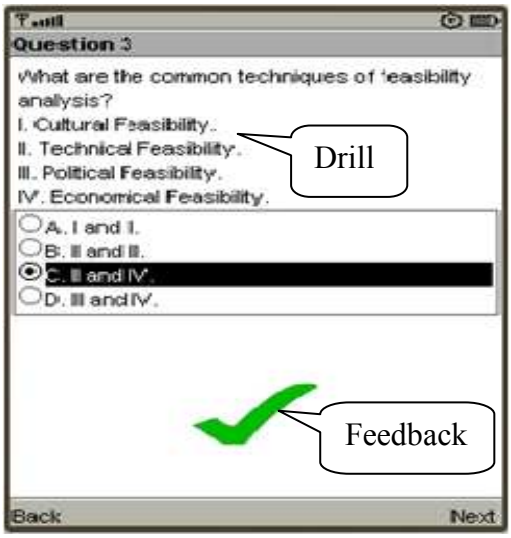


Figure 4.5: Quiz

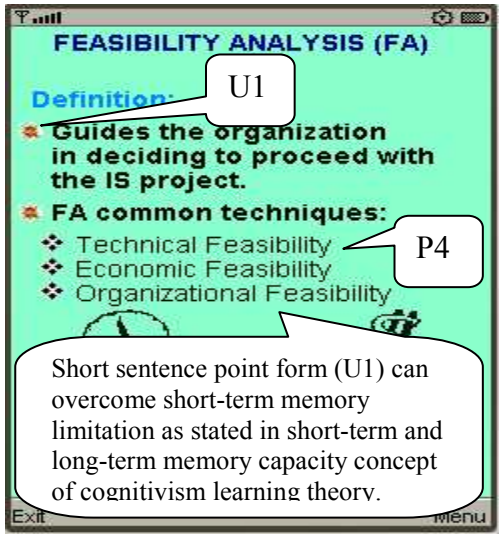


Figure 4.6: Feasibility Analysis

Besides, the course contents that have been learnt by the students were summarized in short sentences point form. Figure 4.6 illustrates the point form usage in the MOSAD application. By implementing this method, students will use the application in order to refresh the studied topic before coming to either test, examination or other assessment. Besides, this method also can overcome students' short-term memory limitations whereby the application provides only the important points of the topic to be revised. This situation fulfills the cognitive learning theory requirements.

Other than that, humanism learning theory emphasizes more on learner-centered type of learning in the application. In order to provide the students with the learner-centered approach, the MOSAD application was designed so that it is easy to be used by the students. The application was very simple in term of language usage which is very straight forward English. The sentences in the course content also can be considered short and easy to understand. Besides, the application was also prepared with simple navigation mechanism in which the students can move from a page to other pages and from section to other sections easily. Figure 4.2 shows the navigation mechanism that was implemented in the application. Finally, Help section was prepared to the students in order to guide them on how to use the application in supporting the learner-centered approach as indicated by Hulse (1992). Figure 4.7 illustrates the Help section screen of the application.

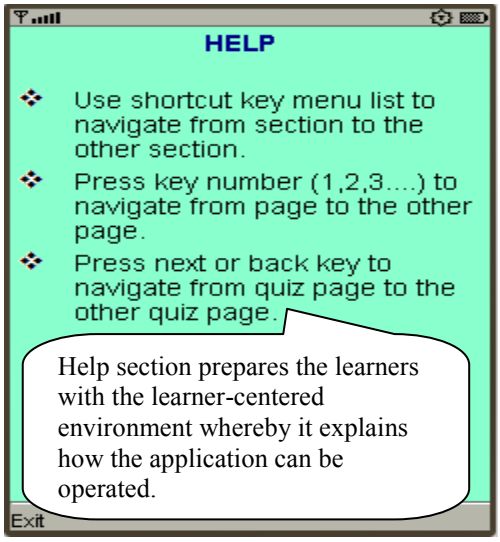


Figure 4.7: Help

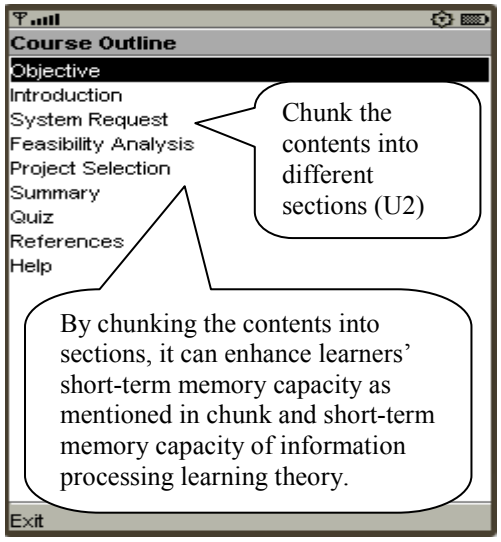


Figure 4.8: Main Content List

For information processing learning theory, there are two concepts introduced which are chunking and the capacity of short-term memory. By organizing the application course contents in short chunks, it can enhance the learners' short-term memory (Miller, 1956). These concepts were utilized in the MOSAD application development whereby short chunks of information were inserted in every page of the application. Besides, the sub topics of the discussed topic also were divided into different sections so that it gives the students with a systematic way of doing revision. Figure 4.8 shows the sections or contents of the application. Users can press the up or down key pad in choosing the sections that they want to study. In addition, this section will give an overview to the users about the elements covered in the discussed topic.

Section 2.7.2 discussed five usability issues need to be taken into considerations when developing the mobile learning applications. Usability concepts are very important in providing to the users with easy and simple application in which the application will be very helpful tool in doing learning activities. The usability concepts utilized in the MOSAD application development include content, natural usage, navigation, consistency and flexibility.

As discussed in the section 2.7.2.1, the contents of MOSAD application was organized in short chunks due to advantage of enhancing learners' short-term memory and easiness in reading and understanding the inserted information. Short chunks contents also can overcome the mobile phones' screen size problems in which it can retain the users' reading pace as indicated by Kaikkonen and Laarni (2002). Besides, the less is more rule was implemented whereby only important information was put in the content in point form. It will ease the learners in finding the important key concepts of the topic to be studied. Figure 4.9 illustrates the implementation of short chunk principle in the application.

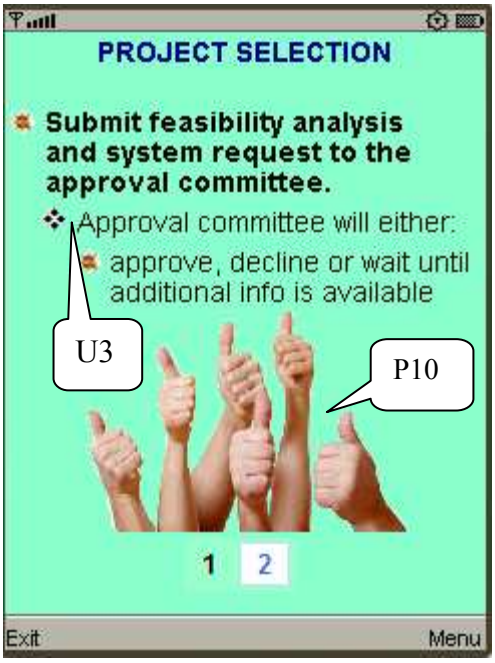


Figure 4.9: Project Selection

Natural usage or user-friendly is an important concept when developing a mobile learning application. By accounting this concept, the well-known mobile commands were implemented in the application. The commands include "Menu", "Next", "Back" and "Exit" will operate the same of the other developed mobile applications. Figure 4.10 illustrates the use of well-known commands in the application.

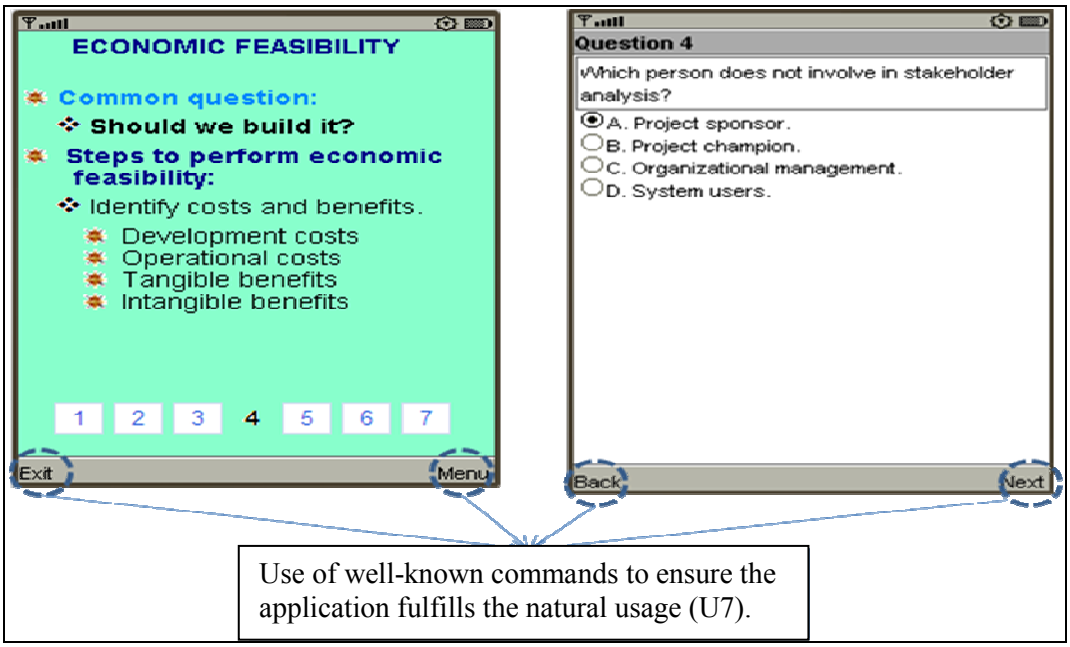


Figure 4.10: Usage of Well-Known Commands

The structure of MOSAD application also was very simple whereby the users took only several times in understanding the operation of the application. Section 4.4 will discuss this issue in details. By having the user-friendly application, it will help the users in focusing more on the contents of MOSAD application as the aim of this application development is to provide the learners with the effective revision tool rather than analyzing on how to use the application.

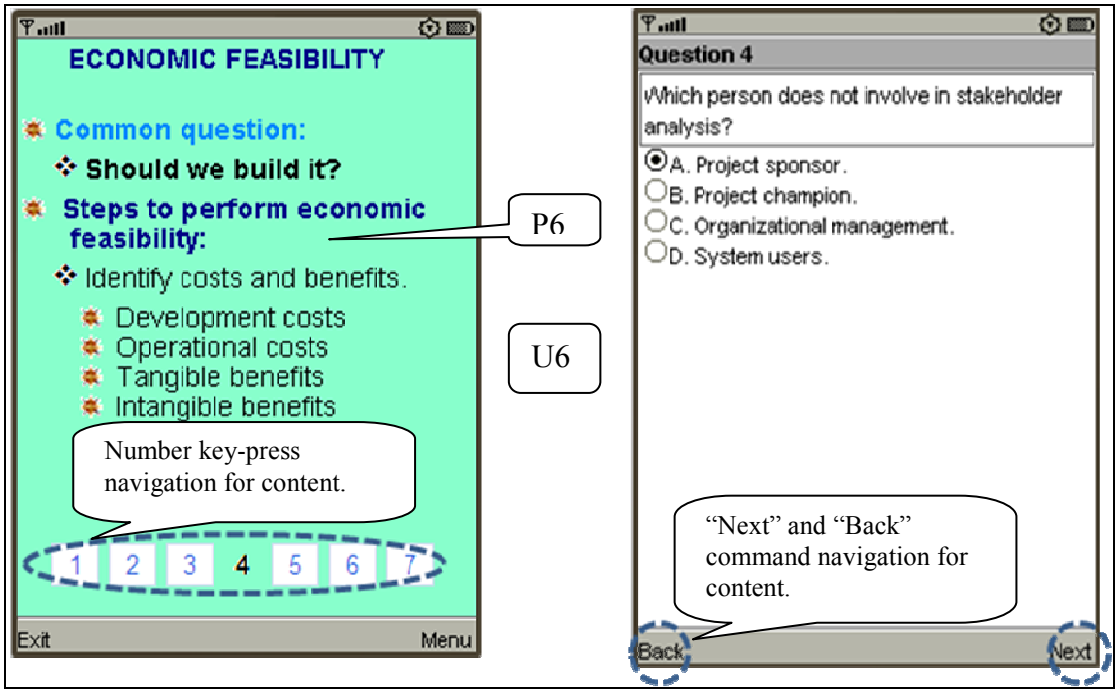


Figure 4.11: MOSAD Navigation Mechanisms

Besides, navigation mechanism is also one of the important elements in mobile applications development. As discussed in the chapter 2.7.2.3, the researchers avoid the scrolling as a way to access the information since it will disturb the learners' reading pace. Researchers also advised to the developers to find out the best mechanism to be used in the mobile learning application. Figure 4.11 presents the navigation mechanism used in MOSAD. For MOSAD application, the number key-press was chosen as navigation mechanism rather than using "Next" and "Back" navigation in accessing the course contents. User can move to the desired page from the current page only with single press. For example, student is reading page one and wants to move to page four. By pressing number four, the page four will appear and ready to be read. As compared to "Next" and "Back" command, user needs to press

"Next" command three times before arriving to page four. Therefore, the implementation of number key-press can minimize the number key-press in accessing the content. However, for quiz section, the "Next" and "Back" commands navigation were chosen in order to move from the question to other questions. This navigation was chosen due to the normal mobile quiz operations whereby the users need to complete the previous question before moving to the next question.

Other than that, consistency concepts were utilized in MOSAD application in three elements. The elements include content structure, navigation and sentences level organization. In every page, the same content structure was implemented. It includes title, contents and navigation mechanism. Besides, the navigation was also put at the same place in every page. Finally, the sentences of the contents were consistently organized in bullet form and important points were emphasized using different font styles. The consistency is very important in ensuring the user-friendliness application. The users will take only several times in studying the application's operation due to the same content structure, navigation and sentences level of organization at every page and every section.

Finally, flexible actions can help the users in navigating the application. Some applications provided several actions that perform the similar tasks. It is to give the users options of methods to access the application. MOSAD application provided the main menu list for the users to choose the section that need to be studied. After studying that section, users need to exit to main menu list and choose another section in order to continue the study. Figure 4.8 shows the MOSAD main menu list screen shot. By inserting the shortcut menu list in each page, it will help the users in navigating to the desired section without exiting to the main menu list. Besides, it is also can minimize the number of keystrokes in performing one task. Figure 4.12 illustrates the shortcut menu list that can be used by the users.

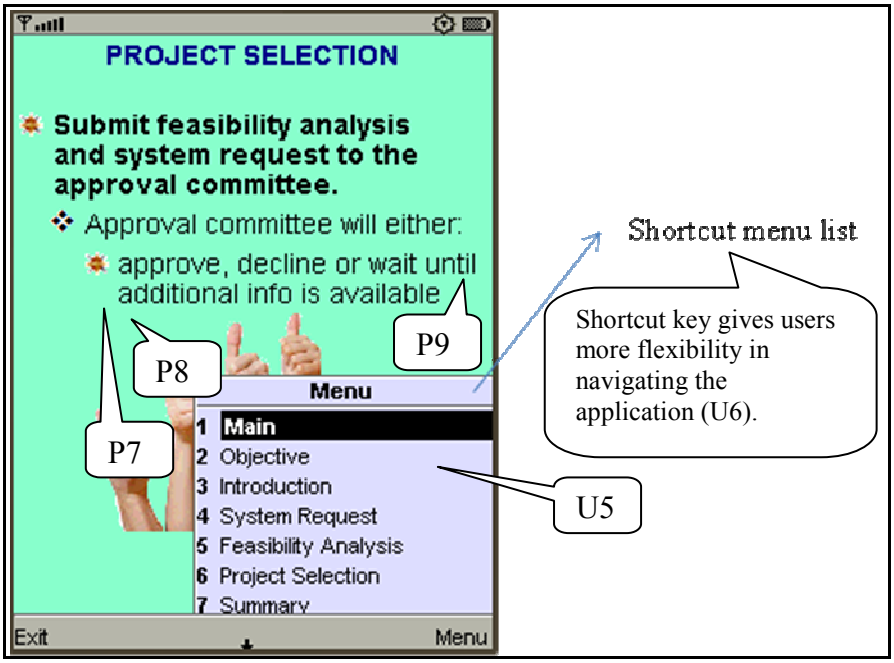


Figure 4.12: Shortcut Menu List

In addition, there are four additional sections that were designed in making MOSAD as an effective tool for revision. The sections include Objectives, Introduction, Summary and References. The Objectives section presents the listed objectives that need to be achieved by the users or learners after completing the revision of the discussed topic. Figure 4.13 shows the screenshot of Objectives section.

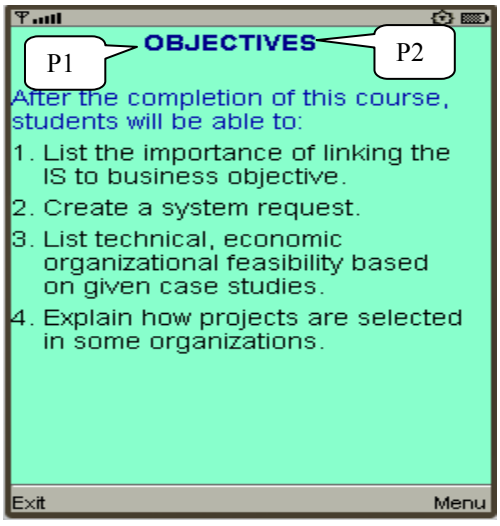


Figure 4.13: Objectives

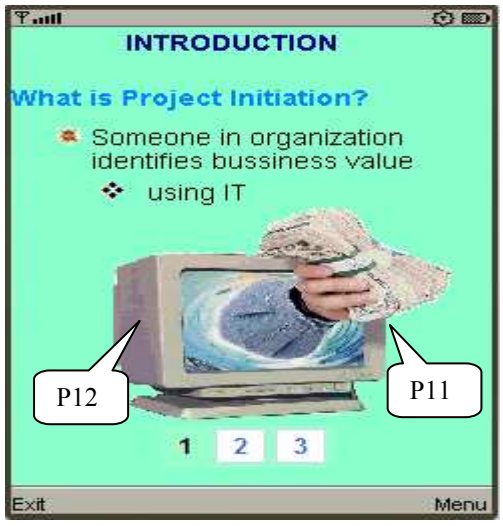


Figure 4.14: Introduction

Introduction section was prepared to give the basic idea of the whole discussed topic in the application. Figure 4.14 presents the Introduction section of the application. This section contains the definition of several keywords that were used throughout of the topic. By defining the necessary keywords, it will ease the users in understanding the topic.

Other than that, the Summary section also has been prepared to give the final overview of the whole topic. This section will give the users an opportunity to refresh the discussed topic that has been revised before the revision end. Figure 4.15 illustrates the Summary section.

Figure 4.15: Summary

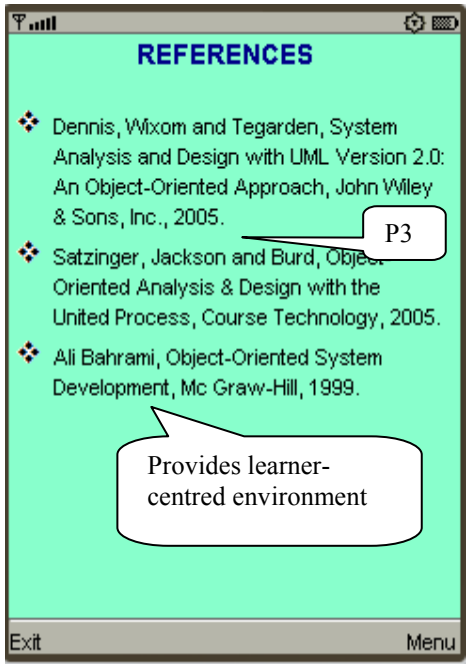


Figure 4.16: References

As for final additional section which is References, this section lists out all the references that need to be found by the users when they feel there is a need of further reading to the discussed topic. Figure 4.16 shows the References section of the application.

4.4 Effectiveness Evaluation on MOSAD

As mentioned in chapter 1.4, an evaluation on the MOSAD prototype should be conducted to determine the effectiveness towards improving students' understanding on discussed topic as a preparation for examination, test or other assessments. The evaluation was done using Quasi Experimental Design by comparing the performance from two groups which using the application for the revision and not using the application.

As discussed in chapter 3.4.1, the Quasi experiment has been designed to include post test on the selected samples, which consists of fifty students in control group (X_1) and 66 students for experimental group (X_2). Table 3.1 shows the composition of each group that has participated in the experiment. This section also presents two types of tests which related to post test Quasi experiment. It includes the hypothesis testing for effectiveness evaluation and independent T-Test on the developed application. According to Gribbons and Herman (1997), post test Quasi experimental design without pre-test can be conducted when the two groups (X_1 and X_2) are equivalent in term of characteristics which can affect the observed differences in post test scores. This concept was applied in the MOSAD testing whereby both students in X_1 and X_2 group have already learnt the Project Initiation topic which will be tested during the testing. Since both groups had equivalence knowledge and experience regarding the topic, post test scores will indicate the effectiveness of MOSAD application as a revision tool which will be used by X_2 as compared to the X_1 that does not use the application as the revision tool. To support the above argument given by Gribbons and Herman (1997), Saint-Germain (2001) gave similar opinion whereby post test only can be conducted when the test participants have already been exposed to the treatment that is basically conducted in pre test. So, this concept has been applied in this study since, both X_1 and X_2 already been exposed to the conventional class treatment which has been conducted during lecture period. Moreover, the post test only Quasi experiment has been conducted since the conducted study used the random samples for both X_1 and X_2 groups. As stated by Trochim (2006), both two groups can be assumed as probabilistically equivalent when the samples of the groups are selected randomly, thus, the pre test is not required.

4.4.1 Post Test Analysis for Effectiveness Evaluation on MOSAD

Table 4.3 illustrates the statistical analysis of post test marks for control (X_1) and experimental (X_2) groups. Based on the table, majority of students in X_1 (64%) obtained 4-5 marks out of 10 where as the highest percentage of students in X_2 got 8-9 marks. Besides, Table 4.3 also shows that the number of students obtained lowest marks (1-3) was 4 students for X_1 whereas no student obtained that range of marks in X_2. Only one student from X_1 obtained full mark as compared to X_2, 3. Besides that, the mean mark for X_2 group is also higher than X_1 which is 7.7576 as compared to 5.160.

Table 4.3: Statistical Analysis of Post Test Marks for X_1 and X_2

Mark	X_1 Group		X_2 Group		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
0-3	4	8	0	0	4	3.45
4-5	32	64	1	1.51	33	28.45
6-7	8	16	22	33.33	30	25.86
8-9	5	10	40	60.61	45	38.79
10	1	2	3	4.55	4	3.45
Total	50	100	66	100	116	100

Based on this produced statistics, it can be concluded that, the X_2 group of students who used the MOSAD as a revision tool obtained better marks as compared to X_1. Thus, MOSAD application can be said as an effective revision tool that can be used by the students.

4.4.2 Hypothesis Testing for Effectiveness Evaluation on MOSAD

Apart from post test evaluation, hypothesis testing to evaluate the effectiveness of the MOSAD application has been identified. Hypothesis is a logical relationship between two or more variables presented in the form of statement (Sekaran, 2000). The variables are tested to examine whether the relationship that have been stated does in fact, got true. The hypothesis for this study is:

Hypothesis (H_0): There is no significant difference in the post test mean scores between the Control and Experimental group.

The result from this hypothesis is given in Table 4.4. The mean score of the post test for the control group (X_1) is 5.160 with standard deviation of 1.6704 while the mean score (X_2) for the experimental group is 7.7576 with standard deviation of 0.9456. This comparison shows that group X_2 achieved significantly higher in the post test as compared to the control group. The significant (2-tailed) value which was generated by SPSS software, $p = 0.019$, is less than $\alpha = 0.05$. According to Masri (2009) and Ahmad (2004), p value is less than α value, ($p < \alpha$) implies that the null hypothesis (H_0) is rejected.

Table 4.4: MOSAD Hypothesis Test Results

Variable	Mean	SD	t-value	Sig.(2-tailed)
X_1	5.160	1.6704		
			8.400	0.019
X_2	7.7576	0.9456		

This result shows that there is significant difference in the post test mean scores between the Control and Experimental group. Thus, it can be concluded that MOSAD application is an effective revision tool as compared to the other conventional learning methods.

4.5 Usability Evaluation on MOSAD

The usability testing is conducted to measure the quality that users experience during interface interaction. In conducting usability testing, this project chose two types of analysis which is qualitative and quantitative analysis.

4.5.1 Qualitative Analysis on Usability in MOSAD

For qualitative analysis, a heuristic test involving five lecturers in the area of Human Computer Interaction (HCI) was conducted after the first version of MOSAD was

completed to strengthen its functionality and usability. The purpose of this test was to get the feedbacks in term of MOSAD application usability and functionality that can be corrected and enhanced. Two of the lecturers have had experienced in teaching the SAD course. The role of these lecturers was to assess and give comments regarding the contents of the MOSAD application through heuristic testing of the application. Table 4.5 presents the qualitative results of the heuristic testing among five lecturers.

Table 4.5: Qualitative Heuristic Test Results

Lecturer	**Comments**
1	- It is recommended to add shortcut keys in every page for better understanding and faster learning of the application.
2	- Embed the sounds as it may increase the users' understanding. - Improve the font size and type. - Text colour should be differentiated with the background colour. - Propose the links as the references in helping students to the further reading.
3	- Differentiate the different levels or importance of the contents via different text sizes and text colours. - Put the Help section in giving information to the users of how to use the application. - The whole application is very well-structured.
4	- Next and back button should also be able to use in addition to number key-pressed as navigation mechanism.
5	- Use standard or normal bullet points. - "I do not need any help at the second time of using the application since it is familiar." - Appropriate pictures or images used. - The use of text in red may be very wrong for a computer display but it could be acceptable for a smaller display since it can be read clearly in this application.

Based on the given comments by the lecturers, many improvements had been made. However, there are two feedbacks that cannot be entertained. For example, embedding sound into the application. This improvement cannot be done due to the limitations of the software used in developing MOSAD application. Besides, "Next" and "Back" keys also cannot be implemented in addition to number key-pressed as navigation mechanism since the soft keys are already used as shortcut key. Actually, it is possible to insert "Next" and "Back" button to the soft keys. However, the addition of the buttons will make the navigation more complex as it requires more keystrokes in order to perform that task which violates one of the guidelines mentioned earlier. Figure 4.17 illustrates the discussed issue.

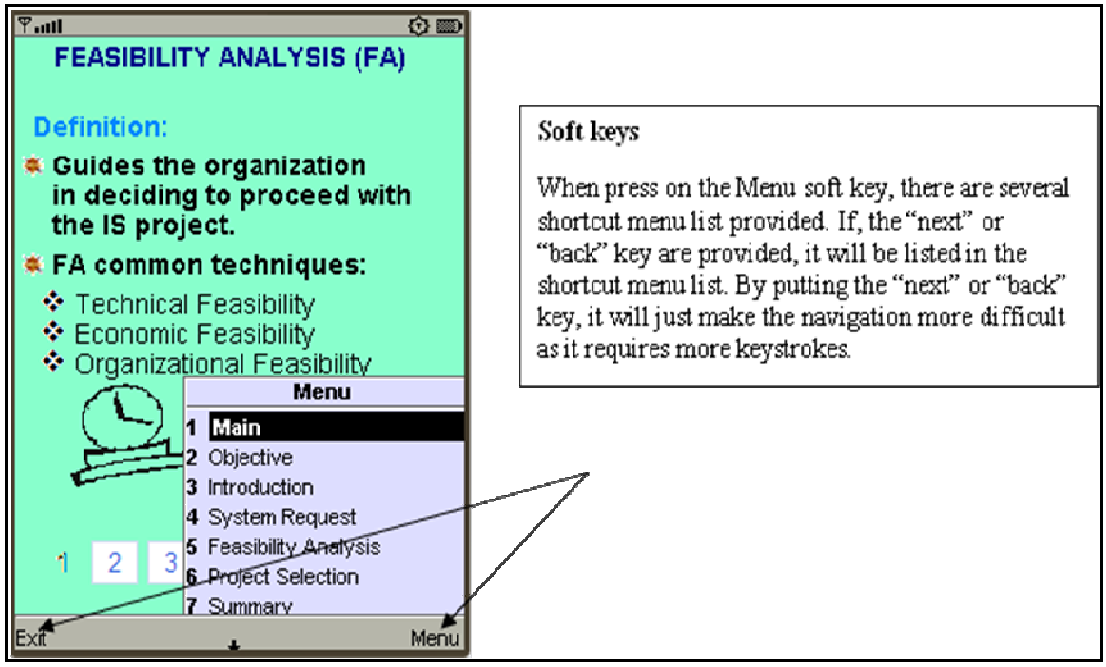


Figure 4.17: Soft Keys Usage

From the identified comments given by the lecturers, the MOSAD application was been improved before the effectiveness and usability tests being conducted to the end users which are students.

4.5.2 Quantitative Analysis on Usability in MOSAD

As discussed in section 3.4, the usability evaluation for MOSAD application will be on the consistency, learnability, minimal action, minimal memory load and flexibility,

which have been used to test the capability of the application as a revision tool for the students. 66 students from experimental group involved in this test. In addition, these five usability factors were chosen because they can potentially influence students' achievement. For example, during the learning process, if students are satisfied with the application in terms of flexibility and consistency, the learning will become easier and more interesting. The result for quantitative analysis from the students of five usability factors are presented in Appendix D. Figure 4.18 then illustrates the mean score of each tested usability factor.

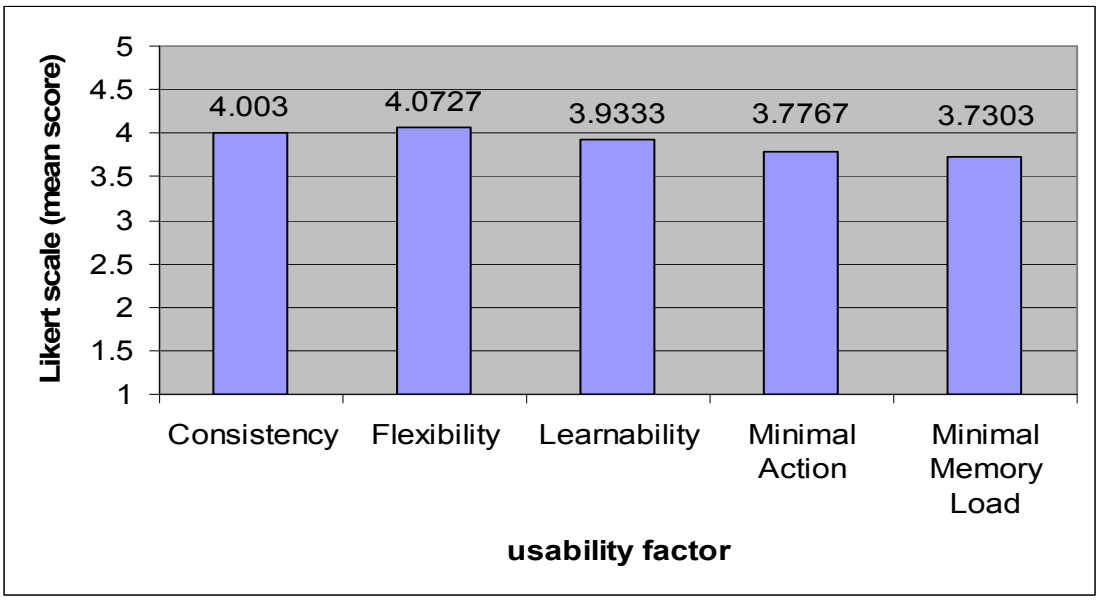


Figure 4.18: Mean of Tested Usability Factors

As shown in Figure 4.18, the feedbacks from the usability test conducted to the experimental group (X_2) have shown that the flexibility factor has gained the highest mean score (4.0727) when compared to the other four factors. Flexibility was measured based on the use of several mechanisms in performing similar tasks. The second highest mean score is consistency whereby the mean is 4.003. This means that the students find that the developed application implemented the same displays at every page of the application. Whereas, the mean score for learnability factor is 3.933, which indicates that the application is fairly easy to operate. Besides, the mean score for the evaluation on the minimal action and minimal memory load factors are also considerably high which are 3.7667 and 3.7303 respectively. The results thus indicate

that majority of the students agreed that the developed MOSAD application has met the requirement of usability elements as the revision tool.

In order to proof the reliability of usability questionnaire result, an observation method of usability study has been conducted. As stated before, there are five usability factors need to be measured which are consistency, flexibility, learnability, minimal action and minimal memory load. The observation method can only be conducted to three of the five factors which are flexibility, learnability and minimal action. Even though the consistency and minimal memory load factors cannot be measured using this method, the learnability factor is very much dependant to both factors and there are related to each other (see Appendix C). As stated by Su et al. (2007), the consistency of contents and displays of mobile application interfaces will make the mobile application users learn the operations of the application much faster. Hence, this parameter can be measured under learnability factor. Same goes to the minimal memory load factor whereby the elements include the short application, usage of short sentences, utilization of point form and different text colours and the images (see Appendix C). All stated elements will improve the users' memory load (Donnelly & Walsh, 2009; Grasso & Roselli, 2005; Kaikkonen & Laarni, 2002; Parsons et al., 2007; Uther, 2002). In this case, learnability factor is also very much related to the minimal memory load factor in which the users will take shorter time to study the contents of the application since the application content provides all elements stated under the minimal memory load factor (see Appendix C).

The usability observation has been conducted to twelve second year Business and Information System students of UTP. Appendix E presents the detail statistical results of the observation. This study covers three usability factors which include flexibility, learnability and minimal memory load. Table 4.6 shows the results of elements covered in each factor.

Table 4.6: Results of Usability Factors Using Observation Method

No	Usability Factor	Studied Element	Result
1	Flexibility	Frequencies of using shortcut key menu list to move from section to other section.	5.8333 ≈ 6 times
		Frequencies of using main menu list to move from section to other section.	3.1667 ≈ 3 times
2	Learnability	Time taken to understand how the application works.	1 minute 34 seconds
		Time taken to complete the revision using the application.	6 minutes 41 seconds
3	Minimal Action	Average number of key-presses to move from section to other section.	2.713 ≈ 3 key-presses
		Average number of key-presses to move from page to other page	1 key-press
		Average number of key-presses to exit from the section.	1 key-press

MOSAD application contains nine sections which include Objective, Introduction, System Request, Feasibility Analysis, Project Selection, Summary, Quiz, Reference and Help. For flexibility factor, in average, the students used the shortcut key menu list to move from section to other section for six times as compared to the use of main menu list which only three times. This result shows that the users really use the prepared flexible function to navigate the application and it became the most preferable choice in easing them to move from section to the other section.

In terms of learnability, there are two elements that have been measured which are time taken to understand the application works and time taken to complete the revision using MOSAD application. The average time taken by the students to understand how the MOSAD application operates is 1 minute and 34 seconds, whereas the average time taken by the students to complete the revision using the application is 6 minutes and 41 seconds. Based on both times taken, it can be concluded that, the students just took few minutes to study on how the application works and to complete the revision as stated in Colazzo (2003), Bevan (2001) and Collura (2006), as compared to do revision using other conventional methods. This scenario was happened due to the utilization of the measured elements identified in

the consistency and minimal memory load usability factors which is stated in Appendix C.

Finally, for minimal action usability factor, the average number of key-presses by the students to move from section to other section is almost three, whereas the average number of key-press to move from page to other page and to exit from the section is only one. According to Nielsen(1993) and Sharp et al.(2007), the usable and acceptable maximum number of keystrokes in performing one task in an application is three. Thus, the MOSAD application can be considered as usable in terms of key-presses since the average number of key-presses used by the students throughout using the application is less than 3.

In conclusion, the presented results of usability observation have supported the validity of usability questionnaire results. Thus, it indicates that MOSAD application has met the requirement of mobile usability factors as a revision tool.

4.6 Conclusion

This chapter has presented the results for the Mobile System Analysis and Design (MOSAD) prototype. The application has been successfully developed according to the design and the adoption of principles and theories. The prototype is evaluated for the effectiveness and usability. For the effectiveness evaluation, it was proven that MOSAD application is an effective tool for students to the revision as the preparation for examination, test or assessment. In addition, the evaluation on MOSAD usability showed positive results when the total average score is higher than the Likert scale mean score which is 2.50. This result of has been supported by the conducted usability observation. Heuristic test also achieved the objective to find out the usability problems in the application. Each identified problems was corrected and enhanced in improving the developed MOSAD application. Therefore, the evaluation has been analyzed via quantitative and quantitative analysis. The following chapter will discuss on the conclusion for the whole research study.

CHAPTER 5
CONCLUSION

5.1 Introduction

This chapter summarizes the whole study and concludes the findings. A review on how the research objectives have been accomplished at the five phases is also presented. This chapter also discusses on the comparison between this research findings with other findings. The future research will be proposed and finally, this chapter will highlight the contributions of the study.

5.2 Discussions

Three main objectives were identified prior to conducting this study that aims to develop a Mobile System Analysis and Design (SAD) prototype as a revision tool. The study has been carried out to meet the first objective before proceeding to the next and so on.

As compared to the other studies, this research produced a simple framework for mobile learning course content application by integrating four elements inside. The elements include ADDIE methodology as an Instructional Design (ID) model, the technology, requirements and learning theories. The framework utilizes ADDIE methodology as a MOSAD life cycle. Furthermore, the Instructional Design (ID) model which is one of the contributions from this research has been produced in the design phase of the life cycle. The elements of ID model include the mobile phones technology elements, instructional strategy, perpetual navigation, learning approach and pedagogical approach. Under pedagogical approach element, the sub elements including level of learners, interactivity and response trough the application were identified. In developing MOSAD application, the important sections for the

application were identified. It includes the objectives, introduction, contents, summary, quiz, references and help. The conceptual framework, ID model and MOSAD Life Cycle have been designed as the guidelines for the application development.

A Mobile System Analysis and Design (MOSAD) application that incorporates two components which are learning theories and mobile learning application principles has been successfully developed. The learning theories adopted are behaviourism, cognitivism, humanism and information processing learning theory. In addition, the principles of mobile learning application development include content, natural usage, navigation, consistency and flexibility. Hence, with the development of the MOSAD application, the second objective is achieved. The adoption of learning theories have overcame the weaknesses of the identified mobile learning application examples in section 2.4. The most common weakness of the previous applications was the use of long texts. By adopting the cognitivism and information processing learning theories, and the content usability principle, the long texts problems have been solved as mentioned in section 4.3.3.

The results of the post test that was used to measure the effectiveness of MOSAD application have been discussed. According to the results, students who used the MOSAD application as a revision tool obtained better marks as compared to the students who did not used the application. Independent T-Test was also performed to evaluate the hypothesis that has been constructed. According to the hypothesis, significance difference is observed in the post test between the control and experimental group. This result matches with the other findings such as Zolfo et al. (2009), Safran et al. (2009), Ariffin & Muthan (2010) and Evans (2008) in which the developed applications gave more benefits to the education sector by preparing more effective way of learning.

The evaluation on the application usability used five evaluation criteria which include consistency, flexibility, learnability, minimal action and minimal memory load. The data were gathered using the heuristic evaluation, questionnaire distribution and observation to the experimental group. Several usability problems were identified

by five lecturers who conducted the heuristic evaluation. The application improvements were done and questionnaire was distributed to experimental group in getting the quantitative data. The evaluation results show that among the five criteria, flexibility has been given the highest rank followed by consistency, learnability, minimal action and minimal memory load. Additionally, each element showed a higher mean score than the Likert scale mean score. In supporting, the usability questionnaire result, the usability observation has been conducted and it showed that the usability questionnaire and usability observation results are inline. Thus, the MOSAD application has fulfilled the usability needs, which has rendered the MOSAD as suitable for full implementation. Hence, this research has met the third objective.

The common method used by the researchers to conduct a usability test is questionnaire. The use of questionnaire for usability test is not sufficient since the data might not reliable due to the bias. Because of that, for this study, three research methods have been used for usability test which are interview (qualitative), questionnaire (quantitative) and observation (quantitative). The combination of these three methods produced more valid and accurate usability data. Thus, this usability test setup differs from other conducted usability tests which only involve two methods which are interview (qualitative) and questionnaire (quantitative).

From these section discussions, the contributions of this study can be summarized as in Figure 5.1.

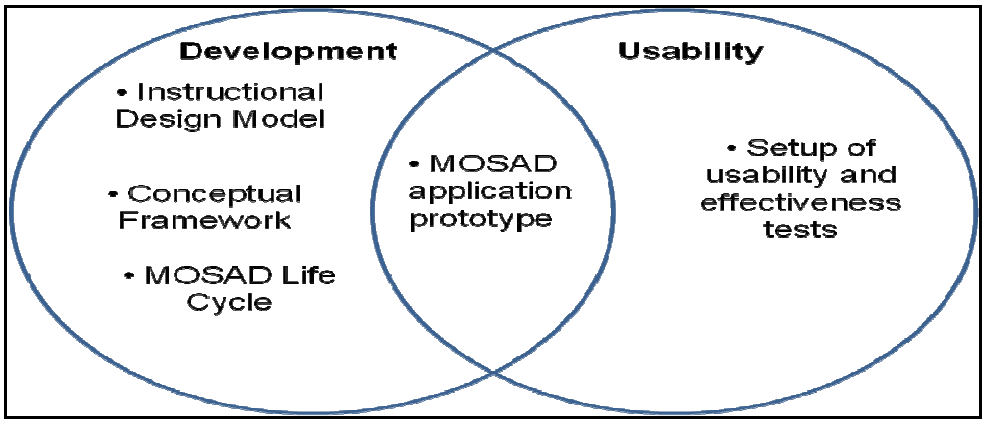


Figure 5.1: Research Contributions

5.3 Future Research

For this research, it focused more on development and usability study of MOSAD application as a revision tool. This project still can be expanded by adding several elements inside. There are two future works that can enhance the developed MOSAD prototype which are integrating dynamic database management system and designing the algorithm that can limit number of words or sentences which can be put in one page (Hashim et al., 2011).

By integrating dynamic database management system with the application, the application contents will be more efficient since the information can be stored in the database and user interface will work as a medium of presenting the information. However, by only integrating the application with dynamic database, there is still a limitation that will make the contents per page look messy when the long sentences from the database inserted into the page. Consequently, the usability level of the application will reduce as it makes the users difficult in reading the contents of the application.

In order to overcome this problem, an algorithm needs to be identified in limiting the number of words or sentences in a page. By setting the number of words or sentences per page, the application will automatically generate new page when the sentences or words of information in the database exceed the set limit identified in the algorithm.

5.4 Conclusion

In conclusion, the research on The Development and Usability Study of Mobile Learning Course Content Application as a Revision Tool has been successfully completed and the objectives have been met. Evaluation on the application was performed and the results show that it has been beneficial and effective to the students as a revision tool in preparing for the assessments. It prepares to the students with the medium in which, students can bring use the application as long as the students bring the mobile phones.

The MOSAD application is an interactive learning application whereby students can access it using the mobile phones technologies. It is hoped that the MOSAD Life Cycle, Conceptual Framework and the Instructional Design Model (IDM) that have been designed will motivate other researchers in education and mobile learning technologies area. Besides, it is also hoped that the concept of MOSAD application which integrated with the learning theories and mobile learning application principles can be used by other higher education students to assist them in performing the revision. Finally, it is hoped that the idea of MOSAD application will encourage the learners in fully utilizing the mobile learning applications for better good in education sector.

REFERENCES

(QIA), Q. I. A. (2009). Mobile Learning. 2009, from http://www.excellencegateway.org.uk/page.aspx?o=ferl.aclearn.page.id958

(UN), U. N. (2009). 60% of World's Population Using Mobile Phones. 2010, from http://www.itindustrynews.co.uk/60-of-worlds-population-using-mobile-phones-says-united-nations-873.html

Ahmad, W. F. W. (2004). *Integration of Multimedia in Visualizing Geometric Transformations for Mathematics Education.* Universiti Kebangsaan Malaysia.

Al-Jabr, A.-F. M. (2006). A Comparative Study of Conventional Learning and E-Learning with Reference to Arab Learners' FL & Translation Skills.

Andrade, E. L. M., Mercado, C. A. A., & Reynoso, J. M. G. (2008). Learning Data Structures Using Multimedia-Interactive Systems. *Communication of the IIMA, 8*(3), 25-32.

Ariffin, S. A., & Muthan, V. K. (2010). Mobile Learning Application in Malaysian Traditional Batik. Universiti Pendidikan Sultan Idris.

Attewell, J. (2004). *Mobile Technologies and Learning*: Technology Enhanced Learning Research Centre. (L. a. S. D. Agency o. Document Number)

Baharom, S. (2000). *Pembangunan Perisian Kursus Matematik Garis Lurus Menggunakan Pendekatan Multimedia Interaktif Untuk Sekolah Bestari.* Universiti Kebangsaan Malaysia.

Bennett, R. (2010). *Going Mobile*. Washington D.C.: The Information Technology & Innovation Foundation (ITIF)o. Document Number)

Bevan, N. (2001). International Standards for HCI and Usability. *International Journal of Human Computer Studies, 55*(4), 533-552.

Bitesize, G. (2010). About Bitesize Mobile. 2010, from http://www.bbc.co.uk/schools/gcsebitesize/about_mobile.shtml

Boyd, D. M. (2008). *Taken Out of Context: American Teen Sociality in Networked Publics.* University of California, Berkeley.

Buchanan, G., Farrant, S., Jones, M., Thimbleby, H., Marsden, G., & Pazzani, M. (2001). *Improving Mobile Internet Usability.* Paper presented at the International Conference on the World Wide Web, Hong Kong.

Cereijo, V. (2010). What is Multimedia. University of Texas.

Chen, C.-M., & Hsu, S.-H. (2008). Personalized Intelligent Mobile Learning System for Supporting Effective English Learning. *Educational, Technology & Society, 11*(3), 154-180.

Colazzo, L., Molinari, A., Ronchetti, M., & Trifonova, A. (2003). *Towards a Multi-Vendor Mobile Learning Management System.* Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2003 Chesapeake.

Collura, M. (2006). *Human-Computer Interaction and Main Principles to Design Practice Human-Centred System.* Universita Della Calabria, Cosenza, Italy.

Crane, R. (2010). Epocrates Mobile CME. 2010, from http://www.epocrates.com/company/

Demiray, U. (2011). *Distance Education and ELearning Practices*: Anadolu University, Eskisehir. (e. Papers o. Document Number)

Dennis, A., Wixom, B. H., & Tegarden, D. (2005). *System Analysis and Design with UML Version 2.0* (2nd ed.): John Wiley & Sons, Inc.

Donnelly, K., & Walsh, S. (2009). *Mobile Learning Reviewed*. (K. a. U. LearnDirect o. Document Number)

Encarta® World English Dictionary. (2009) (North American ed.). Bloomsbury Publishing Plc.

Evans, C. (2008). The Effectiveness of M-Learning in the Form of Podcast Revision Lectures in Higher Education. *Computer and Education, 50*, 491-498.

Foppoli, J. (2010). Advantages of E-Learning Over Traditional Instruction of a Second Language. 2010, from http://ezinearticles.com/?Advantages-of-E-Learning-Over-Traditional-Instruction-of-a-Second-Language&id=139441

Geddes, S. J. (2004). Mobile Learning in the 21st Century: Benefit for Learners.

Göth, C., Frohberg, D., & Schwabe, G. (2006). *The Focus Problem in Mobile Learning.* Paper presented at the Wireless, Mobile and Ubiquitous Technology in Education (WMUTE).

Grant, J., & Gale, R. (1989). Changing Medical Education. *Medical Education, 23*(3), 252-257.

Grasso, A., & Roselli, T. (2005). *Guidelines for Designing and Developing Contents for Mobile Learning.* Paper presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE '05).

Gribbons, B., & Herman, J. (1997). True and Quasi-Experimental Designs. *Practical Assessment, Research & Evaluation, 5*(14).

Hashim, A. S., Ahmad, W. F. W., & Ahmad, R. (2010a). *Implementation of Design Principles of Course Content for Mobile Learning Application.* Paper presented at the International Conferences on User Science and Engineering (iUSEr) 2010, Shah Alam, Selangor.

Hashim, A. S., Ahmad, W. F. W., & Ahmad, R. (2010b). *Mobile Learning Implementation: Students' Perceptions in UTP.* Paper presented at the International Conference on Computer, Electrical, and Systems Science, and Engineering (ICCESSE) 2010, Penang, Malaysia.

Hashim, A. S., Ahmad, W. F. W., & Ahmad, R. (2011). Usability and Effectiveness of Mobile Learning Course Content Application as a Revision Tool. *Journal of Computer Technology and Application, 2*(2), 148-157.

Hobart, J. (1995). Principles of Good GUI Design. 2010, from http://www.classicsys.com/css06/cfm/article.cfm?articleid=20

Hulse, S. F. (1992). Learning Theories: Something for Everyone. *Radiolic Technology, 63*(3), 198-202.

Jacob, S. M., & Issac, B. (2007). Mobile Learning Culture and Effects in Higher Education. *IEEE Multidisciplinary Engineering Education Magazine, 2,* 19-21.

Kaikkonen, A., & Laarni, J. (2002). *Designing for Small Display Screens.* Paper presented at the 2nd Nordic Conference on Human-Computer Interaction, Aarhus, Denmark.

Lin, H. X., Choong, Y.-Y., & Salvendy, G. (1997). A Proposed Index of Usability: A Method for Comparing the Relative Usability of Different Software Systems. *Behaviour & Information Technology, 16*(4/5), 267-278.

Longman Dictionary of Contemporary English: The Complete Guide to Written and Spoken English. (1995) (3rd ed.). Longman.

Masri, M. (2009). *The Development and Usability of A Multimedia Black Cat Courseware Using Storytelling Approach.* Universiti Teknologi PETRONAS.

Masson, B., & Reid, S. (2010). Screen Design Basics, Design for Mobiles: Resources for Designing and Building Mobile Apps and Sites. 2010, from http://patterns.design4mobile.com/index.php/Screen_Design_Basics

Miller, G. A. (1956). The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information. *The Psychological Review, 63*, 81-97.

Naidu, S. (Ed.). (2006). *E-Learning. A Guidebook of Principles, Procedures and Practices. Commonwealth of Learning*: Commonwealth Educational Media Centre for Asia (CEMCA) 2006.

Naismith, L., Lonsdale, P., Vavoula, G., & Sharpless, M. (2004). *Literature Review in Mobile Technologies and Learning*: University of Birminghamo. Document Number)

Naismith, L., & Smith, M. P. (2006). *Using Mobile Technologies for Multimedia Tours in a Traditional Museum Setting. University of Birmingham*: Athabasca University. (A. Press o. Document Number)

Nasiri, A., & Deng, G. (2009). Environmental Factors Influence on Mobile Learning Business. *American Journal of Applied Sciences, 6*(6), 1225-1234.

News, B. (2007, 27 April 2007). Game Combats Campus Culture Shock. *BBC News*, from http://news.bbc.co.uk/2/hi/uk_news/education/6598943.stm

Nie, M. (2006). *The Pedagogical Perspectives of Mobile Learning: Podcasts and E-Tivities for Enriching E-Learning Experience: Pedagogical Design and Technical Implementation.* Paper presented at the Online Educa 2006, Berlin.

Nielsen, J. (1993). *Usability Engineering*. Boston: Academic Press.

Nielsen, J. (2000). Why You Only Need to Test with 5 Users. 2010, from http://www.useit.com/alertbox/20000319.html

O'Malley, C., Vavoula, G., Glew, J., Taylor, J., Sharples, M., & Lefrere, P. (2003). *Guidelines for Learning / Teaching / Tutoring in a Mobile Environment* o. Document Number)

Olson, C. K. (2010). Children's Motivations for Video Game Play in the Context of Normal Development. *General Psychology, 14*(2), 180-187.

Parsons, D., Ryu, H., & Cranshaw, M. (2007). A Design Requirement Framework of Mobile Learning Environments. *Journal of Computers, 2*(4), 1-8.

Pehkonen, M., & Turunen, H. (2003). *Preliminary Guidelines for the Design Of The Mobile Learning Activities And Materials.* Paper presented at the EUROPRIX Scholars Conference, Tampere, Finland.

Quinn, C. (2000). mLearning: Mobile, Wireless, In-Your-Pocket Learning. 2010, from http://www.linezine.com/2.1/features/cqmmwiyp.htm

Robson, R. (2003). *Mobile Learning and handheld Devices in the Classroom*: Eduworks Corporation. (I. Australia o. Document Number)

Safran, C., Ebner, M., Garcia-Barrios, V. M., & Kappe, F. (2009). *Higher Education M-Learning and E-Learning Scenarios for a Geospatial Wiki.* Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare & Higher Education 2009.

Saint-Germain, M. A. (2001). PPA 696 Research Methods. *Experimental Design for Research*, 2011, from http://www.csulb.edu/~msaintg/ppa696/696exper.htm

Sajjad, S. (2010). *Effective Teaching Methods at Higher Education Level*: Department of Special Education, University of Karachi, Pakistano. Document Number)

Seffah, A., Donyaee, M., Kline, R. B., & Padda, H. K. (2006). Usability and Quality in Use Measurement: A Roadmap for a Consolidated Model. *Software Quality Journal Usability and Quality in Use Measurement, 14*(2), 159-178.

Sekaran, U. (2000). *Methods for Business: A Skill Building Approach* (Third ed.): John Wiley and Sons Inc.

Seong, D. S. K. (2006). *Usability Guidelines for Designing Mobile Learning Portals.* Paper presented at the 3rd Internatioanal Conference on Mobile Technology, Application & Systems. .

Sharp, H., Rogers, Y., & Preece, J. (2007). *Interaction Design* (2nd ed.): John Wiley & Sons, Ltd.

Singh, D., & A.B., Z. (2006). Mobile Learning In Wireless Classrooms. *Malaysian Online Journal of Instructional Technology (MOJIT), 3*(2), 26-42.

Siraj, S. (2004). Pembelajaran Mobile dalam Kurikulum Masa Depan. Masalah Pendidikan. *Issues in Education, 27*, 129-141.

Srinivas, H. (2009). Collaborative Learning. *What is Collaborative Learning*, 2010, from http://www.gdrc.org/kmgmt/c-learn/what-is-cl.html

Stansbury, M. (2009). Conference Explores Benefits of Mobile Learning. from http://www.eschoolnews.com/2009/02/19/conference-explores-benefits-of-mobile-learning/

Su, D. K. S., Yee, V. S. Y., & Read, J. (2007). Exploring Text-based and Graphical-based Usable Interfaces for Mobile Chat Systems. *International Journal on Human-Computer Interaction, 1*(3), 37-53.

Traxler, J. (2009). Learning in Mobile Age. *International Journal of Mobile and Blended Learning, 1*(1), 1-12.

Trochim, W. M. K. (2006). Research Methods Knowledge Base. *Two-Group Experimental Designs*, 2010, from http://www.socialreseacrhmethods.net/kb/expsimp.php

Tutunea, M., Rus, R. V., & Toader, V. (2009). Traditional Education vs. E-learning in the Vision of Romanian Business Students. *International Journal of Education and Information Technologies, 3*(1).

Upadhyay, N. (2006). A New Paridgm in Education. *International Journal of Instructional Technology and Distance Learning, 3*(2), 31-34.

UsabilityNet. (2006). Human-Centred Design Processes for Interactive Systems. 2010, from http://www.usabilitynet.org/tools/13407stds.htm

Uther, M. (2002). *Mobile Internet Usability: What Can The 'Mobile Learning' Learn From The Past?* Paper presented at the The IEEE International Workshop On Wireless And Mobile Technologies In Education (WMTE '02).

Wagner, E. D. (2005). Enabling Mobile Learning. 2010, from http://net.educause.edu/ir/library/pdf/ERM0532.pdf

Walsh, S. (2009). Mobile Learning Reviewed. 2010, from http://www.kineo.com/documents/Mobile_learning_reviewed_final.pdf

Wirth, K. R., & Perkins, D. (2008). *Learning to Learn*: Macalester Collegeo. Document Number)

Yuen, S. C. Y., & Wang, S. Y. (2004). *M-learning: Mobility in Learning.* Paper presented at the International Conference of ELEARN 2004.

Zambonini, D. (2009). Mobile: Graphs and Statistics. 2010, from http://www.boxuk.com/blog/mobile-the-business-case

Zolfo, M., Suarez, V., Kiyan, C., Iglesias, D., Waard, I. d., Echevarriaz, J., et al. (2009). *mLearning for Continuing Medical Education in Peru: A Mid-Term Evaluation*: Institute of Tropical Medicine, Peruo. Document Number)

LIST OF PUBLICATIONS

1. Hashim, Ahmad Sobri and Wan Ahmad, Wan Fatimah and Ahmad, Rohiza 2011 *Usability and Effectiveness of Mobile Learning Course Content Application as a Revision Tool*. In: Journal of Computer Technology and Application 2(2), 148-157, David Publishing Company.
2. Hashim, A. Sobri and Wan Ahmad, Wan Fatimah and Ahmad, Rohiza 2010 *Mobile Learning Implementation: Students' Perceptions in UTP*. In: ICCESSE 2010: International Conference on Computer, Electrical, and Systems Science, and Engineering, February 24-26, 2010, Pulau Pinang.
3. Hashim, Ahmad Sobri and Wan Ahmad, Wan Fatimah and Ahmad, Rohiza *Architecture and UML Models of Mobile Learning Application for Course Content.* In: International Symposium on Information Technology 2010, ITSim, June 2010, Kuala Lumpur.
4. Hashim, Ahmad Sobri and Wan Ahmad, Wan Fatimah and Ahmad, Rohiza 2010 *A Study of Design Principles and Requirements for the M-Learning Application Development*. In: International Conference on User Science and Engineering (i-USEr), December 2010, Shah Alam, Selangor.
5. Hashim, Ahmad Sobri and Wan Ahmad, Wan Fatimah and Ahmad, Rohiza 2011 *Mobile Learning Course Content Application as a Revision Tool: The Effectiveness and Usability*. In: International Conference on Pattern Analysis and Intelligent Robotics (ICPAIR), June 2011, Putrajaya.

APPENDIX A
PRELIMINARY STUDY

SURVEY FORM

Objective:

The objective of this survey is to get the information regarding mobile phones used by undergraduate students especially students in System Analysis and Design (SAD) course. The information will include operation system, wireless devices or technologies and types of wireless Internet protocol supported. Besides, this survey also is conducted to get opinions regarding mobile learning implementation in current educational system especially for SAD course.

Background Information

1. Gender:
   - o Male
   - o Female
2. Year:
   - o 1st Year
   - o 2nd Year
   - o 3rd Year
   - o 4th Year
3. Programme of study:
   - o Information Technology
   - o Information Systems

Mobile Phones Used General Information

4. Mobile phone(s) used (specify the models):
   - o Nokia: _____
   - o Sony Ericsson: _____
   - o Samsung: _____
   - o Others: _____
5. Wireless device(s) or technology(s) that your mobile phone(s) provide:
   - o 2G / 3G / 3.5G / 4G (choose and circle)
   - o 802.11 (WiFi)
   - o Bluetooth
   - o General Packet Radio Service (GPRS)
   - o Global System for Mobile-Phones (GSM)
   - o Global Positioning System (GPS)
   - o Others: _____
6. Your mobile phone(s) operating system(s) (OS):
   - o Symbian
   - o Linux / Palm
   - o Windows Mobile
   - o Others: _____
7. Wireless Internet protocol supported by your mobile phone(s):
   - o JAVA
   - o WAP
   - o Others: _____

8. Give your opinions regarding mobile learning implementation into the current learning practices. You need to rate the criteria given below. Please circle (1=disagree at all, 2=disagree, 3=neutral, 4=agree, 5=totally agree).

1	Mobile learning implementation can give you freedom in your learning activities (SAD context).	1	2	3	4	5
2	Mobile learning implementation can provide you more effective way of learning (SAD context).	1	2	3	4	5
3	Mobile learning implementation will reduce your time to get learning materials (SAD context).	1	2	3	4	5
4	Mobile learning implementation will help you in doing revision for the examinations preparation (SAD context).	1	2	3	4	5
5	Mobile learning implementation can remove formality of current educational system.	1	2	3	4	5
6	Mobile learning implementation will encourage study group practices (SAD context).	1	2	3	4	5

Your own opinions:

_____
_____
_____

9. Give your opinions regarding current learning practices implemented in SAD course. You need to rate the criteria given below. Please circle (1=disagree at all, 2=disagree, 3=neutral, 4=agree, 5=totally agree).

1	Current learning practices gave freedom in your learning activities.	1	2	3	4	5
2	Current learning practices provided you effective way of learning.	1	2	3	4	5
3	Current learning practices reduced your time to get learning materials.	1	2	3	4	5
4	Current learning practices helped you in doing revision for the examinations preparation.	1	2	3	4	5
5	Current learning practices removed formality of current educational system (e-learning utilization).	1	2	3	4	5
6	Current learning practices encouraged study group practices.	1	2	3	4	5

Your own opinions:

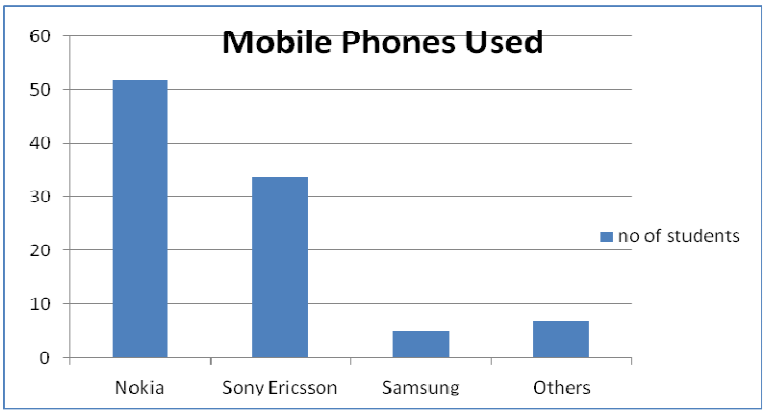
_____
_____
_____

- Thank You -

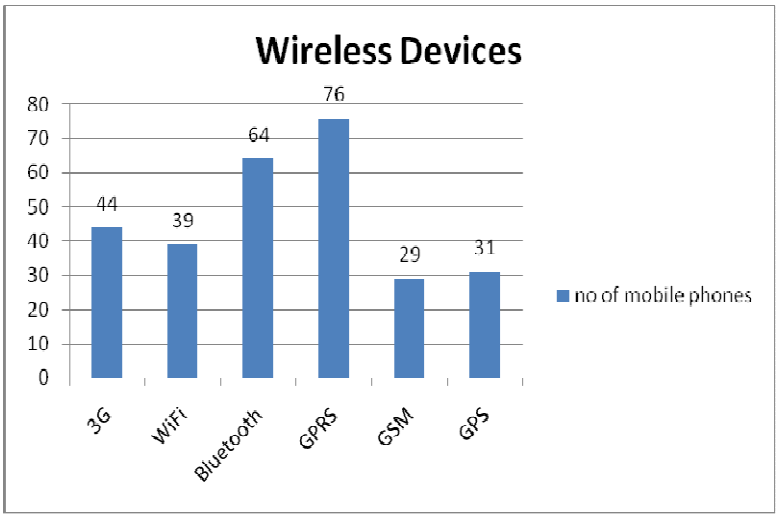
APPENDIX B

PRELIMINARY STUDY RESULT

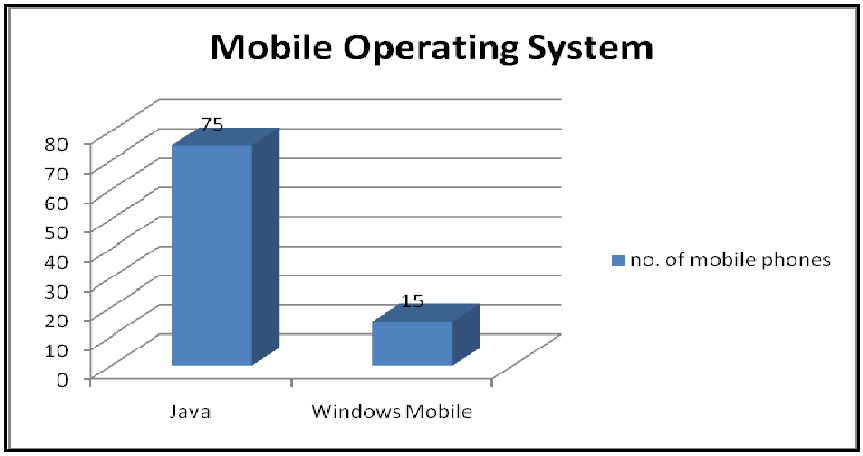
1. Number of mobile phones types used by students of second year Business and Information System (BIS), July 2009 semester, Universiti Teknologi PETRONAS.



2. Types of Wireless Network Technologies Equipped in mobile phones used by students of second year Business and Information System (BIS), July 2009 semester, Universiti Teknologi PETRONAS.



3. Types of Mobile Operating System supported by students' mobile phones of second year Business and Information System (BIS), July 2009 semester, Universiti Teknologi PETRONAS.



4. Second year Business and Information System (BIS), July 2009 semester, Universiti Teknologi PETRONAS (UTP) perceptions on the current learning practices and mobile learning utilization in UTP.

Questions	**Mean**	
	Current Learning Practices	**Mobile Learning Utilization**
Give me freedom in my learning activities.	3.3048	4.0122
Provide me more effective way of learning.	3.2439	4.8293
Reduce my time to get learning materials.	3.9146	4.6585
Help me in doing revision for the examinations preparation.	3.1146	3.7927
Remove formality of current educational system.	3.3170	4.6220
Encourage study group practices.	3.2317	3.3902

APPENDIX C

USABILITY QUESTIONNAIRE

The objective of this survey is to get the users' feedback regarding the developed mobile learning course content prototype called Mobile System Analysis & Design (MOSAD). The evaluation criteria prepared for the users' is based on the usability evaluation approach. This survey contains of two (2) sections: Section A and Section B. For Section A, please tick it accordingly and rate it:

1=strongly disagree, 2=disagree, 3=fair, 4=agree, 5=strongly agree

SECTION A

	STUDENT'S INFORMATION	
1	Gender	Male ◯ Female ◯
2	Year of study	1st ◯ 2nd ◯ 3rd ◯ 4th ◯
3	Please state whether you already took or currently taking SAD course.	Already taken ◯ Currently taking ◯
4	The developed m-learning application is compatible with my mobile phone (s).	Yes ◯ No ◯ If no, please state the model of your mobile phone: _____
5. CONSISTENCY		
a.	The text content format is consistent in every page.	1◯ 2◯ 3◯ 4◯ 5◯
b.	The navigation is consistent in every page.	1◯ 2◯ 3◯ 4◯ 5◯
c.	The soft keys usage is consistent in every page.	1◯ 2◯ 3◯ 4◯ 5◯
d.	The bullets and numbering utilization are consistent in every section.	1◯ 2◯ 3◯ 4◯ 5◯
e.	The usage of different colours, sizes and font types of texts with its utilization is consistent.	1◯ 2◯ 3◯ 4◯ 5◯
6. FLEXIBILITY		
a.	Prepared shortcut menu list in each page gives me the flexibility in navigating from section to the other section.	1◯ 2◯ 3◯ 4◯ 5◯
b.	Prepared key number-pressed gives me more flexibility in navigating from page to the other page.	1◯ 2◯ 3◯ 4◯ 5◯

c.	Prepared main menu list allows me to move to my desired sections.	1 2 3 4 5
d.	Prepared exit command in every page gives me flexibility to exit from the application at anytime.	1 2 3 4 5
e.	The developed application provides flexible sequence control.	1 2 3 4 5
7. LEARNABILITY / USER FRIENDLY		
a.	I just took few minutes to study the developed application.	1 2 3 4 5
b.	I am familiar with each displays displayed in the application screen.	1 2 3 4 5
c.	I knew what the results are if I press the key to perform in order to perform a task.	1 2 3 4 5
d.	I am familiar with the wording used in the application.	1 2 3 4 5
e.	The operation of the developed application is very simple.	1 2 3 4 5
8. MINIMAL ACTION		
a.	I need at most two (2) key pressed in navigating from current page to my desired page.	1 2 3 4 5
b.	I need at most three (3) key pressed in navigating from current section to my desired section.	1 2 3 4 5
c.	I can exit from the application just on one (1) key pressed.	1 2 3 4 5
d.	Consistent navigation requires me with only minimal effort in accessing the application.	1 2 3 4 5
e.	The utilization of point form in the application requires me with only minimal effort in finding the key points of the course content.	1 2 3 4 5
9. MEMORY LOAD		
a.	The developed application is considered as short application and it can optimize my memory load.	1 2 3 4 5
b.	Each page of the application provides me with the short sentences of information. Short sentences of information will give me better understanding.	1 2 3 4 5
c.	The utilization of point form, text colour differences and text sizes differences will ease me in understanding the key ideas.	1 2 3 4 5
d.	The inserted images in the application pages give me additional help in memorizing the key ideas.	1 2 3 4 5
e.	The main menu list gives me an overview of what is the application all about and it prepares my memory before accessing the full content of the application.	1 2 3 4 5

SECTION B

1. Below are key elements of system request **EXCEPT**
   A. Project Champion.
   B. Project Sponsor.
   C. Constraints.
   D. Business Needs.
2. What are the common techniques of feasibility analysis?
   I. Cultural Feasibility.
   II. Technical Feasibility.
   III. Political Feasibility.
   IV. Economical Feasibility.
      A. I and II
      B. II and III
      C. II and IV
      D. III and IV
3. The elements of technical feasibility in feasibility analysis are **INCLUDING**
   I. Project size
   II. Familiarity with business application
   III. Familiarity with technology.
   IV. Compatibility.
      A. I, II and III
      B. I, II and IV
      C. II, III and IV
      D. All above
4. Below shows the steps of performing economic feasibility. Which steps below is the **WRONG** sequence?
   A. Identify cost benefit, assign values, and determine cash flow.
   B. Determine cash flow, determine ROI and determine NPV.
   C. Determine ROI, calculate break-event point and graph break-event point.
   D. Assign value, determine NPV and determine ROI.
5. Which person does not involve in stakeholder analysis?
   A. Project Sponsor.
   B. Project Champion.
   C. Organizational Management.
   D. System users.
6. Given interest rate of 0.03. What is the Net Present Value (NPV) of RM 791, 727 total benefits after 5 years?
   A. RM 682,951
   B. RM 692,951
   C. RM 750,293
   D. RM 760,593

7. Given total benefit RM 791, 727 and total cost RM 2, 716, 819. What is the value of Return on Investment (ROI)?

   A. 2.915 %

   B. 29.15 %

   C. 2.914 %

   D. 29.14 %

8. Who is a project sponsor?

   A. Person that initiates the project and serving as the primary point of contact for the project.

   B. Person who initiates the project, promotes the project, allocate the time project and provides resources.

   C. Person who knows about the project, budget enough money for the project and encourages users to use the system.

   D. Person who makes decisions that influence the project, perform hands-on activities for the project and ultimately determine whether the project is successful by using or not using the system.

9. Who is an organizational management?

   A. Person that initiates the project and serving as the primary point of contact for the project.

   B. Person who initiates the project, promotes the project, allocate the time project and provides resources.

   C. Person who knows about the project, budget enough money for the project and encourages users to use the system.

   D. Person who makes decisions that influence the project, perform hands-on activities for the project and ultimately determine whether the project is successful by using or not using the system.

10. Who is a system user?

   A. Person that initiates the project and serving as the primary point of contact for the project.

   B. Person who initiates the project, promotes the project, allocate the time project and provides resources.

   C. Person who knows about the project, budget enough money for the project and encourages users to use the system.

   D. Person who makes decisions that influence the project, perform hands-on activities for the project and ultimately determine whether the project is successful by using or not using the system.

- THANK YOU -

APPENDIX D

USABILITY QUESTIONNAIRE RESULT

Mobile Learning Usability Factor					
Student	Consistency	Flexibility	Learnability / User Friendly	Minimal Action	Minimal Memory Load
1	3	3	3	3	3
2	3	3	3	3	3
3	4.2	3.4	3.2	2.4	3
4	3	3.2	3	2.8	3
5	3.4	3.6	2.2	3.2	3.2
6	3.6	4	3.6	3.2	3.2
7	3	3	3	3	3
8	2.6	3.4	3.4	3	3
9	4	4	3.6	3.6	3.4
10	3.8	3.4	3.8	3.8	3.4
11	4.2	4	3.8	4.6	3
12	5	5	5	4.6	5
13	3.6	3.2	3.6	4	3.8
14	4.2	4	4	4	4
15	4	4	4.2	3.4	3.2
16	3.6	3.8	4	4.4	3.6
17	4	4	3.8	3.6	3.8
18	4.4	4	3	3	3
19	5	5	3.4	4.2	3.4
20	3.8	3.4	4.6	3.2	3.8
21	4.8	4.6	3.8	4.4	4
22	4	3.8	4.4	4.4	3.6
23	4.4	4	4.8	3.8	4.2
24	5	5	4.6	4.2	4.6
25	4	4	4	3.4	4
26	5	4.6	5	4.8	4.6
27	4	4.2	4.4	4.4	4.4
28	4	4.4	4	4	4.4
29	3.4	5	4	4.2	3
30	4.2	4.2	4.4	4.6	4
31	4.2	4.4	4.4	4.4	4.6
32	4.2	4.4	4.2	3.8	4.2
33	5	5	4.4	4	4
34	3.8	5	4	4.4	3.8

Student	Consistency	Flexibility	Learnability / User Friendly	Minimal Action	Minimal Memory Load
35	5	5	5	5	4.6
36	3.2	4	3.2	3.2	3.6
37	4.8	5	3.8	4.2	3.4
38	4.8	4.6	3.8	3.6	3
39	3.8	4	4	3.8	4
40	3.4	4.4	3.8	3.4	4.2
41	3.6	3.6	3.8	3.4	4.2
42	4	4	4.2	3.6	3
43	4.8	4.6	4.8	4	3.8
44	4	4.6	4.2	3.6	4.2
45	3.6	3.8	3.6	2.8	4.2
46	4.4	3.8	4.2	4	4.4
47	3.8	3.6	4.2	3.8	3.6
48	3.8	3.8	3.8	3.8	4.2
49	3.6	3.6	3.6	3.6	3.2
50	4.4	4.8	4.8	4.4	4.4
51	4	4.4	4	4	4
52	3	3.6	4.2	3.8	3.8
53	3.6	4	4	3.4	3
54	3.6	3.8	2.6	3.4	3
55	3.8	3.8	3.6	3.6	3.6
56	4.6	5	3.8	4.4	4.4
57	4.8	4.8	5	4.4	4
58	4	4	3.6	3.6	3
59	4	4.4	4	3.8	3
60	3.8	3.4	3.2	2.8	3.6
61	4.4	4.8	4.4	3.4	4
62	4	4	4	4	4
63	4.4	4.4	3.8	3.8	5
64	4	2.6	4	3.6	2.8
65	3.8	3.6	4	3.6	3.6
66	4	4	5	4	4.2
Average	4.00303	4.072727	3.933333	3.766667	3.730303

APPENDIX E

USABILITY OBSERVATION RESULT

1. Usability Observation Elements Results

	Student	1	2	3	4	5	6	7	8	9	10	11	12	Average
Flexibility	Frequencies of using shortcut key menu list to move from section to other section.	4	5	6	8	6	4	7	3	7	6	6	8	5.833333
	Frequencies of using main menu list to move from section to other section.	5	4	3	1	3	5	2	6	2	3	3	1	3.166667
Learnability	Time taken to understand how the application works (m:s).	1:31	0:48	1:54	1:20	1:23	0:58	1:44	2:30	2:04	1:33	1:49	1:18	1:34
	Time taken to complete the revision using the application (m:s).	6:17	5:43	7:43	6:42	8:04	4:49	5:57	6:36	7:12	8:30	7:24	5:15	6:41
Minimal Action	Average number of key-presses to move from section to other section.	3.222	2.889	2.6667	2.1111	2.6667	2.8889	2.5556	3.5556	2.7778	2.6667	2.3333	2.2222	2.712983
	Average number of key-presses to move from page to other page.	1	1	1	1	1	1	1	1	1	1	1	1	1
	Average number of key-presses to exit from the section.	1	1	1	1	1	1	1	1	1	1	1	1	1

2. Number of key-presses to move from section to other section.

Student	1	2	3	4	5	6	7	8	9	10	11	12
Objective	1	1	1	1	1	1	1	1	1	1	1	1
Introduction	4	2	2	3	4	2	3	7	4	2	4	2
System Request	2	5	2	3	2	2	2	2	3	2		3
Feasibility Analysis	3	2	3	2	2	5	3	5	2	3	3	2
Project Selection	5	4	3	2	2	3	2	4	3	2	2	2
Summary	2	6	2	2	4	6	2	4	2	4	5	2
Quiz	6	2	4	2	2	2	3	2	3	3		2
Reference	2	2	3	2	2	2	4	5	2	5	2	3
Help	4	2	4	2	5	3	3	2	5	2	4	3
Average	3.222	2.8889	2.6667	2.1111	2.6667	2.8889	2.5556	3.5556	2.7778	2.6667	2.3333	2.2222