REQUIREMENTS MODEL OF COLLABORATIVE MOBILE LEARNING (CML)

OMAR HAMID FLAYYIH

MASTER OF SCIENCE (INFORMATION TECHNOLOGY)

UNIVERSITI UTARA MALAYSIA

2016

Permission to Use

In presenting this thesis in fulfillment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Awang Had Salleh Graduate School

UUM College of Art and Science

Universiti Utara Malaysia

06010 UUM Sintok

Kedah Darul Aman

Malaysia

Abstrak

Teknologi mudah alih merupakan satu alatan inovasi yang membantu pembelajaran. Namun, kajian sedia ada berkaitan pembelajaran mudah alih (m-pembelajaran) belum benar-benar menggabungkan pendekatan pembelajaran tertentu bagi menghasilkan cara baru yang memberi manfaat kepada pembelajaran. Ekoran itu, banyak penyelidik percaya bahawa terdapat keperluan untuk menerapkan model pedagogi dan arahan ke dalam teknologi m-pembelajaran, terutamanya bagi menyokong pembelajaran berkumpulan. Pada masa sama, banyak penemuan menunjukkan bahawa pereka bentuk berhadapan cabaran dalam mereka bentuk sistem yang menyokong kerjasama melibatkan pelbagai alatan. Justeru, para pengkaji mencadangkan agar inisiatif membangunkan kerangka bagi pembelajaran moden dalam pelbagai persekitaran diusahakan. Kerangka tersebut perlu menyediakan maklumat yang kaya melalui m-pembelajaran bagi pembelajaran berkumpulan. Usaha ini membolehkan pembelajaran kolaboratif (CL) yang lancar, menyeronokkan, dan anjal berlaku. Oleh itu, kajian ini mengenalpasti kebarangkalian pembangunan model instruksional bagi aplikasi mudah alih yang menggabungkan CL dan m-pembelajaran yang dinamakan model pembelajaran mudah alih kolaboratif (CML). Bagi tujuan tersebut, mengenalpasti keperluan utama dengan meneroka isu-isu penting dalam model sedia ada dan kajian berkaitan dalam karya sedia ada, di samping menemubual pelajar merupakan keutamaan kajian ini. Model yang diusulkan dan prototaip yang dibangunkan telah dinilai dan disahkan oleh empat orang pakar. Di samping itu, 43 responden kajian telah menggunakan prototaip dan memberi maklumbalas penerimaan mereka menggunakan borang soal selidik model penerimaan teknologi (TAM). Hasil ujian menunjukkan penerimaan terhadap model amat tinggi, mengesahkan kefungsian CML. Penemuan seperti ini mencadangkan bahawa model tersebut mampu memperbaiki produktiviti, menunjukkan cara menggunakan tenkologi mudah alih dalam CL. Kajian ini merupakan panduan kepada pereka bentuk dan pembangun dalam bidang m-pembelajaran.

Keywords: pembelajaran mudah alih (m-pembelajaran), pembelajaran kolaboratif (CL), pembelajaran mudah alih kolaboratif (CML), reka bentuk instruksional, aplikasi mudah alih Android.

Abstract

Mobile technology is one of innovative tools used to facilitate learning. However, the existing studies related to mobile learning (M-learning) have not deeply combined relevant learning approaches for giving a new way that benefits the learning sphere. Accordingly, many researchers believe that there is a need to incorporate pedagogical and instructive models into M-learning technology, especially for supports of team-learning. At the same time, many investigations prove that designers faced challenges in designing systems that involve collaboration with various stationaries. Therefore, researchers suggest for an initiative on more investigations for modern learning in modeling of M-learning domain. The model should provide rich amount of information through M-learning for collaborative learning (CL). This comes from understanding, collecting and modeling usable design, holds functionalities and non-functionalities issues to be the corner stone of the intended model. Consequently, this research studies the possibility of modeling an instructional model for Android mobile application combining the CL and M-learning concepts calls Collaborative M-learning (CML) model. Thus, determining the essential requirements by exploring the most important issues in the existing models and related works in the literatures, as well as interviewing learners are the priorities of this study. Content analysis method was used to analyze the gathered data in determining the requirements needed. The model and the prototype have been reviewed and verified by four experts. Also, 43 respondents in the field of Information Technology (IT) have tested the prototype and provided feedback on their acceptance, through Technology Acceptance Model (TAM) questionnaire under the usability evaluation. Results show that their acceptance upon the model is high, validating the functionality of the CML. Such findings recommend that the model is able to improve productivity, showing the technique to utilize mobile technology in CL. This study serves as a guidance for designers and developers in M-learning.

Keywords: Mobile Learning (M-learning), Collaborative Learning (CL), Collaborative M-learning (CML), Instructional Design (ID), Android Mobile Application.

Acknowledgment

In the Name of Allah, the Most Gracious and Most Merciful

Above all else, all praise to Allah for giving me the strength, steadiness, and helping me to have this work done on time. Then, I would like to express my deepest gratitude to my supervisor, **Dr. Azham bin Hussain** for his intellectual guidance and kind support given to me during the period of this study. Also, I would like to thank our Coordinator **Dr. Norliza bt Katuk** who helped me through the discussion and supported me to accomplish this work. My deepest appreciation and heartfelt thankful for my evaluators, **AP Dr. Haslina bt Mohd** and **Dr. Shafinah Farvin bt Packeer Mohamed** who assisted me during my research process with their moral support and knowledge.

I want to express my gratitude and dedicate this thesis to my father **Hamid Flayyih** and my mother **Khawlah Tawfeeq**. My goal would not have been achieved without them. They have supported and are continuously praying for me during my studies and they encouraged me and felt confident in my abilities to complete my study, I pray to Allah to keep them safe and well. Also, I dedicate this thesis to my wife **Hind Mohammed** and my son (**Ameen)** who unremittingly supported me during the years of my study. They made this work possible. Moreover, I am also grateful to all my brothers and sisters for their care and assistance in many moments of inspiration and support during my study.

Also, I am thankful for my best friends **Husam Abdulhameed**, **Mohammed Rafid**, **Firas Farhan**, **Ahmed Naser**, **Monadhil Faeiq**, **Adil Abdullah** and **Abdullah Ibrahim**, for helping and supporting me to complete my dissertation. Lastly, I express my deepest thanks to Ministry **of Education in Iraq**, as well as my **Educational Directorate of Salah Al-Din** for their support and giving necessary advice and guidance, as well as arranging all facilities to accomplish my study (Master of IT). I express my thanks to the **staffs of IT**, **College of Arts and Science**, **University Utara Malaysia** and those who contributed indirectly towards the achievement of my study.

Omar Hamid Flayyih

Table of Contents

List of Tables

List of Figures

List of Abbreviations

CML	Collaborative Mobile Learning
M-learning	Mobile learning
E-learning	Electronic learning
U-learning	Ubiquitous learning
BYOD	Bring Your Own Device
LMS	Learning Management System
CSCL	Computer Supported Collaborative Learning
MOOS	Massive Open Online System
ID	Instructional Design
CSCL	Computer Supported Collaborative Learning
CE	Collaboration Engineering
GSS	Group Support System
PSA	Process Support Applications
RLOs	Reusable Learning Objects
QR	Quick Response
CSAM	Collaborative Situated Active Mobile learning strategies
IT	Information Technology
UML	Unified Modeling Language
RAD	Rapid Application Development
TAM	Technology Acceptance Model
SPSS	Statistical Package for the Social Sciences
FRAME	Framework for the Rational Analysis of Mobile Education
ZPD	Zone of Proximal Development
HTML	HyperText Markup Language
XML	Extensible Markup Language
AOSP	Open Source Project
JIT	Just-in-Time compiler
API	Application Programming Interface
CE	Collaboration Engineering

PSS	Process Support Systems
GSS	Group Support System
PSA	Process Support Applications
ICT	Information and Communications Technology
SNS	Social Networking Services
mCSCL	mobile Computer-Supported Collaborative Learning
SDK	Software Development Kit
JDT	Java Development Tools
JSP	Java Server Pages

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter introduces related topics to this study, which represent background, followed by the problem statement, research hypotheses, and significance of the study. Finally, scope of the study is also presented in this chapter.

1.1.1 Mobile Learning (M-learning)

Since the beginning of this century, with the introduction of mobile devices, the term of Mobile learning (M-learning) became frequent along with Electronic learning (E-learning) and Ubiquitous learning (U-learning), the concept comes on the agenda since the vast emergence of wireless communications, Internet access and mobile device proliferation have defeat time and space limits on communication (Lai, Chang, Wen-Shiane, Fan, & Wu, 2013). The term of M-learning has increasingly grown among learners. It has become an interesting subject for researchers since a user may have more than one device. According to the annual report of International Telecommunication Union (2013) the quantity of mobile phone users around the world exceeds the real population. Figure 1.1 indicates the estimated number of mobile phone users.

In their study, Koh, Rawi, and Zhang (2011) stated that M-learning refers to the use of mobile devices such as laptop, tablet, smartphones or any portable computer anytime-anywhere, particularly with the rapid growth of wireless communication technologies and the innovative design of modern devices which represent the main factors that have supported the emergence of M-learning concept. The concept of M-learning concentrates

on the use of the provided technologies of mobile devices with the wireless communication to deliver information for students out of classrooms (Pegrum, Oakley, & Faulkner, 2013).

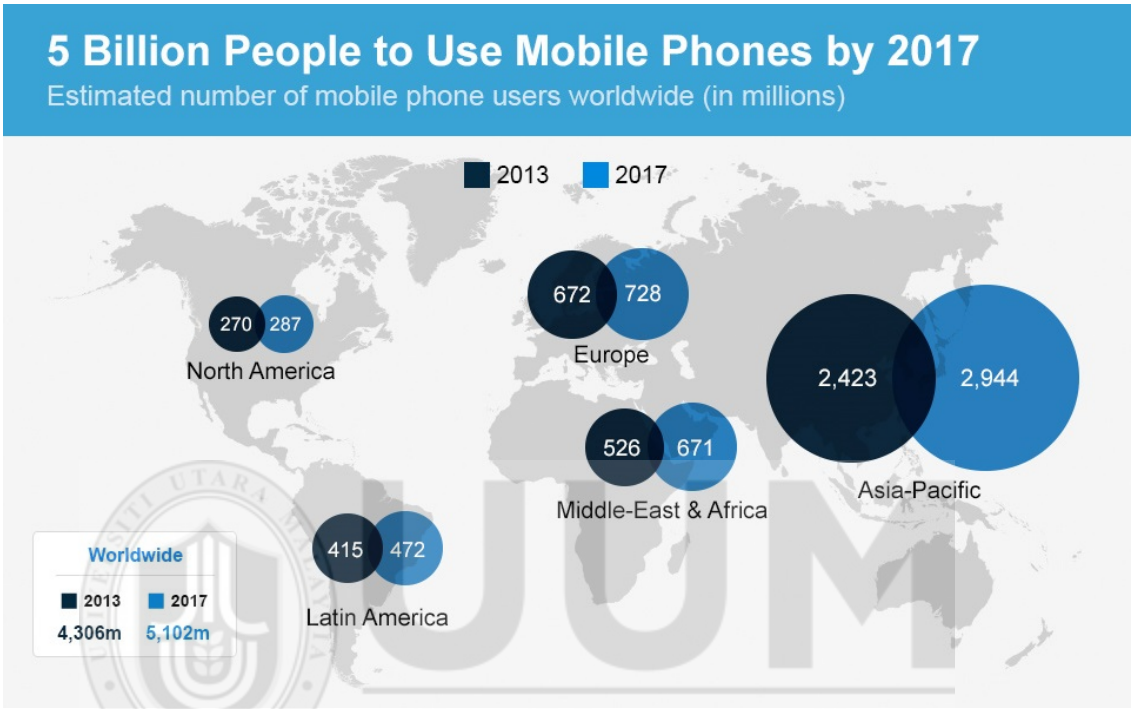

Figure1.1: Estimation on the Number of Mobile Phone Users (International Telecommunication Union, 2013)

Khader and Almasri (2014) emphasized that M-learning is not merely E-learning with a roaming device, but it has provided a free and right manner of learning to enable learners' access to the instructional content of information, when they have a proper time and place to exploit and save time. Mobile technology offers active and continuous method to access login within the educational environment. Thus, it gives more abilities to acquire further knowledge as well as strongly motivating learners to proceed to interested area out of schooling rooms. The reason behind the need of investigating mobile device lies in

its considerable part in the life of billions of people for daily communication (Goggin, 2012).

Nowadays, the mobile technology involves modern figures of learning tools having the ability to carry and present the scientific materials in collective and innovative ideas which cannot be collected without this technology. Characteristics of the new technology of mobile devices have enhanced the availability of most practical accessories of learning, as well as offering the main features of connection and synchronization among various kinds of mobile devices. Many researchers have studied the way of utilizing M-learning as an effective tool to enrich the educational activities and learning content, in addition to giving learners meta-cognition in different and new ways that encourage attaining a high-level of knowledge related to their instructional subjects (Ko et al., 2015).

1.1.2 Collaborative M-learning (CML)

In the recent years, M-learning has moved from being a theory, scientific exploration, and technology notion into an actual and valued contribution to educational environment such as Collaborative M-learning (CML) as it is based on practical experience among group members and it offers an opportunity to take advantage by applying knowledge of other learners (Cowan & Butler, 2013). CML is an aspect of students' share, exchange and interaction with the digital content through using two or more mobile devices (Chang, Wu, Lai, & Sung, 2014).

Consistent with Ng, Zemerly, and Hammadi (2011), the main objectives of CML include enriching the curriculum of the realistic scientific environment, delivering experiences

content among the learners' groups, besides ensuring the selection of perfect material through interaction dealing with CML approach. That is, the demand to make a new framework for modern learning in different environments and increase the amount of information through utilizing the mobile technology in the group learning (Sarrab & Elgamel, 2013a).

Typically, CML is an educational approach for both teachers and learners based on cooperate work between them, particularly in relation to the educational terms that include the use of mobile technology such as Bring Your Own Device (BYOD), Learning Management System (LMS), Computer Supported Collaborative Learning (CSCL) and Massive Open Online System (MOOS). Accordingly, Yusoff & Dahlan (2013) believe that there is a need to design many pedagogical and interactive models.

1.1.3 Instructional Design (ID)

Generally, the design is a systematic planning process leading up to the implementation procedure. Based on Pahl and Beitz's (2013) study, modeling the educational content must follow certain criteria to produce an acceptable and usable information for the learners. Clearly, M-learning and CL are terms mainly based on the learning aspect so that they are associated with the learning principles in order to follow the rules of the instructional aspect of teaching and learning processes. While, the Instructional Design (ID) is a term describes the science that seeks methods and processes to achieve desirable and instructional products as well as developing them under certain conditions (Nam and Jang, 2013).

Undoubtedly, designers have different views in designing an educational model on the basis of connecting the theoretical and practical aspects of learning. Hence, the theoretical view is related to the psychological science in general and learning theories in particular. While, the practical and applied aspect is determined by the technological instruments to give learners the integrated process in concurrent with the development (Barker, Quennerstedt, & Annerstedt, 2013). Regarding M-learning/research, there is a serious lack of prescriptive knowledge, for instance, a sufficient specific guideline. Hence, several researchers have mainly concentrated just on providing a conceptual model, design, and its methodologies. As a response to that, this study focuses on determining the requirements for modeling a collaborative M-learning (CML) in supports for usability. Particularly, it emphasizes on user acceptance upon factors leading to meaningful information in M-learning environment.

In other words, formulating an ID model requires providing the guideline about what and how instructors tend to use mobile devices in accordance with the instruction flow. Furthermore, there must be a prescriptive understanding on design activities in M-learning environments and CML models. Nam and Jang (2013) believed that collaborative learning is an unstructured group process mainly concerned with problem-solving and knowledge building. It is noteworthy that a point of collaboration is reflected by 'unstructured group process'. The characteristics of collaborative learning reasoned by the necessity of providing an adequate environment to the educational context. Also, adequate learning environment is one of the critical factors for successful collaborative learning.

1.2 Problem Background

Contemporary societies have faced many challenges in relation to the nature of life, style of work, and the work of various organizations. These challenges in those communities highlighted in the progress of information technology and modern communications, which played a key role in changing the nature of life and the form of institutions, including educational institutions, in a radical concept of education or learning from more concepts and processes affected by the large and direct impact winning development in this area. Then, this has been represented in the emergence of many new forms of education systems, notably mobile education systems (McNaughton, Light, & Naughton, 2013).

In the same context, several sectors have been affected by M-learning technology begun applying it as a benefit tool. Higher education is one of these sectors which has exploited M-learning to facilitate and achieve its educational objectives (Garcia & Cano, 2014). As a result, studies started to explore the capabilities of M-learning and combine it with other educational concepts such as the Collaborative Learning (CL), which represents the process of associative learning between two or more learners, to become Collaborative Mobile Learning (CML) planned for the educational purposes (DeWitt, Siraj, & Alias, 2014). Recently, there are many researchers have studied the important issues related to designing CML from various perspectives. In the M-learning field, numerous studies have discussed the foundations of constructing a successful CML model based on CL approach and the results achieved in the instructional process during the recent decades. Designing the CML model depends on considering several aspects focused on three main subjects, namely: learning content, learners, and teacher. In general definition, the model

is a simple and visual representation of a certain system designed as a figure, diagram or flow chart to show properties of the system (Shaltout, 2013).

Technically, Cheng and Yu (2015) found many challenges for mobile application designers such as stationary collaboration scenarios and insufficient requirement information. They often occurr in mobile collaborative learning and Computer Supported Collaborative Learning (CSCL). Cheng and Yu (2015) investigated the possibility of designing CML application called "ThinkLight" using the Collaboration Engineering (CE) and thinkLets methods, which represent the essential roles of modeling the CML application and serving university students in their collaborative study. Their study revealed providing of collaboration supporting trials. For instance, the Group Support System (GSS) technology can enhance the effectiveness and efficiency of the collaboration. Also, Process Support Applications (PSA), as a collaborative software application, has the probability of giving enough collaboration proficiency to students, i.e., making them collaborate and "facilitate in a box" without extensive training and without a facilitator (Cheng, Li, Sun, & Zhu, 2014). However, the instructor's observing issue was not included in the ThinkLight model of Cheng and Yu (2015), and its user interface require some modifications related to simplicity and usable aspects. In short, their study raises design issues concerning how CML could be involved in designing a cross-menu easily. It is evident that designers have faced challenges embodied by the stationary collaboration scenarios.

Basically, the enhancement of using multimedia files in the CML model is one of the necessary issues. Wald, Li, and Draffan (2014) have adopted CML model in their research about designing CML application named "Synote" and found a drawback related

to commercial lecture capture systems, saying that such systems would be costly and do not easily facilitate mobile accessibility in students' interactions. Their research focused on the functions of the aforementioned application since its structure is based on the Hypermedia properties. The potentials of functioning various kinds of files are in the Hypermedia especially the multimedia files, for example, videos, slides, images, and student's or teacher's created notes. Besides, Synote model is accessible, manageable, searchable, and exploitable for all learners, teachers, and other such users. The formation of constructed Synote made it appropriate for various contexts, content, assignments, pedagogical topics, learning differences and learning preferences. Hence, Wald et al. (2014) has focused on the synchronous communication using Synote model, meaning that Synote application would be used in classrooms and in a synchronous manner only to apply the educational CML processes. In addition, Synote model has been designed to be a Web application compatible with different mobile devices, which indicates that there will be no function if there is no internet connection in the host mobile device. Regarding its future work, it recommends researchers to study more types of file sharing feature, since it is noteworthy for group collaboration applications (Shaltout, 2013).

Strategies of forming the basic elements in modeling CML application symbolize a new perspective in order to establish usable design through adoption of two concepts which are Reusable Learning Objects (RLOs) and Quick Response (QR) code used by Power (2013). The model was based on Collaborative Situated Active Mobile learning strategies (CSAM), in addition to Gulf-based investigators, educational designers, and front-line instructors, who want to utilize M-learning (Power, 2013). In response to that, the research has debated the major elements that must be included in the model, which

involved motivating learner, optimal learning conditions, and the benefits of social interaction. It has attempted to take into consideration the motivation for group engagement and learner audience characteristics. Additionally, CSAM studied interactivity on many levels among learners. Furthermore, it has discussed the issues related to the usable, compatible appearance and providing a suitable level of challenge among group members or other learning groups. However, CSAM has been applied in the workplace and it was more effective in some subject areas than others; moreover, it was practiced only on tablets for it is more flexible than other mobile devices such as smartphones. Power (2013) encourages for enhancing the learning with collaboration opportunity and suggested to include a new technology in the design of CML, for instance including the QR code to apply the learning activity situated in a realistic context. CML model involves learner engagement with educational content, which will, in turn, decrease monotony and make learning more meaningful.

According to Nam and Jang (2013), the domain of modeling and designing CML environment remained in the primary phase since it centered on some insufficient issues. For example, the researchers mentioned that the previous research have intensively studied the learners' perception with the adoption of traditional instruction subjects. Another side that has been focused on, is how to teach in collaborative environment and instructors' use of mobile technology. Also, Nam and Jang (2013) mentioned that the perspective knowledge refers to what is emphasized to be involved in the CML design. Learning activities need to follow arrangement processes particularly within a group of learners so that they should be addressed within the instructional context. Nonetheless, this model might not be applicable directly by a specific subject as it is designed for a

general usage. As a future work, the study has suggested some important issues, including instructor's evaluation process development, self-evaluation for the group, and feedback issue for both learners and instructors. Also, it recommended that various studies must be implemented to build an instructional design for diverse levels of learners and educational learning contents.

To sum up, the initial examination of previous models reveals the most important issues that should be included in the CML model which are group discussion, group classification, group chatting, group notification, group evaluation, file sharing, decision making and problem solving as well as instructor's monitoring and feedback. Therefore, this study intends to propose a CML model, based on the earlier discussions in order to enrich the literatures of the M-leaning area through combining it with relative learning concepts, representing the idea of collaborative learning notion using M-learning technology.

1.3 Research Questions

The following questions are formulated based on the problem discussed in the previous section. They address the CML model:

1. What are the limitations of the existing CML models?
2. How to improve the limitations in the existing CML models?
3. How to evaluate the functionality, usability and acceptance of CML prototype?

1.4 Research Objectives

The objectives below are intending to respond the aforementioned questions as follows:

1. To identify the limitations of the existing CML models.

2. To improve the limitations of the existing CML models.
3. To evaluate the functionality, usability and acceptance of CML prototype.

1.5 Significance of the Study

Conceptually, the contribution of this research lies in its attempt to form an improved CML model based on the limitations of the selected existing models. Many educational concepts were involved in this study in order to determine the desired requirements and ensure the acceptance and usability of the proposed model. Practically, the purpose of this study is to design the CML model based on the improved requirements of the CML model to be a guideline for designers and developers in the future. Furthermore, it encourages the users of the mobile device to adopt M-learning collaboratively as a useful tool through highlighting the educational potentials of mobile technology to enrich the learning process more by the use of mobile devices under the CML approach.

1.6 Scope of the Study

This research focuses on the modeling CML application for the mobile device on Android system platform 2.0 or later. In that regard, this study scopes not only on the functional issues including group discussion, group classification, group chatting, group notification, group evaluation, file sharing, decision making and problem solving as well as instructor's monitoring and feedback, but also the non-functional issues including usability, security, privacy, availability, reliability, efficacy and compatibility. The respondents in this are undergraduate students of Universiti Utara Malaysia (UUM). They were among those enrolling in Network Management and System Analysis Design

courses. Their lecturers consulted this study in reaching them. In average, they are between 18 and 44 years old.

1.7 Organization of the Study

Chapter 1 establishes the background of this study. Particularly, it addresses general information about CML models and determines the problem to be investigated and solved. Also, it reveals the main questions about CML model within the identified scope as well as addresses the importance of this study. Then, Chapter 2 reviews previous works related to this study. Next, Chapter 3 outlines the research methodology this study has gone through in achieving the stated objectives. It consists of four main phases. Further, Chapter 4 compares the existing models relevant to the CML to determine the functionality and non-functionality elements for CML model. Consequently, Chapter 5 explains the design and development of the prototype incorporating the CML model. When the prototype has been tested, Chapter 6 represents the results in terms of functionality and acceptance of the prototype using the Technology Acceptance Model (TAM). Finally, Chapter 7 concludes the whole study, including an address on the problems and limitations encountered during studying the CML model. It also addresses some recommendation and suggestions for future enhancement.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter mainly focuses on previous studies. It reviews the related literature in order to determine the important issues that contribute to filling the gap of this study based on the earlier research. It starts with the definitions of related concepts to clarify them, in addition to several models that are discussed to achieve the first objective of this study. Furthermore, it searches the various dimensions of CML modeling to understand the rules of right design for the instructional paradigm.

2.2 M-learning Concept

Since long time ago, knowledge exchange and experiences have depended on the communication among people, which has taken many figures and has been developed by time in line with the life changes. Human use communication to make distances closer, recognize modern requirements and express opinions with peers. Also, learning technology has taken various shapes reflecting its job as being a benefit tool devoted to learning, as well as being associated with learning and teaching theories (Arnold and Paulus, 2010). The world has witnessed the so-called mobile era by the existance of scientific progress and technological developments, in which the means of technology have become portable and designed with small sizes for individuals' communication. The mobile phone ranked in the top of these devices used as a facilitator at anytime and anywhere. The vast expansion of mobile devices use is caused by the evolution of wireless technology such as Wi-Fi, Bluetooth, and GSM, etc. (Wasserman, 2010).

The mobile phone has spread among learners regardless of their age, gender or financial level, even that the number of mobile phones in any state exceeds the number of its individuals (Sarrab and Elgamel, 2013). Accordingly, this prompts governments in both developed and developing countries to employ the inventive technologies in each field of life, including the field of education, in order to develop their systems and make efforts serving their societies. The implementation of mobile technology in educational activities has become the feature of this era since it based on a new deep vision related to cognition part. However, mobile learning is still a controversial issue, between supporters and opponents, regarding its use in the learning systems as an assistive technology in the instructional process. This has been emphasized by Gikas and Grant (2013) who pointed that mobile computing devices play an important role in higher education as they have advantages for students learning such as accessing information and communication content and providing various ways for learning. Indeed, mobile learning is a new way for learning and teaching models giving a part of sharing, listening and interpreting opportunities (Fazlina, Manap, & Rias, 2013).

On the other hand, researchers such as Koole, McQuilkin, and Ally (2010) have diagnosed some negative issues when using mobile devices for instructional tasks, including: the smallness of the screen size, limited storage capacity, battery life, types of supported files and security concerns. In order to analyze the process of mobile learning, the model of Koole et al. (2010) based on the Framework for the Rational Analysis of Mobile Education (FRAME) was used to address the aspects of mobile learning, figured as a Venn Diagram representing intersections between device usability, learner, and the social aspects of learning, as shown in Figure 2.1. Mobile learning takes advantage of the

context of the device with respect to individual learners, the ability of the device to interact with the environment as well as with other learners with mobile devices. Mobile technology for learning aspect has attracted academics to utilize it as a benefit tool in many institutions to enhance the online learning and receive significant notification about their curriculums at critical times (Pegrum et al., 2013).

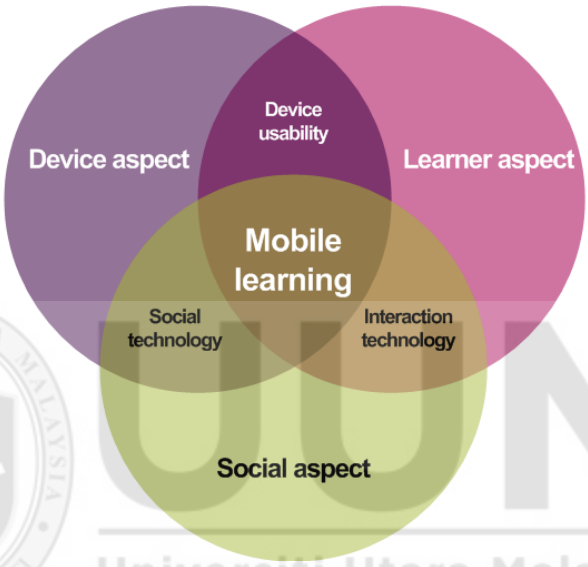

Figure 2.1: Koole's FRAME (Koole et al., 2010)

2.3 Collaborative Learning (CL)

Collaborative Learning (CL) refers to a method of teaching and learning by dividing learners into small groups having the different competency and scientific background to perform certain shared work between them (Laal & Laal, 2012). The CL aims to achieve an instructional objective by working as a team in order to solve a problem, complete a task or make a product. Learners' understanding, interesting and knowledge are other aims related to the application of CL depending on sharing their opinions and exchange ideas to present successful work. Based on Strijbos (2011), the two important elements in CL are teaching the individual himself and ensuring that all group members have been

learned, that means the workgroup is interdependent and solidary by encouraging others to learn and teach them to attain the achievement level of the group. Therefore, every individual's mark will be equal to others participants' marks. According to the study of Laal, Naseri, Laal, and Khattami-Kermanshahi (2013), it has been suggested to apply CL among students as it improves social interaction, enriches social behavior like respect, union, and friendliness, and reduces violence.

Besides, CL develops self-esteem and involves the participants taking part and responsibility for the results. As an umbrella term, CL refers to a diversity of instructional methods containing a shared knowledgeable energy by learners, or learners and educators together. Typically, learners are teamwork mutually looking for knowledge, explanations, solutions, or making a product (Kirschner, Paas, Kirschner & Janssen, 2011). Activities of CL vary broadly, but the majority of them focused on students' investigation or application of the course subjects, not merely what the educators present or clarify about it. Collaborative learning illustrates an important shift away from the typical instructor-centered or tuition-centered environment in institution classrooms. In the collaborative classroom, the discourse or listening, the note-taking method may not fade out fully, but it stays alongside other procedures that are centered on learners' conversation and working actively within the subjects of the course to make a collaborative and interactive teaching team (Al-Huneidi, Al-Huneidi & Schreurs, 2012). Lecturers who use collaborative learning approaches tend to consider themselves less as experts deliver knowledge to students, more as designers of intellectual experiences for students and as instructors of a more developmental learning method.

Lev Vygotsky is one of the supporters of collaborative learning through his theory, communicative learning theories assist us to know how people study in the social contexts (learn from each other) and tell us about how teachers form active learning communities. Lev S. Vygotsky (1978), a Russian teacher and psychologist, who proved that we learn through our communications and interactions with others, has studied how to control the learning process by our social environments. He prompted that knowledge takes place over the interactions of learners with their peers, educators, and other specialists. Accordingly, instructors can construct a learning situation that maximizes the learner's capability to interact with each other by collaboration, argument, and feedback. Furthermore, Lev Semenovich Vygotsky (1934) discussed that culture is the main decisive element for knowledge construction. He added that this cultural lens assists us to learn by following the rules and interacting with others' skills and capabilities formed by our culture:

1. Developing Learning Communities.
2. Community of Learners Classroom.
3. Collaborative Learning and Group Work.
4. Discussion-based Learning (Socratic Questioning Methods).

Instruction that supports social learning:

1. Students work together on a task.
2. Students improve across the curriculum.
3. Instructors select meaningful and challenging tasks for the students to work.
4. Instructors manage dialogue that supports deeper learning.

Consequently, educational plans that support literacy through the syllabus play a significant role in the learning structure as well as grouping of whole class leadership, group and individual exercise, and independent education. Besides, educators need to offer the chance to learners about lead sorted discourse. The discussion that contents on an aim with substantial notes that construct off each other, and there is an expressive interaction between learners that consequences in queries that help deeper understanding. The instructor, or particular theme skilled, plays the significant role of facilitator, making the situation where directed and guided interactions can occur. Several other learning theorists have adopted Vygotsky's CL development notions and suggested approaches that concerned with deeper awareness construction, help learner debates, and construct active education societies over small group based instruction.

Principally, Vygotsky revealed that knowledge always occurs in and cannot be isolated from a social context. Therefore, educational plans that encourage the sharing of expert information where learners collaboratively work together as a team to make a study, distribute their results, and accomplish or achieve a mission have assisted in making a collaborative society of learners. So, within the sociable firm that consists of learner-learner and expert-learner learning construction happen and collaboration on actual problems or work that construct on each individual's language, talents, and knowledge formed by each person's culture. Lev S Vygotsky's (1978) Zone of Proximal Development (ZPD) explains gaps in the different levels of thinking, activity and learning that individual learners are capable of achieving (see Figure 2.2).

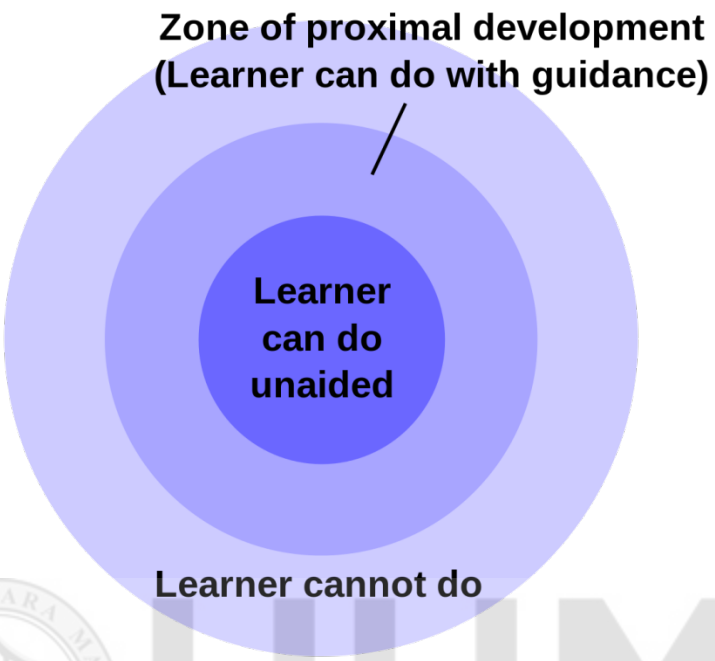

Figure 2.2: Zone of Proximal Development (ZPD) (L.S. Vygotsky, 1978).

2.4 Mobile Application and Mobile Web

A mobile Website resembles other Websites in that it contains browser-based HTML pages that connected together and can be accesses through the Internet by WIFI, 3G, 4G, or LTE. The clear feature that differentiates a mobile Website from a normal Website lies in that mobile has been designed to be a smaller portable device with touch-screen interface (Wong, 2012). Like other Websites, mobile Websites can show script, data, images and video. Also, they have access mobile-specific characteristics, for example, click-to-call (to dial a phone number) or location-based mapping. But, mobile applications are actual applications that are downloaded and installed on the mobile device rather than being rendered within a browser. Users visit device-specific portals such as Apple's App Store, Android Market, or Blackberry App World in order to find

and download apps for a given operating system (Allen, Graupera, & Lundrigan, 2010). The mobile application may download content and data from the Internet in a similar style of a Website or it can download the content so that it can be accesses without an Internet connection.

A Web application is an application that turns on a Web server and accessed by users across the Internet or a local intranet. Web applications typically contain static resource files, Web elements, helper classes and libraries (Wu, Luo, & Luo 2010). A Web browser is normally used as a thin client hence all the processing done on the server. Web applications are usually organize in three-layer architecture a user interface level, a functional process logic level, and data storage level. A Web browser is the user interface level and dynamic Web content technology such as ASP or Java is used in at the functional (business logic) level. Data Storage is handled by the database, Web applications are an extension of a Web server Espada, Crespo, Martínez, G-Bustelo, and Lovelle (2012). Web applications are either service oriented or presently oriented. A presentation-oriented Web application produces interactive Web pages containing languages like (XML and HTML) and dynamic content in response to requests. Most of these open sources Open Source Web Platform (LAMP) (e.g. Linux, Apache, MySQL and PHP). A service-oriented Web application then implements the endpoint of the Web service. Figure 2.3 simplifies the different between mobile application and mobile Web.

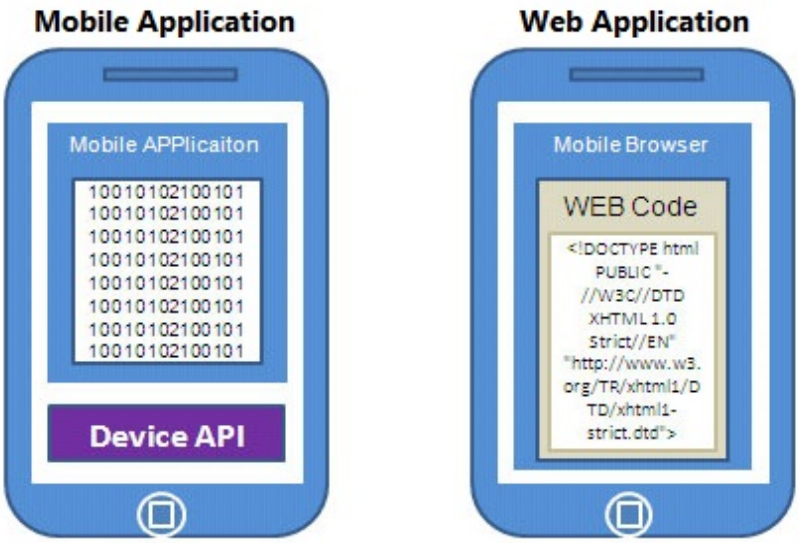

Figure 2.3 Mobile Application and Mobile Web

2.5 Android Mobile Application

As a definition, Google Inc. it referred to that system which is a very common technology in mobile devices presented the name of Android and it is capable of running multiple application programs since it is an operating system. Android system is a worldwide revolution amid mobile technology industry as well as this operating system has the feature of open-source software assembling plus middleware and key applications for mobile devices. The popularly name Android developed its operating system based on an improved version of the Linux kernel. Then, Google released the majority of the Android codes under the umbrella of the Apache License. The Android operating system built according to open source license and free software with the starting of the Open Handset Alliance, which was a consortium of hardware, software, and telecom companies devoted to advancing open standards for the technology of mobile devices. The maintenance and

further development of Android were been tasked with The Android Open Source Project (AOSP) Moser (2011).

In the content of the Android system, Java applications running on a Java-based and object-oriented application framework running on a Dalvik virtual machine containing JIT compilation on top of the Java core libraries were been adopted for the Android open-source software mass. C language joined with the surface manager in writing the libraries of the Android system. The rest content of Android system is SQL lite relational database management system, Open Core media framework, OpenGL ES 2.0 3D graphics API, SGL graphics engine, SSL, and Bionic libc. Totally, 12 million lines of code, including 3 million lines of XML, 2.8 million lines of C, 2.1 million lines of Java, and 1.75 million lines of C++ are the formation of Android system Sironi and Tisato (2013). In the application, Android system used in many figures of mobile devices that can be as operating system for smartphone, tablets, and notebooks. Many companies depend on Android as the operating system in their mobile devices products, for instance, Samsung, LG and Sony, including the Dell Streak, Samsung Galaxy Tab, TV and other devices. The first commercially presented phone to run the Android operating system was the HTC Dream, released on 22 October 2008. In early 2010, Google collaborated with HTC to introduce its flagship Android device. This tracked later in with the Samsung-made Nexus S. The Android technology is on evolution and its developing day by day to offer its users with the best technology (Brähler, 2010).

2.6 Collaborative M-learning (CML)

Technology era imposes on the educational sector use of innovative ways and modern means to reach instructional subjects by beneficial ways for students. Dewitt and Siraj

(2010) have defined CML as gaining of a new knowledge and skills anytime and anywhere by an individual resulting of interactions in group learners' trough using mobile devices. Certainly, mobile technology is one of the important tool uses in such context. It has several advantages to adopting it in learning tasks such as practical and educational applications in addition to the seamless learning (Wong & Looi, 2011). Bringing mobile technology in the higher education sector becomes essential among students that are assisting them to do their communication operations by notifying, reminding, interacting and keeping them in touch. From this point, educators see that mobile devices such as smartphones, tablets and laptops are necessary to be carried at the campus in order to exploit innovative solutions from the mobile technology to solve several problems for individual and groups.

In the digital age, The Internet as a communication medium and an interaction platform are rapidly changing the face of the learning environment. As Internet-based online teaching gains popularity, it has led to the emergence of new learning concepts such as problem-based learning mentioned by Donnelly (2010), as well as transference and transformation of established teaching practices from traditional classrooms to online environments (Baran, Correia, & Thompson, 2011). Students or learners whom they working within the group, they have many ways to connect, access and share information consistent with the acceleration for the adoption of mobile technology. Learning in the group could achieve the high level of performance and gains the major target condition that involves organized steps for working, make the right decision based on the subject review and divide balanced tasks among group member. Besides, active education is one such strategy of CML, which merely means the use of mobile devices to simplify

collaboration in active learning strategies that situated in an authentic context or the natural environment.

CML is not a term used simply in previous literature to describe a category of M-learning and CL approaches; rather, it used as a new descriptive term to combine the two subjects in strategic approaches and learning objectives. CML is also offered here as a new strategic planning framework to provide guidance for M-learning instructional design decisions, a framework for reflective M-learning practice and a tool for self-evaluation of the CML instructional design. Indeed, communication styles such as chatting, Email, calls or meeting trough M-learning apps supported to CML approach and they are effective methods among teamwork learners. As a useful tool, the CML concept has time-saving and involves with this is established workload dividing as stated by Peters and Hewitt (2010), through exploring the collaboration between members of group learning, debating highlighted thinking, feelings and insights through the cooperative working, as well as highpoint the blocks they encounter during their working. In today's world where regardless of your profession you are asked to do more with less, facilitators, directors, and leaders must boost cooperation if out of necessity if little else. In case like this where teams are in competition but collaboration is also necessary, motivation to collaborate must be applied on both sides of the aisle in order to simplify coming together (Järvelä & Järvenoja, 2011).

Supporting collaborative learning by using mobile technology based on analyzing online interaction and internet-based technology needs to investigate the field of social interaction mainly. Ting and Tai (2013) reviewed prior researches and concentrates on analyzes the social interaction that offers in groups of learning, and then remarks that

learners' social interactions are synthesized with the subject content to represent the instructional information. The study suggested the concerning to methodology that helped to focus future studies by empirical proofs. Resulting to the study, the chance is existent to encourage and improve graduate learner abilities, with the renewable technology learning become highly fruitful. It makes the entity of learning challenging, interesting, encouraging, attractive, and fun for everyone and mobile technology can be utilized to help students actively interweave their experience in both social and informatics realms to support their learning (Ting & Tai, 2013).

Active education is the learning based on the small group, according to Lan, Tsai, Yang and Hung (2012) that is found the best performance comes from a collaborative group of students. Students have the chance to learn from and to instruct each other. There will be even major compression to execute and be responsible confederated with the challenges of the modern figure of learning, fresh technologies for education, and novel requirements for graduate competence. Underlying all this is deep uncertainty concerning the right role and activity of dissimilar universities in systems of magnitude higher education. Active learning has reached content of the various activities involve valuable, uncourageous, competitive and collaborative work. Communication and collaboration on a limited scale simplified, thus reducing a sense of isolation felt by some. The concept, based on technical ability is a mutual and suitable means of investigating new skills. Therefore, in actual life, technological tasks do not exist in isolation.

The concepts of Computer-Mediated Communication (CMC) and Computer-Supported Collaborative Learning (CSCL) have moved CL learning environment from synchronous to asynchronous by computer assist (Loncar, Barrett, & Liu, 2014). Learners from varied

experiences supplied with the chance to be receive, share experiences and skills, and to contribute in unique methods, that allowed them to improve their understanding about the school and about their social context over direct knowledge and reflection on their local milieu. Block adhesion, credit, honor and appertaining are prove, and how a feeling of community of literature is established. It comprehends with a valuation of instructive methods, design by instructors and educators, as well as the findings of instructive researchers and guidelines for evading the pitfalls. The essential to the efficiency of collaborative learning is sociable interaction, and the fault of it is an element reasons the negative result of collaborative learning. So, group learning encourages the student in online learning and accomplishment through the interactive environment of CL and the computed technologies (Y. H. Lee, Waxman, Wu, Michko, & Lin, 2013).

Study of Popov, Biemans, Brinkman, Kuznetsov, and Mulder (2013) proposed a script program for students' communications stated that improves the quality of students' discussions in mixed- and same- culture learner groups. Learners who work as a team under the collaborative learning approach; the script can improve collaborative learning as technology instrument for doing practically part among team members. The researcher mentioned that the script engages the participants to prepared instructions about how learners should share, cooperate and interact. Technology-enhanced student-centered learning environments are not merely dichotomous alternatives to straight education; they show choice approaches for basic different learning goals. In any learning surrounding eventually imagined by its foundations and assumptions about learning, education, and the learner. As the assumptions change, the interaction among the foundation shifts. The

issue is not the natural excellence of one approach over another, but notice of the foundations, assumptions, and methods suitable to specific learning goals.

Prior studies emphasized on the interaction of networked learning environments Dabbagh and Kitsantas (2012), that expresses we subsist in a networked, information-based community in which groups and technology are required to direct the intricacy of education, live, and working, as well as it is a natural formula for connecting formal and informal learning. Institutions have got a planned position for learning to promote the technological and group work capabilities of learners, teenagers, and youthful adults, if must surmount the unique supposition for history joined with technology-assist education and utilize collaboration as an essential portion of the education aid major move of prior awareness and knowledge. Moreover, the CL as the educational utility of small teams is essential and fruitful to exchange the knowledge among the group. So that, learners working together to increase their understanding and each other is learning. Collaborative learning worldwide supported by an application that it founded on a well-formulated theory that has been confirmed by plentiful studies and operationalized into applied processes that could be used for many grades of instruction.

The constructivism involves collaborative working and learning by actively engage learners among cooperative theoretical bases (Cheong, Bruno, & Cheong, 2012). Engage learners in a continuous cooperative procedure of construction and reshaping knowledge as a characteristic result of their experiences and authentic interactions. CL with mobile technology must highlight on student ability to think flexibly, solve problems and make a decision within a group learner by working to gather to facilitate complex problems. Therefore, students are invigorated to develop them active instead of passive learners by

acquiring collaborative and cooperative skills, and lifelong learning skills. The improvement in mobile technology and the swift changes in the organizational infrastructure put an increased emphasis on team learning within the workforce. Group learning promotes the growth of critical thinking ability as the fundamental goal of technology education. Therefore, comprehensive instructional systems about enrich learning environments should involve thinking critically, to analyze and unite information in the educational, social, technical, economic, and scientific problems, in order to make the teamwork creatively in learning groups. Figure 2.4 illustrates CML model that combines the two concepts.

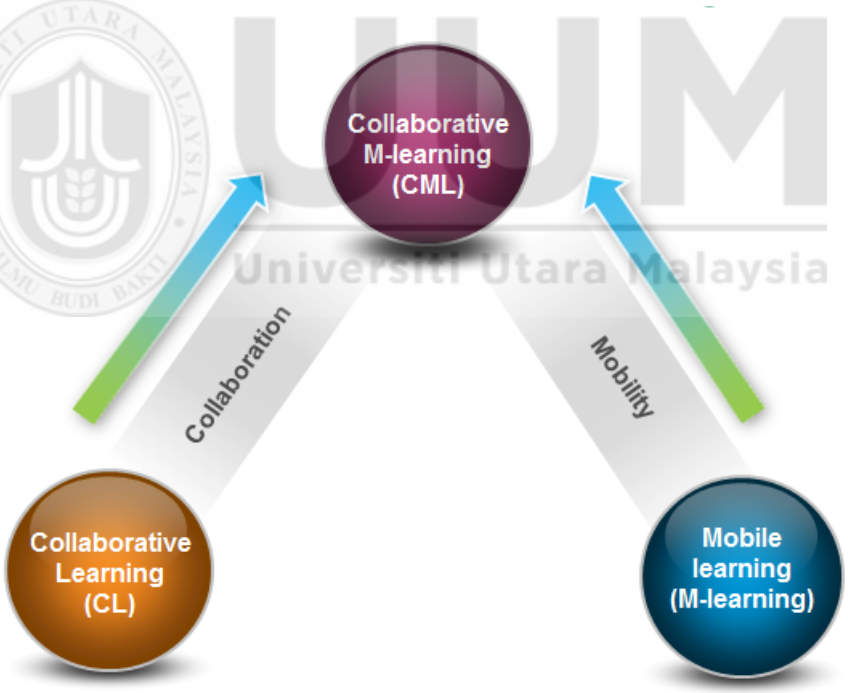

Figure 2.4: Proposed Collaborative M-learning Model

2.7 Related Works to Collaborative M-learning (CML)

CML is an idea to apply CL concept over using mobile technology, and the researcher believes that it is a great potential to share, facilitate and get knowledge effectively, however, the research carefully follows some research have been studied several issues in the field of CL and M-learning, then they suggested to adapt and utilize collaboration concept with mobile technology in the learning domain.

Cheng (2015) found that Computer Supported Collaborative Learning (CSCL), Face-to-face collaborative learning and collaborative mobile learning are often encountered some problems, for example, inefficiency and ineffectiveness. The research situated on two queries, firstly, how can model a mobile application (APP) exploit the methods of Collaboration Engineering (CE) and thinkLets to aid university students for collaborative work? And, secondly, are the effectiveness and efficiency improved by the developed application supporting the students' collaboration? Responding to that, researcher adopts some concept such as Process Support Systems (PSS), Group Support System (GSS) and Process support applications (PSA) beneficially to model CML application.

Cheng (2015) highlighted that the effectiveness and efficiency of collaboration can achieve by technology. As a collaborative software application, PSA might make it possible to give adequate collaboration knowledge to students, which makes collaborate and "facilitate in a box" without a facilitator without training. The research indicates what kind of mobile collaboration application is suitable and practical for university students to collaborate in a case study or other group work. The model concentrates on functionality issues, for instance, it enables to specifying topics for particular discussion, in addition to having arranged process including solving a problem and make decisions about selecting

the best solution. Other considerations, Group work privacy, database history and easy to understand how to use the functions of the application. Following previous models of research is a scientific way to get more understanding about the idea of design and to avoid some mistakes might not be noted from the designers.

Wald et al. (2014) proposed that the commercial lecture capture systems can be expensive and do not easily facilitate mobile accessible, student interactions, and users would clearly find a textbook difficult to use if it had no contents page, index or page numbers. Based on that, developed a CML model called, "Synote". The model overcomes the problem that while users can easily bookmark, search, link to, or tag the whole of a recording available on the Web they cannot easily find, or associate their notes or resources with, part of that recording. Synote can use speech recognition to synchronize audio or video recordings of lectures or pre-recorded teaching material with a transcript, slides and images and student or teacher created notes. The model designed as a Web application to be compatible with various devices, particularly, mobile device.

Researcher Wald et al. (2014) establishes several functions base on the aforementioned problem and synchronizing communication between learners. For example automatically or manually creates and synchronizes transcriptions, moreover, allows teachers and students to create real-time synchronized notes or tags and facilitates the capture. In addition, a replay of recordings stored anywhere on the Web in a wide range of media formats and browsers, as well as, text captions and images synchronized with audio and video enables all their communication qualities for different contexts. Therefore, the model involves function multimedia files, such as presentation, video, and picture.

Learners can navigate to a presentation, subscribe to that presentation and leave a comment on one of the slides.

Synote is appropriate for different contexts, content, tasks, learning styles, learning preferences and learning differences. According to Wald et al. (2014) found that can reduce the memory demands of spoken language by the text. Additionally, Synote has considered the possibilities of creating a private discussion for learners, after that subscribe to one of the discussions and leave a comment. In order to manage Synote, the research discussed the group function about how would they quickly find out about a comment on their discussion, navigate to one of the discussions they are subscribed to and unsubscribe, and navigate to a discussion they have left a comment on and edit and delete some of their comments. Psychologically, Synote model regarded some learners' points, for instance, speech can better express subtle emotions, and images can communicate moods, relationships, and complex information holistically.

Regarding the limitations, Synote focused only on synchronous communication so that it can be available only on the Web (Web application). In addition, it suggested to be used only in classrooms. Besides, captions can be displayed on a desktop browser with the video but it is not possible on iPhone to display both the transcript window and the video due to the size of the screen. So, there was a need to rearrange the view to be totally linear. Wald et al. (2014) conclude that one of the easiest ways to make videos suitable for Synote Mobile was to use YouTube with its captioning and transcription service. A future approach could be a quick responsive delivery from cloud storage system to cloud transcoding service, but this would incur cost. Considering different dimensional for

modeling a CML paradigm, it is necessary to achieve successful model to be adopted in the learning process and between learners.

Power (2013) determined some strategies as a guideline for designers in the subject of modeling CML. It focused on non-functionalities through presenting a new perspective about effective learning strategies based on learning concepts and theories. Conceptually, the research adopts Reusable Learning Objects (RLOs) as learning tools that able to use many times to serve learners in several ways. Also, Quick Response (QR) code which is the most modern process to navigate certain information by scanning its code. Theoretically, Collaborative Situated Active Mobile (CSAM) model stands on a synthesis of an analytical framework that research learning theories, which have been often referenced in the M-learning literature. Power (2013) offers a new perspective for instructional design, reflective practice, and self-evaluation of CML instructional design. CSAM illustrates the use of mobile technology to ease collaboration in active learning strategies that are situated in a realistic context or natural environment.

Providing learners with an opportunity to collaborate is one of CML design necessities giving by Power (2013) research. Incessant access to instruments and resources that enable learners to interact with each other and with their learning environment can be offered by mobile technology. Skills of learners can be drawn upon each other's and motivation to learn more than would be possible acting in isolation. The researcher mentioned that CML has the ability to interact and collaborate so that even learners moving outside of a traditional classroom, they can actively communicate with their learning environment in novel ways, which would not be possible without technology.

Generally, CSAM emphasized on three classes of elements when designing effective instructional M-learning model, firstly, carefully considering the characteristics of the learner audience must be paid, this involves specific learning needs, demographic profiles and learning style preferences. For instance, learner age, educational levels, as well as, intrinsic motivation levels, backgrounds of technology skill, geographic, proximity to (or isolation from) peers and teachers, in addition, individual interests among others. Secondly, group elements of the interaction types that will be constructed into the educational design must target to achieve the highest possible levels of interaction across all possible fields. This involves, learning interaction content and context, too, among peers and with the instructor. The notion is to avoid having individual learners merely get content; instead of, all learners must be working collectively to make contextualized understandings and skill sets. The third collection of elements related to mobile device that probably be for the strategies of learning is critical issue, which must really exemplify the most invisible of the elements. Nevertheless, CSAM is not without limitations, so that it is used only on the tablet kind of mobile devices and the model applied on workplace and workers domain in addition to scope the study only in GCC countries (Power, 2013).

Nam and Jang (2013) studded the Instructional Design (ID) through the development and validation a model of collaborative learning in M-learning environment for small groups. The researcher used a systematical method to design the model. As an important role, ID was the interesting source in the research. In determining the research gap, the study declares that the field of designing CML is still in prime stage and most of studied have investigated repeated scenarios. An illustration, they have adopted designing of learner-

centered and the usage of traditional learning subjects as the learners' perception of mobile technology model. The second frequent issues about, how to teach in the environment of M-learning model, including materials' development of the digital learning. In addition to, study the efficiency of mobile technology on the learning and teaching context. Another consideration must be included in the design of CML model, is the significant lack content, such as the perspective knowledge about how to make a guideline for designers, most of researches have focused on some issues which are not sufficient. For instance, providing design framework and methodologies of these studies to understand only the model design.

Nam and Jang (2013) discussed the limitations of most previous research related to CML model, and defines them as following: do not provide a guideline for the instructors, about what and how teachers give notice of the mobile device usage according to the instruction flow. Moreover, they do not contain the prescriptive knowledge to be involved in the design activities for CML model. There is a point as a worthy of notice that the reason of CL is an unstructured group process, is for essentially interested with the problem solving, make decision and knowledge building. The researcher ID model attempts to fill the gap of aforementioned problems by design CML model that has better integration about three main subjects in the design, which are the collaboration of technological, teacher and peer scaffolding which play complementary roles. The model of that study conducted by a systematic method based on Delphi technique to later center on a number of questions in determining the system design model, the three round of Delphi method analyzed and formed the structure of the ID model (see Figure 2.5).

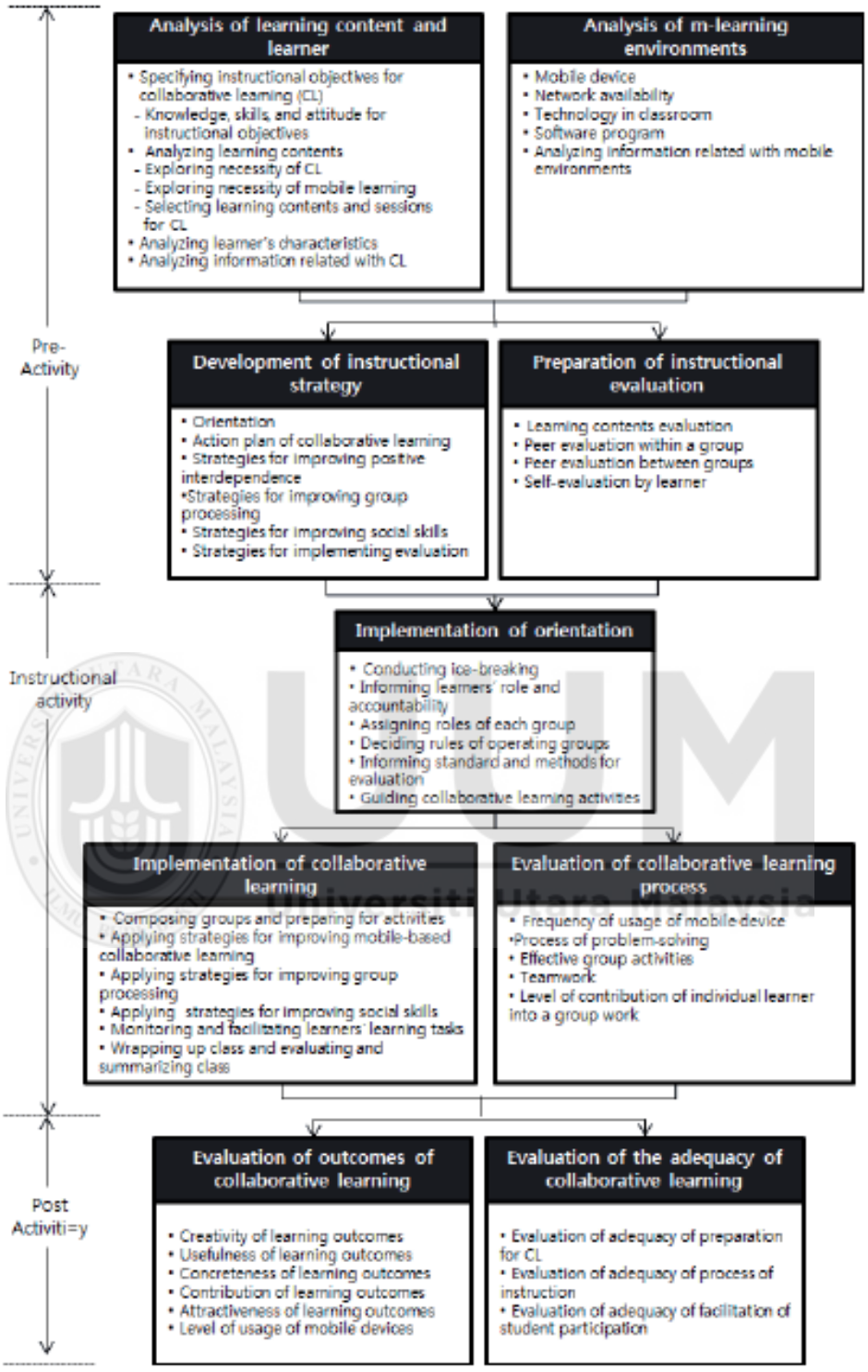

Figure 2.5: ID Model for collaborative learning in m-learning environments (Nam & Jang, 2013).

The ID model takes the development of educational strategy, which considered several instructional activities. In detail, development of orientation program, collaborative learning action plan, strategies of positive interdependence improvement, improvement of group processing, social skills improvement, and evaluation implementation. Instructional strategies development to throw light on employs educational plans in order to support instructors. Besides that, ID models confirm on methods of educational material collection and the utilizing methods for online learning community effectively. As well as the planning of instruction evaluation was collected of some educational activities, for instance, organizing for education contents evaluation, evaluation of peer within a group, evaluation of peer among groups, and self-evaluation by the learner (Nam & Jang, 2013).

The design of ID model is not like face to face CL, as it consists of perspective knowledge about the mobile technology usages suitably. Also, it is unlike Web-based collaborative learning since it focuses on online Information and Communications Technology (ICT) in addition to Social Networking Services (SNS). So that, CML model would be fruitful design, on condition that, concentrates on the CL in mobile technology environment. Nam and Jang (2013) found three outcomes in its model evaluation; firstly, the model involves an instructional design model, additionally, teaching and learning the model. The educational model focuses on the instructional innovative process for the faultless classroom, while, the learning and teaching emphases on the educational activities. Secondly, the result of using mobile technology guiding in order to make the best use of M-learning and CL together to what have of effectiveness and efficient on the learners. The third finding was the time saving for instructors through orienting learners

with guided model about how they use, interact and collaborate themselves in organized and sorted manner. Nam and Jang (2013) concludes some limitations of this study, which are the developed model, may not be directly applied to specific subject matters as it is somewhat universal and general. Research need to adapt various methods for rigorous validation. Additionally, it needs to be reflected to further ID model in the future according to the suggestions by two teachers as end-users of this model at the phase of the usability test. Further research should be implemented to develop diverse and revised versions of this developed model which are adequate for each subject matter and different levels of learners and contents.

According to above studies in the literature review, there are many issues that are the most important points should be considered as much as possible in the modeling of CML since strong point, meanwhile, other weaknesses points must avoid as the guidance of previous studies. The following table illustrates briefly these issues:

Table 2.1

Comparison of the Most Important Issues for Modeling the CML.

Authors and Years	Names of Model	Strengths	Weaknesses
Cheng (2015)	ThinkLight	Collaborative enhancement, specific discussion, arranged process, solving a problem and make decisions to select the best solution, group work privacy, time saving.	'Facilitate in box' means without instructors, depended on evaluation of self-students' work, limited to talk, needs to be improved for aesthetics and simplicity.

Wald et al. (2014)	Synote	Speech recognition, synchronize pre-recorded teaching material with a transcript, slides and images and student or teacher created notes, specific discussions, subscription, edit comments.	Website mobile application only, needs to rearrange the view to be totally linear, encouraged to be used in classrooms only, more suitable on tablet type of mobile devices.
Power (2013)	CSAM	CML application for workplace and realistic context training, conceptual guide for instructional design of M-learning, learner motivation, ideal learning conditions, and cares the benefits of social interaction in learning,	Applied on workplace and workers domain rather than the educational field, needs to optimal learning conditions, application design outcomes carried from tablet devices only, and limited scope with the high developed country.
Nam and Jang (2013)	ID Model	Constructed based on systematic technique, teaching and learning considerations, knowledge of using perspective, instructional design for developers advising.	Not for specific subjects as it for general usages to some extent, needs to improvements to be for different levels of learners and educational contents.

The investigation of modeling CML gives the understanding about significant issues of current researches model, Song (2014) explores how groups and individuals make sense of conditions and built knowledge supported by mobile technologies. The research tries to conduct a systematic analysis of methodological approaches established in the Mobile Computer-Supported Collaborative Learning (mCSCL) study literature in order to highlighted possible methods more conducive to analyzing the effectiveness of mCSCL performs, aims of the Song (2014) study conducted to determine the methods managed, effectiveness of mCSCL and the issues what at that time existed approach methods of mCSCL studies. This study was been dealt with at length, in addressing the research demands a group of criteria formed based on literature review, including studies that have met such this purposes (Wong & Looi, 2011). The measurements of the research which have adopt mobile technology to support collaborative group learning, evaluation with empirical evidence for various studies of mCSCL and researches that asked explicit research questions, in addition to some general points that illustrate the limitation of mobile devices such as screen smallness, storage capacity, battery life, and so on.

Song (2014) study found that the inspecting measurements and assessments are dependent on theoretical framework used in the study and the research questions being asked. Measurement in CSCL can take one of the three forms: assessing the individual about the individual's experience (assessing the individual learning process and outcomes), assessing the individual about the group's experience (assessing the individual learning process and outcomes contributed to the group collaborative learning), and assessing the group as a whole (assessing group's learning process and outcomes). In CSCL Measuring, contains note, capturing and summarizing both

individual and group behaviors, from which investigators conclude processes and results of learning. The affecting factors measurement in CSCL involves differences of individual, tool use, context, activities of the collaboration, and different theoretical backgrounds of the researchers. The reasons that, the mobility feature of mobile devices' nature, collaborative learning may occur in constantly changing contexts for instance, from physical to virtual, from individual to social, and from informal to formal learning spaces). Therefore, capturing the students' learning process is a very requiring task. The study concludes that, although designed learning practices in both in-and out-of-class and design-based research are on the rise to foster learners' collaborative learning, new endeavors are still scant to address methodological issues in mCSCL practices. Thus, the review of the study suggests lighting the potential directions for further mCSCL research (Song, 2014).

Boticki, Wong, and Looi (2013) stands theory of CSCL when studied other issues of CML modeling, in identification the research problem, teachers face the challenge of tapping this technological enabler their classrooms to design lesson activities that genuinely integrate mobile devices into curriculum and lesson plans. Then, adopted Design-based Research concept in an attempt to better integrate mobile devices into everyday classroom practices, it proposed a design for collaborative learning in which technological, teacher and peer scaffolding play complementary roles. The collaborative technology, students' relationships and social interactions, and the teacher's facilitation can collectively provide scaffolding to the students.

One of the biggest misconceptions regarding computer supported collaborative learning is that "the social interaction happens automatically" stated by Boticki et al. (2013), and

the study focuses on the specific roles of collaborative scaffolding through the technology, the teacher, and peers. It gave a careful consideration to including different kinds of content in its design. The research proceeds from the assumption that the teacher scaffolding provides contextual assistance, supplementing both technological and peer scaffolding, by intervening at critical points in order to facilitate the activity progression. Also, it discussed that activity rules are content-dependent and are reinforced both by the technology and through collaboration with teachers and peers. The technology itself designed to be adaptable to new content areas since it allows for content-independence by accepting multiple sources of content. Collaboration process cares the learners, that it fills the experience gap between one another to share equally knowledge among them.

The study emphasized on the collaboration as evidence that the dynamic grouping approach shows the potential to generate greater diversity in students' collaborative patterns and richer learning processes. As well as it inserts competition and collaboration productively in one learning environment by using a live synchronous point-based reward system. Also, focuses on synchronous communication, but, the limitation consideration in the study were some points such as the indoor usage in the classrooms only and the actual application is for Chinese language only in the domain of language learning. Besides, it used as face-to-face collaborative learning activities, to ensure proper enactment of specific collaborative scripts or scaffolds. Boticki et al. (2013) have suggested using the system as guidance since students will be able to choose their own preferred approaches to doing the collaborative activity while being guided by the system. Not only, but also redesign the model to fit new technologies and UI design principles, in addition, to expanding the research scope in future.

2.8 Expert Review

Productivity has been commonly examined through expert review. In such technique, UML experts examine the CML model and with its UML design. It is applicable to find usability problems in the design and implementation (Paavilainen, Korhonen, & Saarenpää, 2011). Accordingly, this study employs expert review to examine the UML diagrams to ensure the CML model meets its specifications and each requirement is available in the right amount. According to Paavilainen, Korhonen, and Saarenpää (2011), the experts should evaluate based on usability assessment. Hence, this study made the CML model and UML diagrams available to the experts in the field of Software Engineering (SE) one by one. Altogether, not less than three experts (more explanation in Chapter 4) involved. This enables this study to identify design flaws in the early design stage. It was found that the employed usability experts can identify usability problems as accurately as in user testing, agreeing the statement by Paavilainen, Korhonen, and Saarenpää (2011).

2.9 Usability Evaluation

Measuring user's satisfaction such as usefulness, ease of use, and acceptance is possible through usability testing method. The literatures describe it as an overall measure of how easy the user interface is to its users. Nielsen (2012) refers web usability to the ease of use of a user interface (UI) design. For instance, navigation is one of the important components of the application design that supports users in searching for information and in browsing through the content. Much useful information can be obtained through usability testing. Such information can help designers and companies to improve their design to meet users' needs. Various usability evaluation methods have been developed.

According to Hasan and Abuelrub (2013), those techniques can be categorized into the following.

- **User-based usability evaluation methods** – usually involve users, being observed while undertaking pre-defined tasks with the purpose of identifying usability problems.
- **Evaluator-based usability evaluation methods** – involve a number of expert evaluators, assessing the user interface to judge whether it conforms to a set of usability principles.
- **Software-based usability evaluation methods** – involve software tools in the process of identifying usability problems. The software tools automatically collect statistics regarding the detailed use of systems.

In this study, the first category was used to evaluate the usability of the CML prototype as it is within the scope of this study, which is usability and user acceptance. Biel, Grill and Gruhn (2010) mentioned that, the design and development of a prototype is based on the gathered requirements. To get information on whether the prototype satisfies the requirements and whether it is an optimal solution to a given design problem, it has to be evaluated by the intended users.

According to Folstad, Box, Law, Hornbaek, and Copenhagen (2012), the goal of a usability test is to improve the process a product is designed and developed, so that other products could avoid doing the similar mistakes. Accordingly, Lee, Moon, Kim, and Yi (2014) underline that every usability test shares these five characteristics:

- The primary goal of a usability test is to improve the usability of a product. Further, for each test, it can have more specific goals, that are articulated when planning the test.
- The participants represent real users.
- The participants do real task.
- The researcher can observe and record what participants do and say.
- The researcher can analyze the data, diagnose the real problems, and recommend changes to fix those problems.

Accordingly, this study considers all the suggestions. Hence, real users involved in the user test. They were observed and their actions were recorded for analysis. Details of the procedure are discussed in Chapter 3, 4, and 5.

2.9.1 Technology Acceptance Model (TAM) Questionnaire

The usability test involved in this study was conducted by mean of questionnaires. Regarding to the questionnaire, Technology Acceptance Model (TAM) format used in such evaluation subject, it builds on social psychology and attempts to explain why user engages into consciously intended behaviors (Al-Rahimi, Othman, & Musa, 2013). Also, the TAM questionnaire tasks interpret the user interactions with the technology in attempt to find the important issues, related to the user interface. TAM which was originated in the area of information systems, has been widely used to examine the perceived usefulness and perceived ease of use as correlated with people's intention to use a system or technology. Recently, TAM has been one of the popular research tools that can help to investigate such intention and further identify various factors for accepting different technologies (Seliaman & Al-Turki, 2012).

The simplicity of this questionnaire model and its ease of use make it very popular and well suited to many research settings in which prediction of behavior is the major purpose of the researcher in this study, in order to improve collaborative learning among students in higher education using mobile technology. In TAM, a user's acceptance to adopt the CML application can be measured by three tasks: perceived usefulness, perceived ease of use and collaborative learning. A later development of TAM questionnaire included the perceived usefulness as one of the usability factors of this study. It is dimension of measuring whether the CML model is useful, and to what extent is useful, this task gains the user's feedback, so that would be directly influenced the usability result test (Lai, Wang, & Lei, 2012). While, the perceived ease of use refers to the degree to which an individual expects no physical and mental difficulties in adopting the technology at hand (Al-Rahimi et al., 2013). The user's perspective about the collaborative learning through mobile technology represented in the third task of the TAM questionnaire list, which is refers to the prospective user's belief that adopting a given technology will contribute to a better performance among the group of the learners (Al-rahmi, Othman, & Mi Yusuf, 2015).

2.10 Summary

In attempting to cover related and previous studies of the literature review, this chapter discussed the most important issues of modeling CML, represented by the functional and non-functional subjects. The study considered the usability, acceptance, group discussion, group classification, group chatting, group notification group evaluation, file sharing, makes decision and problem solving as well as instructor's monitoring and feedback as

functionality issues. While, the non-functional issues of the CML model are: usability, security, privacy, availability, reliability, efficacy and compatibility. The model serves group of learners using mobile technology through to enhance their collaboration. Additionally, is to defining the concepts and the supported theory for CML approach, and review related works that refer to the main approaches and connected to this study as well as make the comparison between previous models to determine their strong and weak points. Besides, explain the technology terms which have the association with the proposed idea for CML modeling.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the overall procedure of this study, referred to as research methodology. Research methodology illustrates the techniques and methods that this study went through in managing the whole process (Creswell, 2013). As this study aims at determining the requirement of CML model (as stated in Chapter 1), reviewing the existing models is a must. It is outlined in the following section.

3.2 Research Design

In this part, the whole phases in this study are elaborated, conveying the procedures to solve the discussed problem (in Chapter 1) and achieve the research objectives. Based on the objectives, the following four main phases are necessary, in which each is detailed illustratively in Figure 3.1:

1. Conceptual study.
2. Requirements Identification.
3. Constructing CML Prototype.
4. Evaluation of the proposed prototype.

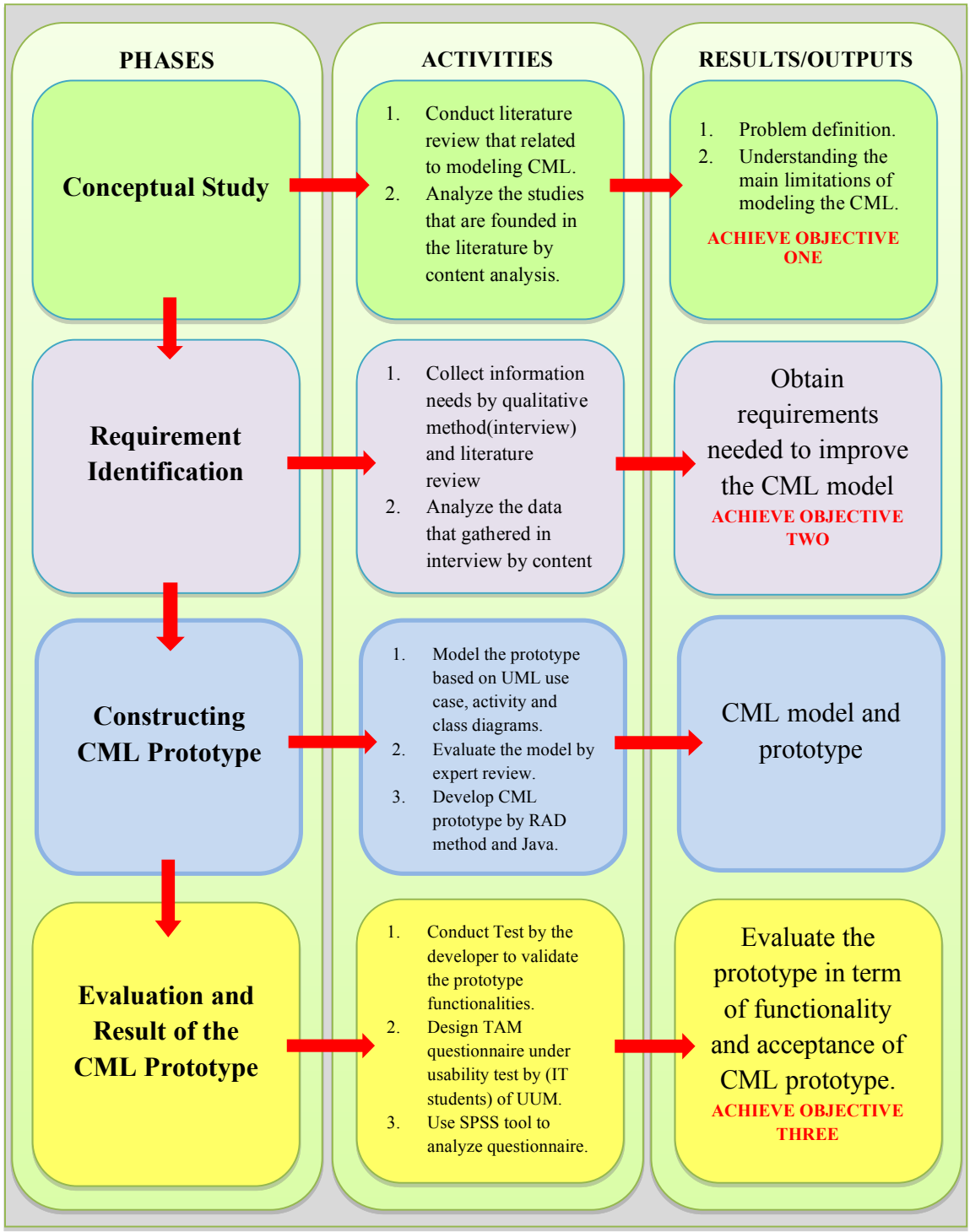

Figure 3.1: Research Design

Consistent with Klassen, Creswell, Clark, Smith, and Meissner (2012), the four mentioned phases can be modified through the research design in order to achieve the research goals. As shown in Figure 3.1, research objectives explained within the four major stages showing the accomplishment of the proposed study.

3.2.1 Conceptual Study

The initial phase started with the conceptual study to clarify the main topic of this research as an introduction to the specific subject that is mainly related to the M-learning. Researchers have emphasized on addressing the design tasks and conceptualizing the real problem as well as illustrating the suitable technique for the proposed appropriate solution in information technology (Ostrowski & Helfert, 2011). As a first phase, conceptual study usually presents the useful information to assist the researcher regarding the general concept of the existing study. The study explains the M-learning, collaborative learning, and instructional design to form a full image about what is CML model. Consequently, it defines the most important subjects relevant to the term of CML representing its emergence, significance, and effectiveness on the daily life particularly for the instructional usages.

As stated by Ravitch and Riggan (2011), conceptual study refers to the analytical tool that organizes ideas and guides research through the literature review as the important activity. In the literature phase (in chapter two), it reviewed the related works to the field of study which might have almost similar findings to be analyzed by content analysis and comparative analysis have been carried out in order to determine the major elements of modeling the CML design. Previous studies hold the clarified limitations of CML model that are collected in aiming to help the researcher when studying various dimensions of

CML. Also, it provides an evaluation to identify the most important issues in constructing the intended model of CML. Besides, literature review describes the different viewpoints from past studies as useful observations to highlight the research problem and determine the gap in the investigated area. At the end of this phase, the results were to define the main gap and major issues that should be included in the modeling of CML to achieve the first objective.

3.2.2 Requirements Identification

The second phase in the research design was determining the requirements of modeling CML obtained from the previous phase, including: determining the problem statement and identifying the important topics of CML model from the literature review to prepare the right questions aiming at understanding the requirements of design CML model based on CML approach. Alarcon, Guerrero, Ochoa, and Pino (2012) agreed on that obtaining the requirements is a challenge of establishing CML as it leads to either the success or failure of the proposed application. Hence, identifying the requirement of modeling the CML in this study obtained from two resources, which are the literature review and the interview. Determining the requirements for the educational application gathered from the literature review mainly. It is known that most of the available educational applications are focusing on given information, theories, and facts about the educational approach. Then, the interview has completed the right lines to understand the requirements of modeling the CML design.

3.2.2.1 Requirements' Gathering from the Literature Review

This study depends on the investigation and understanding of the problems, solutions, features, limitations of related and existing applications, as well as their requirements.

The importance of the related and existing models lies in providing the right issues to improve the CML design. It is a much frequent subject; therefore, to modeling a fruitful application for collaborative learning using mobile technology. It is recommended to learn from and understand other models that have similar features (Small, 2011). The successful design of CML model requires collecting a set of requirements, which are considered to be the most important part in this study. Likewise, the research procedures can be emulated for the developers and designers to be implemented and used as a guide (Power, 2013). Therefore, this study has investigated the related and existing studies, as were stated in Chapter 2.

3.2.2.2 Requirements' Gathering from Interview

The interview is a qualitative method prepared as an instrument for data collection in gathering user's requirements (Creswell, 2009). Respondent's discussions and their information allow the researcher to explore whether the suggested model issues was guided to improve the limitations or not. The interview is known as one of the most important ways to acquire the information and clarifying the right requirements in order to adopt the suitable solution for the research problem. However, the participants were ten IT students of Universiti Utara Malaysia (UUM) whom they enrich the requirements collection by answering the interview questions about the modeling of the CML. On the other hand, the contents of the interview consist of ten related questions to gather the requirements of this research. According to Alkhazali (2012), The interview involve five major steps as follows:

1. **Selecting interviewees:** As the first step, it gives the way to select the interviewees for modeling the CML in order to gather the requirements. Selecting

the interviewees must be based on users' requirements with the most known applications for collaborative learning.

2. **Designing the interview questions:** This step presents the final design for the interview questions regarding their opinions on the CML model to be suitable for clarifying and determining the requirements. The questions were designed based on researcher ideas to obtain the requirements.
3. **Preparing for the interview:** This step includes preparing the interview meetings with the target users, considering the conditions of conducting the interview. The most important points are determining the time and place before conducting the interview. So, the researcher kindly contacted the respondents beforehand, then appointments were made.
4. **Conducting the interview:** This phase presents the way to conduct the interview. First, the researcher explained the main topic, the model and related system, as well as the contribution of the study. Then, the respondents were asked one by one to get their feedback. The session was video-recorded where answers were also noted on papers.
5. **Follow-up:** Finally, the system requirements for modeling the CML application were determined based on the previous steps.

The interviewees included different students' nationalities. However, they were within the field of Information Technology (IT) in the Universiti Utara Malaysia (UUM). The questions focused on the important issues of latest applications, which is used the learning within a group of students using mobile technology, and what their opinions about the proposed a new mobile application for collaborative learning was. The

interview conducted a one to one meeting, and the questions that were asked to the respondents during the interview are:

1. Do you have learned within learning group?
2. How do you communicate your classmates within learning group after finished school?
3. Do you have any experienced in using the collaborative learning application on a mobile phone?
4. If a new mobile application for collaborative learning will be proposed, what are the functions you hope to be implemented in the application?
5. What do you think the best way to organize the collaborative learning through mobile technology?

After collecting the requirements of CML model from the literature review and the analysis of students' answers in the interview using content analysis method, the second objective was achieved.

3.2.2.3 Content Analysis

The content analysis technique was utilized in the analysis on the related and existing models of the collaborative learning using mobile technology (Bozkurt et al., 2015). It was used to analyze the frequency, intensity and repeated data from the models; in addition to predominance of values, trends, supports and rejections. Content analysis is a procedure for categorizing verbal or behavioral data for the purposes of classification, summarization, and tabulation (Egbokhare, 2014). They could lead to certain findings on functionality and non-functionality. Then, based on the findings, a model could be composed.

The requirements should involve high level design objectives and goals that guide the design decisions in the application development life cycle. Besides, the issues must reflect knowledge and understanding of the practices, weaknesses and Strengths of models (Khan, Othman, Madani, & Khan, 2014). This analysis helps the application designer in several ways, so that identifying the most important limitations of existing models could be improved to be included in a new CML model. In addition, this can be achieved by adding extra features to make its use easier and more comfortable. In addition, proposing a design model for the CML application would lead to a better fulfillment of users' requirements, as well as identifying technologies and ideas that can be transferable and applicable to new functions.

3.2.2.4 Sampling

The purpose of the interview method is to be used as a tool for developing various suggestions from students in University Utara Malaysia (UUM), for instance, their views and needs. Therefore, these views could be obtained from the students' answers to the questions of interview based on the research to be conducted. Several questions were considered in this process of data collection in accordance with the nature of respondents. Hence, the interview conducted with UUM students in the field of Information Technology (IT) who, as Kooloos et al. (2011) stated, have the best performance as well as being the best reviewers. They were randomly selected among students of Universiti Utara Malaysia (UUM) who were taking Network Management and System Analysis and Design courses. As undergraduate students, they were between 18 and 44 years old. Their lecturers assisted this study in selecting them. The interview was conducted in one week..

3.2.3 Constructing CML Prototype

In this phase, research process transforms the obtained requirements to scheme content for modeling and developing CML prototype using the suitable technique and the needed tools to create CML prototype in a specific Android platform. Modeling process guide the designer towards the correct way step by step for prototyping the CML. Basically, modeling the CML prototype requires to design analysis for the model requirements by drawing logical diagrams, which help in designing the intended model. The famous tool that can describe the whole system functions and tell their scenario is the Unified Modeling Language (UML). UML is a graphical language that visualizes, specifies constructs and documents the objects of a software-intensive system. According to Almutairi, Bell and Chen (2013), the following are design artifacts for a prototype:

1. Use case diagram: this diagram used to show the system components and the user relations.
2. Activity diagram: this diagram used to give the details to describe the functions of the system about all activities introduced in the previous step.
3. Class diagram: this diagram used to describe the whole system classes and their interrelationships based on the use of case diagram.

In this study, all the design artifacts are worked on, before the prototype was developed. Then, the UML designs were revised and verified by UML experts. The expert review used to help the developer concerning the UML diagrams as the logical design; as well, to ensure that the model of CML design adjusted to its specifications, and each requirement is available in the right amount. According to Paavilainen, Korhonen, and Saarenpää (2011), the expert review method is widely adopted as a usability assessment

method for evaluating such educational model. In this study, the experts are four lecturers from Universiti Utara Malaysia (UUM) in the College of Arts and Sciences, as they are specialists in the field of Software Engineering (SE). The CML model and UML diagrams have been displayed to them one by one, and then the experts gave valuable feedback and clarifications since there were some mistakes in the UML design. Consequently, the UML diagrams of the CML model were corrected and adopted to be the base for the CML prototype development in the constructing phase.

Next, the process of developing the CML prototype should be chosen by appropriate technique and instrument; hence, Rapid Application Development (RAD) method was the proper approach for developing CML model. It is a software development methodology that uses the minimum of the planning for the benefit of rapid prototyping (Daud, Bakar, & Rusli, 2010). The advantages of the RAD method are represented by its easy implementation, user satisfaction improvements, and shorter time to design the prototype.

Most of the development environments for Android system have used Java programming language as it is common programming language for coding the content of Android applications, the study adopted it to develop the CML prototype as well as some other tool that have supported the study project (see Table 3.1). The mobile technology and systems have rapid development and faster updates that led to the emergence of a new development platform, Android system has various programs for making an application such as Android Studio, Java, and SDK tools. Building the CML as a pedagogical model based on CML approach is the achievement of objective two in this research and it enables the researcher to proceed in order to test and evaluate the prototype.

Table 3.1

Constructing Tools

Tool	Description
Unified Modeling Language (UML)	Modeling CML prototype by using use case, activity and class diagram
Rapid Application Development (RAD)	Development methodology
SDK Java tools	Development environment
Windows 7,8	Operating system

3.2.4 Evaluation

This stage focused on the CML prototype evaluation as the fourth and last phase in the research design. Firstly, the expert review was utilized to ensure that the model of CML conforms to its specifications and all the requirements are present in right quantity. Paavilainen, Korhonen, and Saarenpää (2011) mentioned that the expert review method is a widely adopted as a usability inspection method for evaluating such educational model. Then, test cases in Software Engineering (SE) were used to check the functionality of the prototype by the developer. Test cases refer to a set of conditions under which a tester determines whether an application software system or one of its features is working as desired or not (Causevic, Sundmark, & Punnekkat, 2012). Secondly, another test was to measure the user satisfaction by investigating the students' acceptance of using the structured prototype for the CML. Moreover, measuring the collaboration process was listed in the questionnaire as task to ensure the success of the participants during their interaction and testing the prototype (Al-Rahimi et al., 2013). The method that was used

to get the approved result is the Technology Acceptance Model (TAM) (Liu, Chen, Sun, Wible, & Kuo, 2010).

Finally, Students were provided their feedback through answering a survey questionnaire of the TAM model as an instrument of the quantitative method by distributing the questionnaire to 30-40 students in the field of Information Technology (IT) in UUM and the participants' age was (18-34). Then, the researcher identified the weaknesses and the strengths of the developed prototype to give a clarified indication of students' approval and must be not ignored by those trying to design and implement fruitful application under CML approach. To answer the objectives of this study, conducting the analysis was in the event of getting an answer using descriptive statistics and the relationship of independent variables and the dependent variable were tested using correlation analysis, the analysis was conducted using Statistical Package for the Social Sciences (SPSS) program (Green & Salkind, 2010). The outcomes of the research confirmed, and that leads to the future research works that can be joined with this application that could be implemented for the entire prototype.

3.2.4.1 Questionnaire Design

Technology Acceptance Model (TAM) format used in such evaluation subject. TAM questionnaire tasks interpret the user interactions with the technology in attempt to find the important issues, related to the user interface. It is based on social psychology and attempts to explain why user engages into consciously intended behaviors (Al-Rahimi et al., 2013). The questionnaire measures the user's acceptance, which centers on three dimensions: perceived usefulness, perceived ease of use, and collaborative learning using mobile technology. TAM that was originated in the area of usability, has been widely

used to examine the perceived usefulness and perceived ease of use as correlated with people's intention to use a system or technology. In this study, the list of questions adopted from the literature, a five-point Likert scale (1 for strongly disagree to 5 strongly agree) was applied in this questionnaire (Al-Rahimi et al., 2013). The questionnaire is divided into two sections, firstly a section containing short explanation about the study and its purpose. It is coupled with questions on demographic background of the respondents, which includes gender, age and education level (see Appendix A). Second part of the questionnaire locates 21 questions, for respondents to express their perceptions on the three dimensions stated above. The questionnaires were returned as soon as they have tested the prototype, in the same session. It is one of the popular research tools that can help to investigate such intention and further identify various factors for accepting different technologies (Seliaman & Al-Turki, 2012).

3.3 Summary

The methodology is important and used to conduct all kinds of research that are the right guide for accomplishing the study's objectives step by step. The methodology of this research is adopted from (Creswell, 2013). Research design and methodology are planning the phases of this study starting with the conceptual study to know the main problem, then to identify the three objectives going to prototyping the proposed application approach and this was in the third stage of the methodology in order to model the CML.

CHAPTER FOUR

REQUIREMENTS IDENTIFICATION

4.1 Introduction

This chapter describes the gathering and analysis requirements for the proposed model. It dealt with the description of the CML modeling requirements that were gathered from reviewing previous studies and interviews as a technique in the qualitative method. The requirements modeling was analyzed using content analysis method to ensure determining and extracting the important issues and beneficial features for CML design in a qualitative way. Additionally, this chapter focused on how the information was gathered and analyzed.

4.2 Requirements Analysis and Understanding

Developing the CML model requires collecting and understanding the issues and factors that can enrich the study contents on designing an instructional model, taking the benefit of using mobile technology for learning in group environment. Basically, the research was based on the most important issues that have been extracted from the previous studies in order to determine the potentials of involving them in the proposed model as much as possible since this phase is a primary source in collecting the necessary information. Additionally, users were interviewed to gather the requirements of the model, as they are experienced with mobile technology and have been dealing with technical issues in the field of informatics and computer science.

4.2.1 Related Works and Existing Models Analysis

Principally, this study was carried out depending on the analysis and understanding of the problems, solutions, features, limitations of related and existing applications and their

requirements. The importance of the following related and existing models lies in providing the right options to modeling the CML design. It is a much frequent subject; therefore, to modeling a fruitful application for collaborative learning using mobile technology, it is recommended to learn from and understand other designs that have similar features (Small, 2011). The successful design of CML model requires collecting a set of requirements, which are considered to be the most important part in this study. Likewise, the research procedures can be emulated for the developers and designers to be implemented and used as a guide (Power, 2013). Therefore, this study has investigated the related and existing studies that have similar models, as were stated in chapter 2.

The content analysis technique was utilized in the analysis of the related and existing models of the collaborative learning using mobile technology (Bozkurt et al., 2015). Model subjects are proposed by extracting the most important issues represented by the functionality and non-functionality subjects that would fulfill the major requirements in the best manner. The principles involve high level design objectives and goals that guide the design decisions in the application development life cycle. The issues reflect knowledge and understanding of the practices, weaknesses and Strengths of models. This analysis helps the application designers in several ways, so that identifying the most important topics of existing models could be improved to be included in a new CML model. This can be achieved by adding extra features to make its use easier and more comfortable or by engaging its function to be more effective and efficient. In addition, proposing a design model for the CML application would lead to a better fulfillment of users' requirements as well as identifying technologies and ideas that can be transferable and applicable to new functions.

4.2.1.1 ThinkLight

Designing of a mobile collaboration application for student collaborative group work was the subject behind modeling the ThinkLight. It was designed as an Android-based mobile application utilizing methods of Collaboration Engineering (CE) and thinkLets in order to support the university students to collaborate their work and study. The ThinkLight focused on examining the effectiveness and efficiency of the application for students' collaboration through the use of mobile technology represented by an Android platform smartphone (Cheng, 2015). Figures 4.1 and 4.2 illustrate ThinkLight model.

Strengths of TinkLight

The application provides the following important issues:

1. Enhancement of Collaboration by facilitating students' communication and promoting their processes and modes of thinking.
2. Specific discussion for various subjects to cover several types of learning materials through classifying the students group in addition to group work privacy.
3. Solving problems and making decisions to select the best solution that led to time saving.

Weaknesses of ThinkLight

1. The feature provided in this application called 'Facilitate in box' that means without instructors the students can learn, however, it means without monitoring.

2. Based on the evaluation of self-students' work, the application was limited to talk and needs to be improved in terms of aesthetics and simplicity.

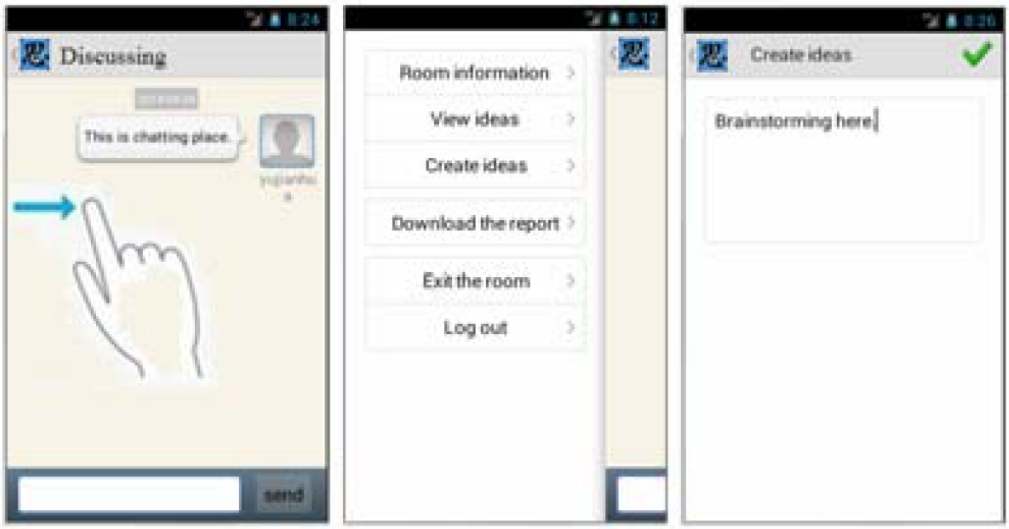

Figure 4.1: ThinkLight Discussing module; Main menu; Create ideas (Cheng, 2015)

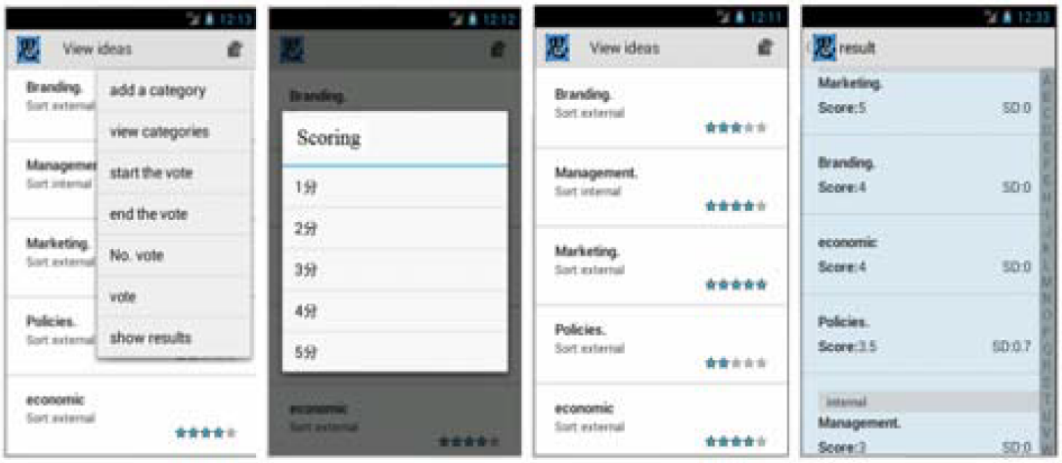

Figure 4.2: ThinkLight View ideas; Pull-Down menu; Scoring; Showing results (Cheng, 2015)

4.2.1.2 Synote

A collaborative mobile learning free to use and synchronizing communication between learners contain several functions such as automatically or manually creates and synchronizes transcriptions, besides allowing teachers and students to create real-time synchronized notes or tags and facilitates the capture (Wald et al., 2014). In addition, all their communication qualities for different contexts are enabled through a replay of recordings stored anywhere on the Web in a wide range of media formats and browsers along with text captions and images synchronized with audio and video. So, the model involves functions of multimedia files, such as presentation, video, and picture. Learners can navigate to a presentation, subscribe to it and leave a comment on one of the slides.

Synote is appropriate for different contexts, contents, tasks, learning styles, and learning preferences and differences. According to Wald et al. (2014) found that Synote can reduce the memory demands of spoken language by the text. Additionally, it has considered the possibilities of creating a private discussion for learners, then subscribing to one of the discussions and leaving a comment. In order to manage Synote, the research discussed the groups' function concerning how would they find out a comment on their discussions, navigate to one of these discussions they have subscribed to in addition to unsubscribe and navigate to a discussion they have commented on or edited and deleted some of their comments. Psychologically, Synote model regarded some learners' points, for instance, speech can better express subtle emotions and images can communicate moods, relationships, and complex information holistically. Figures 4.3 and 4.4 show the Syntalk features and Synote discussion.

Strengths of Synote

1. The speech recognition is the modern feature that differentiates this application. This feature facilitates writing through word pronunciation to be written automatically in text places.
2. Synchronize pre-recorded teaching material with a transcript.
3. Slides, images, and student or teacher created notes, specific discussions, subscription, edit comments.

Weaknesses of Synote

1. Basically, it is a Web site mobile application rather than a built-in mobile application.
2. Needs to rearrange the view to be totally linear, more suitable on the tablet type of mobile devices.
3. The model of Synote is designed and encouraged to be used in classrooms only.

Figure 4.3: Synote Android UI; Syntalk feature (Wald et al., 2014)

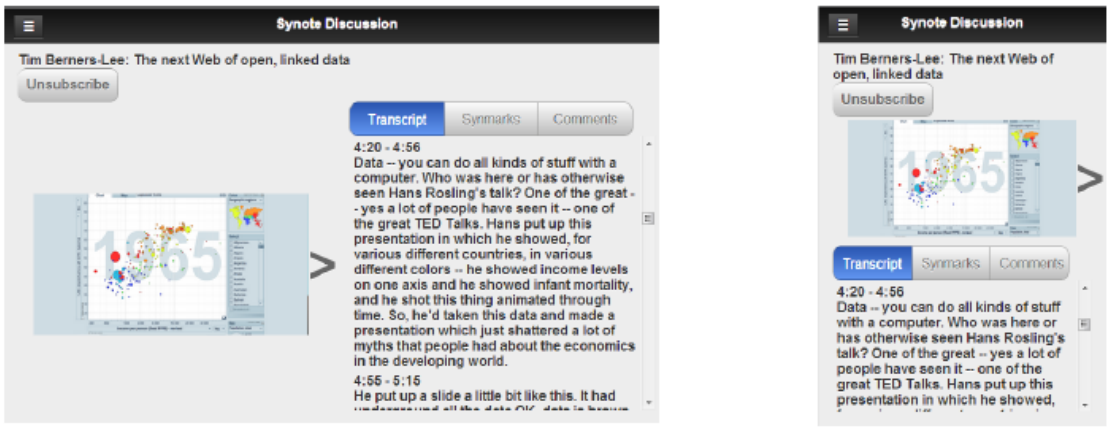

Figure 4.4: Synote Discussion in landscape and portrait modes (Wald et al., 2014)

4.2.1.3 CSAM

Collaborative Situated Active Mobile (CSAM) is a model based on the research that adopts Reusable Learning Objects (RLOs) as learning tools, which can be used many times in order to serve learners in several ways. Power (2013) determined some strategies as a guideline for designers in the subject of modeling CML. This guideline focused on non-functionalities through presenting a new perspective about effective learning strategies based on learning concepts and theories; as well, it discussed the functionality of the model. The researcher suggested the feature of Quick Response (QR) code which is the most modern process to navigate certain information by scanning its code (see figure 4.5). Power (2013) offered a new perspective for instructional design, reflective practice, and self-evaluation of CML instructional design. CSAM illustrates the use of mobile technology to enhance collaboration in active learning strategies that are situated in a realistic context or natural environment.

The model effectiveness was the focus of attention in this design since providing learners with an opportunity to collaborate is one of CML design necessities given in Power

(2013)'s research. Incessant access to instruments and resources that enable learners to interact with each other and with their learning environment can be offered by mobile technology. Furthermore, skills of learners can be drawn upon each other and the motivation to learn would be possible more than acting in isolation. The researcher mentioned that CML has the ability to interact and collaborate. Accordingly, even learners moving outside of a traditional classroom can actively communicate with their learning environment in novel ways, which would not be possible without technology.

Strengths of CSAM

1. Create a reusable learning object to teach is a concept that facilitates students' learning through the use of mobile technology and sharing information.
2. One of the most important issues is the group learning motivation rather than isolation which involves enjoyable, engagement and offering an appropriate level of challenge.
3. It has careful consideration for learners'/audiences' characteristics and focused on the M-learning activities.
4. Learner motivation, optimal learning conditions, and the benefits of social interaction in learning.

Weaknesses of CSAM

1. The model is designed and used for the tablet mobile device only; it has the limitation of screen size for other types of mobile devices.
2. Applying the model on workplace only, this means that it is suitable for classrooms only to be a tool for learners' group.

3. Does not involve supervision or monitoring as an instructor design, the collaboration happens between the learners only.

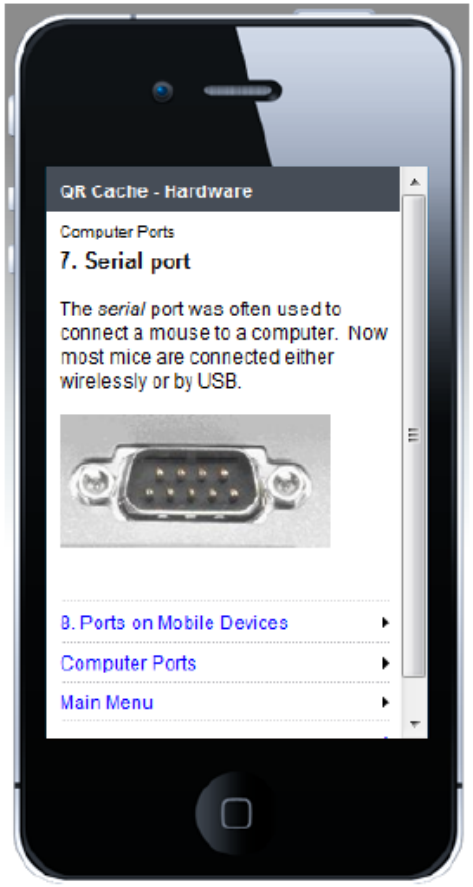

Figure 4.5: Mobile Reusable Learning Objects (RLOs) and Quick Response (QR) (Power, 2013)

4.2.1.4 ID Model

ID model is a learner-centered and using the traditional learning subjects as the learners' perception of mobile technology model for collaborative learning (Nam & Jang, 2013). This model is situated on Instructional Design (ID). It adopts the development of educational strategy which took into account several instructional activities, including:

development of orientation program, collaborative learning action plan, strategies of positive interdependence improvement, improvement of group processing, social skills improvement, and evaluation implementation. Instructional strategies development throws light on applying educational plans in order to support instructors.

Besides that, ID models emphasize on methods of educational material collection and the utilizing methods for online learning community effectively. As well as, the planning of instruction evaluation collected some educational activities, for instance, organizing for education contents evaluation, the evaluation of peer within a group, evaluation of peer among groups, and self-evaluation by the learner (Nam & Jang, 2013). Moreover, it is unlike Web-based collaborative learning since it focuses on online Information and Communications Technology (ICT) in addition to Social Networking Services (SNS). So, CML model would be a fruitful design on condition that concentrating on the CL in mobile technology environment. There is a noteworthy point that the reason of CL as an unstructured group process is essentially interested with problem solving, making decision and knowledge building. Figure 4.6 indicates ID Model for collaborative learning in M-learning environments (Nam & Jang, 2013).

Strengths of ID Model

1. Collaborative M-learning design and instructional model involving students' interaction within group of learners under the considerations of educational criteria (e.g. having students and instructors).
2. The model considers the innovative technologies represented by cloud computing and social networking services in the design.

3. Teaching and learning considerations in the model means including instructors' knowledge perspective as well as students' mutual experience.

Weaknesses of ID Model

1. To some extent, the model cannot be customized for specific subject as it is for general usages and different materials without being able to name a certain topic for a group.
2. Needs improvements to be appropriate for different educational and learners' levels.

Table 4.1

Strengths and Weaknesses of the existing CML Models.

Authors and Years	Names of Model	Strengths	Weaknesses
Cheng (2015)	ThinkLight	Collaborative enhancement, specific discussion, arranged process, solving a problem and make decisions to select the best solution, group work privacy, time saving.	'Facilitate in box' means without instructors, depended on evaluation of self-students' work, limited to talk, needs to be improved for aesthetics and simplicity.
Wald et al. (2014)	Synote	Speech recognition, synchronize pre-recorded teaching material with a transcript, slides and images and student or	Website mobile application only, needs to rearrange the view to be totally linear, encouraged to be used

		teacher created notes, specific discussions, subscription, edit comments.	in classrooms only, more suitable on tablet type of mobile devices.
Power (2013)	CSAM	CML application for workplace and realistic context training, conceptual guide for instructional design of M-learning, learner motivation, ideal learning conditions, and cares the benefits of social interaction in learning,	Applied on workplace and workers domain rather than the educational field, needs to optimal learning conditions, application design outcomes carried from tablet devices only, and limited scope with the high developed country.
Nam and Jang (2013)	ID Model	Constructed based on systematic technique, teaching and learning considerations, knowledge of using perspective, instructional design for developers advising.	Not for specific subjects as it for general usages to some extent, needs to improvements to be for different levels of learners and educational contents.

The strengths and weaknesses of the current models have been analyzed and tabled. As seen in Table 4.1, certain model is better in certain part, but lacks in other parts. Based on that, this study combines the advantages and disadvantages in those model to form a new

set of requirements. Both functionality and non-functionality are considered. Content analysis method was used for tabling the issues. According to Egbokhare (2014) content analysis is a procedure for categorizing verbal or behavioral data for the purposes of classification, summarization and tabulation. Based on the findings, Table 4.2 details the information for further considerations.

Table 4.2

Analysis of the Related Works and Existing Models

No.	Model Names and Authors	Functionality	Non-functionality	Limitations
1	ThinkLight Cheng (2015)	• Group chatting. • Group discussion. • Files organization. • Problem-solving and decision-making. • Group classifying. • Group feedback.	• Privacy • Usability • Reliability • Efficiency	• No monitor or teacher to help the group. • Limited to talk. • Needs improvements on aesthetics and simplicity.
2	Synote Wald et al. (2014)	• Web-hosted recordings. • Speech recognition. • Teacher or student created notes. • Material synchronization. • Group discussions, edit subscription, comments. • Support multimedia files. • Social media sharing with Twitter. • Post notification.	• Availability • Compatibility • Usability • Privacy	• Web site mobile, Web application only. • Smartphone's display not linearly. • For classrooms only. • Not phablet design, only for tablet device.

3	CSAM Power (2013)	• Group meeting (chat, discussion). • Learning style preferences (ages, educational levels). • Quick Response (QR) Codes. • File sharing.	• Compatibility • Usability • Availability • Efficacy	• Group learning without lecturer or monitor. • Designed according to tablet type devices only. • Limited scope with the high developed country.
4	ID Model Nam and Jang (2013)	• Group teaching and learning. • Cloud source and local files sharing. • Group discussion and notification. • Instructor's feedback and advising the learners. • Problem-solving and decision-making. • Group evaluation for group improving.	• Efficacy • Availability • Usability • Reliability	• Cannot be customized for a specific group name, it is for general usages to some extent. • Needs improvements to be for different levels of learners and educational contents.

The above discussion of the existing models and related works reveals the important issues of the preliminary exploration of strengths and weaknesses for each model. The issues of functionality, non-functionality and limitations listed in two tables. The classified information collected and analyzed to be the fundamental result of the content analysis method. A qualitative content method was utilized to analyze features such as frequency, intensity and repeated data from the aforementioned models; in addition to predominance of values, trends, supports and rejections of what is involved within the meanings of content analysis method. Content analysis is a procedure for the categorization of verbal or behavioral data for the purposes of classification,

summarization and tabulation (Egbokhare, 2014). Table 4.2 shows the detailed information for the analysis of related works and existing models.

4.2.1.5 Analysis Result of the Related Works and Existing Models

In relation to the analysis results, number of items referring to the most important issues were extracted and classified as functions and non-functions according to the above analysis. The outcome was organized according to the result of the analyzed information over and over using the content analysis technique then summarized in the below Table 4.3 which presents the analysis result of the related works and existing models. Fundamentally, investigation and comprehension of issues, arrangements, elements, limitations of the related and existing applications and their necessities represent the initial phases in guiding this study. This was regarded in reviewing the related and existing models to make the right choices in demonstrating the CML design. Likewise, the examination techniques can be adopted by the engineer and developer to be implemented with a specific end goal to help them as a tool for modeling (Power, 2013).

Table 4.3

Analysis Result of the Related Works and Existing Models

No.	Functionalities	Non-functionalities
1	Group discussion	Usability
2	Group chatting	Security
3	Group classification	Availability
4	Group notification	Efficacy

5	Group evaluation	Privacy
6	Instructor's monitoring	Compatibility
7	Instructor's feedback	
8	File sharing	
9	File organization	
10	Problem solving	
11	Make decision	

Regarding the analysis process, it was conducted through the content analysis method of the related and existing models for the collaborative learning by using mobile technology (Bozkurt et al., 2015). The obtained model subjects were proposed in accordance with the most essential issues of other aforementioned models, which are classified as the functionalities and non-functionalities issues. The collected subjects would satisfy the significant necessities in the best way. The standards of model include high level plan destinations and objectives that guide the correct model choices in the application improvement life cycle. The result shown in Table 4.2 combined with the next analysis of interview to obtain the right choices in order to make designable model of the collected data as well as highlighting the important subjects, features or findings in modeling the CML application.

4.2.2 Analysis of the Interview

Interview is a commonly used technique in gathering information (Creswell, 2009). In this study, the interview as a technique in the qualitative method was used to collect the requirements by conducting a one to one meeting in order to ask the respondents the study related questions and then getting the answers. Developing the model of CML

requires collecting and understanding the issues and factors that can enrich the study contents on designing an instructional model taking the benefit of using mobile technology for the learning in group environment. Basically, the research depended on the most important issues that have been extracted from the previous studies in order to highlight the potentials of involving them in the study model as much as possible, since making this phase is a primary source to collect the necessary information. The questions in the interview were asked to clarify the most important requirements and the interview was prepared to obtain the information, which determine the right selection of the functional and non-functional subjects in modeling the CML application. Below are some questions being asked to the respondents in the interview:

1. Do you have learned within learning group?
2. How do you communicate with your classmates in the learning group after graduating?
3. Do you have any experience in using the collaborative learning application on mobile phone?
4. If a new mobile application for collaborative learning will be proposed, what are the functions you hope to be implemented in this application?
5. What do you think the best way to organize the collaborative learning through mobile technology?

Table 4.4

Analysis of the Interview

Interview Analysis						
Question No. / Students No.		1	2	3	4	5
Students' Answers	1	Yes, I am learning within a group of friends, we learn as group (e.g. group assignment) and other.	I Use social media application (Facebook, whatsApp) to communicate with my group.	I have no idea about this type, just the texting message for group discussion.	Extend the range of discussion to involve lecturers and students from other colleges.	I propose a private and public discussion to sort the conversation.
	2	No, I do not because when I want to learn I set alone.	Internet is much provided and we used WhatsApp group and Facebook texting message.	No, I do not have any idea about a specific application for group learning.	Video chatting such as Skype would be helpful and voice room also.	Using voice note could decrease the much conversation and texting discussion.
	3	Yes I have assignment groups consisting of 4-5 students.	I use WhatsApp group and Facebook group for some.	The idea is that mobile technology decreases the distance.	Learning style especially for learning environment (background, ring tone)	Chatting timer to set a certain duration for finishing the chatting
	4	Yes I have a group for learning in my college as a group assignment	I use WhatsApp and Viber for group connection.	Yes, it is application for group to share information.	Group chatting, sharing files and solving problems for group only.	I suggest using the chatting only to sort the discussion.
	5	Yes I have some groups in my study; we get benefit by sharing the knowledge.	We use Facebook and if no Facebook we use WhatsApp No in China	Yes, there are some programs for tutorials and learning exercise.	Programming language learning in mobile phone.	Text message and private chat to solve the random messaging.
	6	Yes, I have groups of learning.	Mostly, we create group in Facebook and use text message or call.	No, I do not have idea.	I do not have idea.	Delivered and seen messages.

	7	Yes, I have groups in many materials and for group assignment.	WhatsApp group and Facebook group.	No, I do not have.	Text discussion, specifying materials, sharing pictures, notifications.	Classifying and categorization pictures and text. Making expected and last final question part.
	8	Yes, I have groups of students to share my idea and information collaboration.	I use social media (WhatsApp, Facebook) and I prefer WhatsApp.	Yes, I have the idea of sharing information such as Mendeley and Endnote.	Chatting and problem-solving, sharing multimedia files.	Writing notification to organize the texting.
	9	Yes, I have many groups of learning in my study.	We communicate using WhatsApp and Viber applications.	Yes, I used Wikipedia and YouTube as they are useful for collaboration.	Video live chatting is a better way for communication as it saves the full conversation.	Usability design, resource sharing and picture as well as video chatting.
	10	Yes, I have group in my class. They are five students, they study with me and share information.	I use such application like Facebook and WhatsApp for group.	Yes, communication text and file sharing.	Like and dislike.	I think if there is no picture it will be better, only texting message.
Analysis Result		Mostly, they have group learning and group assignment consisting of 3-5 students.	WhatsApp and Facebook with texting message features.	Group meeting for discussion and share information, file sharing, collaborative learning application.	Group chatting, Group discussion, File sharing Problem solving.	Private and public discussion, chatting, texting message and file sharing with classification.

As shown in the Table 4.4, it illustrates the interview analysis of the respondents' answers, which represented the second part of data collection. Equally, the provided answers were processed by the same procedure being applied on the previous step using analysis of the textual content. In a scheduled way, the process of analysing the interview answers was in a careful consideration reading the ten responses, opinions, and suggestions of interviewees to interpret the content sense and find the correlations in

order to reach the correct analysis. Consequently, the interview analysis was based on the content analysis method that classified the analysed information, tabulation and groups as well as ignoring the data that has inconsistent context among the answers.

4.2.3 Result of the Interview

The data gathered from interviewees were transformed to valuable information by content analysis method to determine the appropriate requirements for modeling the CML design. Content analysis is often used in such case to determine the useful information by analyzing the contents using the notation and the frequent statements (Bozkurt et al., 2015). The students' reviews enriched the content of the study by giving their opinions and suggestions concerning their experiences in the field of using mobile technology as a tool for their learning and the pros or cons issues that they encountered through their usage. Consistent with their answers to the aforementioned question in the interview, the result of analyzing their reply is as follows:

- **Result of question one:** 9 of 10 students have group learning and group assignment as group learning also, mostly consisting of 3-5 learners.
- **Result of question two:** 7 of 10 students use WhatsApp and Facebook applications with texting message features.
- **Result of question three:** 6 of 10 students' answers identified the collaborative M-learning application as group meeting for discussion, share information, file sharing, and collaborative learning application.
- **Result of question four:** 7 of 10 students' answers selected group chatting, group discussion, file sharing and problem solving as the preferred functions or features of their using experiences to be implemented in new CML model.

- **Result of question five:** 6 of 10 students' answers chose private and public discussion, chatting, texting message and file sharing with classification to sort and organize the interaction through using mobile technology as a collaborative learning tool.

In short, information on the analyzed data enriches the preliminary result. The respondents' answers in the interview clarify the fuzzy picture on the existing findings. The contribution of the interview analysis represents the valuable information about user requirements gathered through interviews. It provides rich information through interactions with respondents. It is one of important requirements to design the application. Therefore, it is necessary to understand the users' opinion and their requirements. The purpose is to capture the perfect picture of the functional and non-functional requirements of the model.

4.3 Requirements Modeling

The results above revealed the analyzed information on determining the model requirements from the interview made with students in the field of IT in the Universiti Utara Malaysia. As respondents, they provided the valuable information to the study in order to identify the most important issues of modeling the CML application. According to Creswell (2009), content analysis was used to analyze the result which is compared with the analysis result of related works and existing models to be combined with the current result. Content analysis and qualitative method depend on each other, so that they were used to find the harmonious correlations to integrate them, and make the objectives, which answered the research assumptions and questions. Each step in the collection of requirements requires a careful reading and closer consecutive text to build each other

using knowledge of the nature relation that bind them (Bozkurt et al., 2015). The analysis of the existing model and related work from literature review in addition to the interview analysis as a whole presented the final model requirements as the functionalities and non-functionalities to be adopted in the designing of CML model. Below, Table 4.5 shows the summary of model requirements for the CML design.

Table 4.5

Summary of Model Requirements

From	Functionalities	Non-functionalities
Existing Model and Related Works in the Literature Review	• Group discussion • Group chatting • Group formation • Group notification • Group evaluation • File sharing • File management • Problem solving • Make decision	• Usability • Security • Availability • Efficacy • Privacy • Compatibility
Students' Interview	• Group discussion • Group formation • File sharing • Group chatting • File classification • Problem solving • Make decision • Private group discussion • Public group discussion	• Usability • Privacy • Compatibility • Availability • Reliability • Efficacy

Result of final CML Model Requirements	• Group discussion • Group formation • Group chatting • Group notification • Group evaluation • File sharing • File organization • Make decision • File management • Problem solving	• Usability • Security • Privacy • Availability • Reliability • Efficacy • Compatibility

Modeling CML application aims to determine the requirements of application design. The importance of this research lies in its contribution to the body of knowledge to be used as a guidance for the designer and developer in the field of M-learning and especially for CML model (Power, 2013). The importance of research requirements determines the design successfulness. The identified requirements for modeling the CML design were divided into two major classifications as follows:

1. Functional requirements.
2. Non-functional requirements.

4.3.1 Functional Requirements

In the application design, the functional requirements refer to the implementation of a certain operation that happens after particular events. According to Al-Shemarry (2010), functional requirements are intended to capture the anticipated behavior of the system. It is a named procedure that performs a distinct service; the CML model requirements contain many functions for the application work. The functions represented the important issues that were collected under the research topic which combined the Collaborative Learning with the M-learning concepts. It is of instructional significance

that the study adopted the two concepts since they are closely connected with instructional principles that emphasize on evolving many aspects in the learning area and achieving the main target, which is utilizing the new learning tools (see Table C.1 in Appendix C).

4.3.2 Non-Functional Requirements

In the modeling of CML application, non-functional requirements represented the most important properties since they determined the main criteria obtained from the collected and analyzed data. According to Ameller, Franch and Cabot (2010), they formed attractive target among researchers in the requirements engineering. Non-functional features used to measure some subjects that are responded by the application such as performance, quality of operations, quality attributes, security, accuracy, modifiability, and performance in the application jobs. Table C.2 details the most important non-functionalities issues, which considered in the modeling CML application. In (Appendix C) the non-functional requirements listed in one table.

4.4 Requirements Identification

The requirements for CML gathered through reviewing the existing models, uncover a set of modeling issues. This process led to the initial determination of the functional and non-functional requirements of CML model. Then, the interviews with the target users have clarified and verified the actual requirements. Throughout the process, both quantitative and qualitative approaches were involved, including questionnaire, interview, and content analysis. It was done so to ensure that the gathered requirements are rich. Basically, the findings of the requirement identification include: firstly, the issues related to group-learning and their administration, such as group formation, group

discussion, group evaluation and group decision, in addition to file management. Secondly, the major issues related to the behavior of the prototype during the interactions with users. Generally, the findings cover the most important requirements to design the intended model in an attempt to fill the knowledge gap, particularly the CML model.

4.5 Summary

This chapter introduces the gathering and analysis phase of model requirements as it planned in the research methodology. The requirements represented the functionalities and non-functionalities depending on the strengths and weaknesses as well as the limitations from two sources. The sources were the existing models and related works of the literature review and the students' interview of the aforementioned sample in this study. They were the most important issues that determined the right and suitable subjects as the CML model requirements. Altogether, the four models included in the comparative analysis and interviewing ten students to analyze the data from the two sources using content analysis technique. Then, the result determined the important subjects required in modeling the CML application. The researcher believed that the CML model is important for learning groups and would be a valuable contribution for both designer and developer. The result used in the next chapter to be applied in the designing and building phase.

CHAPTER FIVE

DESIGN AND DEVELOPMENT

5.1 Introduction

This chapter explains the design and development phases of the CML model which represent one of the study objectives. Based on the requirements modeling stated in Chapter 4, the list of the functionalities and non-functionalities issues transformed into diagrams in order to analyze them logically using the Unified Modeling Language (UML) designs. Next, the outputs validated using the expert review technique, and then the prototype of CML model implemented.

5.2 System Analysis and Design

Modeling the CML Prototype requires the analysis of application requirements by drawing diagrams that help in designing the intended model. The famous tool that can describe the whole system functions and tell their scenario is the Unified Modeling Language (UML). UML is a graphical language that visualizes, specifies constructs and documents the objects of a software-intensive system. In this study, the UML diagrams were drawn using Violet software ("Violet UML Editor," n.d.). This section involves the UML diagrams which illustrate drawing of the use case diagram, Activity diagram and class diagrams which represent the essential figures for modeling the CML prototype.

5.2.1 Use Case Diagram

The method that shows the main scenario of the CML design is the Use Case diagram which illustrates the system actors, functionalities and their interactions. Besides, it describes each connected user with the system in some way to clarify his job. Use Case

diagram defines the requirements of model system from one or more users' perspective (Almutairi et al., 2013). The main target of the use case diagram is to understand the designed processes in which the model undergoes and recognize model's functionalities. The Use Case diagram of CML model consists of three actors including: lecturer and group admin, in addition to student who represents the rest group members. This case is the formal method to gather and indicate the interactions between the various types of users in this design. The Use Case differentiates what tasks that can be done by the system, not how the system does it. As well as, it refers to the task that can be performed by the system while the actors refer to the persons who deal with this system and can initiate some tasks in it. Figure 5.1 illustrates the CML Use Case Diagram.

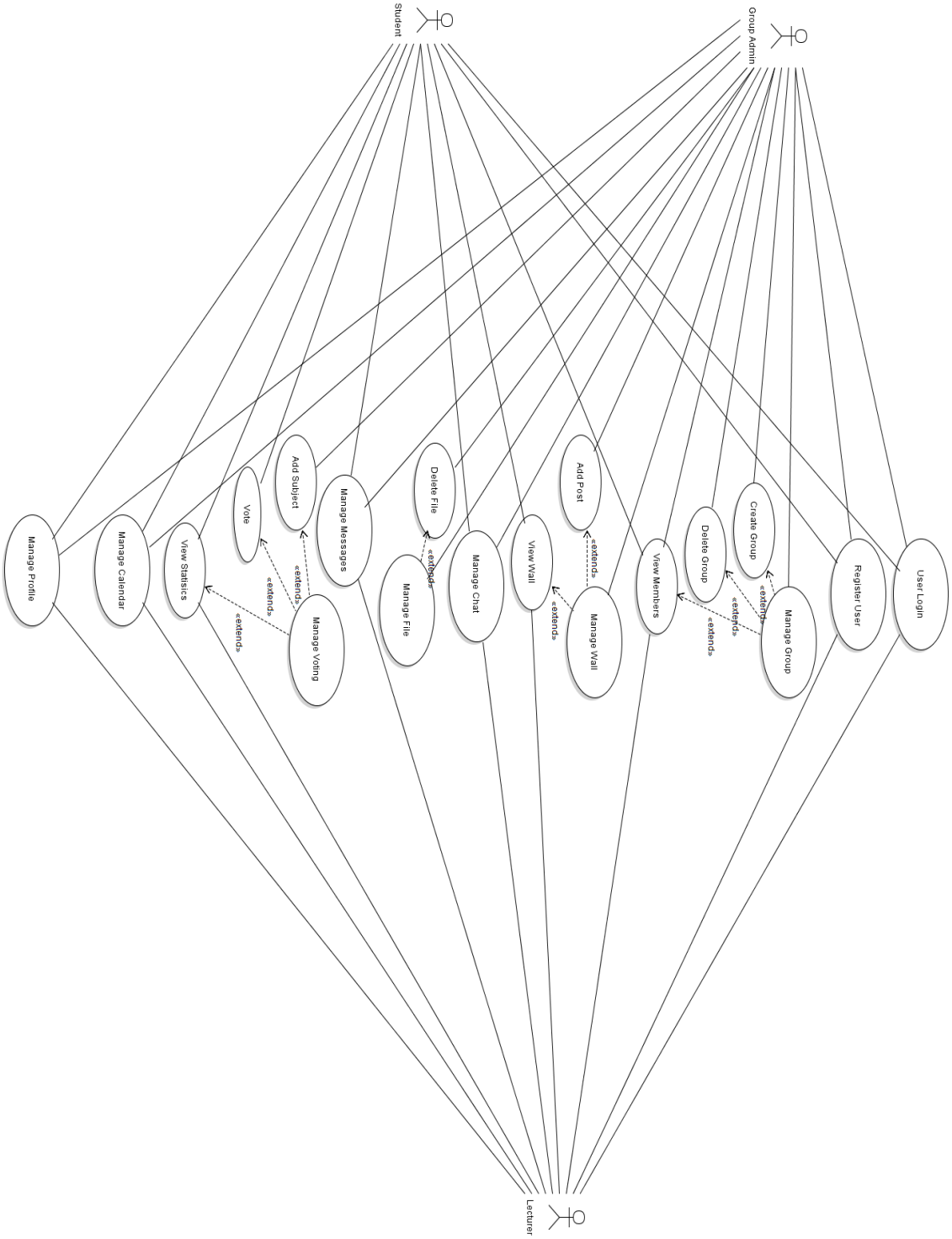

Figure 5.1: Use Case Diagram for CML Model

According to the aforementioned Use Case diagram, the system involves the two main components represented by the Actors and the Use Cases. The actors refer to the lecturer, group admin, and the students. The lecturer has some different functions that distinguish his jobs from students' users. The group admin is the actor who can manage the group (e.g. create, delete and add subject) as well as viewing the group information. The students or group members have some functions with least authorities.

The study assumes the lecturer to be the responsible user for assigning the group's admin by managing most options that are related to manage and feedback all groups as well as every member in one class. Regarding the group admin, his unique job is the group administration within one group boundary so that he has the authority as the students' leader to initiate most activities for one group; the whole activities illustrated in detail in the next UML Activity diagrams. The third actor in the CML Use Case diagram is the student who represents the rest users in the system that they form the actual groups. Instructor, admin group and student have to log in the system in case they have username and password; otherwise, they have to sign up for a new registration by filling up the information needs to be a ready user then to log in the system.

5.2.2 Activity Diagrams

The logical sequence of actions in the CML model is represented by the UML Activity diagrams considered to be among the important schemes in UML designs. Furthermore, an Activity diagram shows parallel and alternative behaviors and a way that can document the system work. In requirements engineering, Activity diagram is a very common approach so that it can be used to model a big and complex processes design to show the logical operations that would not conflict with its work (Syriani & Ergin, 2012).

The concept of Activity diagrams involves series of objects that explain the system states and the connections among them, including the users' responsibilities. In the CML model, the Activity diagrams indicate the system's movements including the various users' activities directed by each one within his job. Next, the system functions separated one by one in detail as Activity diagrams.

5.2.2.1 User Registration

The registration operation is one of the system conditions to log in according to the workflow that allows unregistered user to be one of the system's components. The registration process starts with choosing sign up selection to view the places of filling the new user's information and then filling all mandatory fields to complete the task of users' registration. Regarding the information required for the registration, it includes first name, last name and password on condition of choosing one of users' types, i.e. to be either a lecturer or a student as they are the main classifications of the system's user. Logically, after filling all fields completely, the next step is the first verification that has to be done; and then the system checks the second status of matching the password to ensure whether the password spelling is correct or not. Lastly, the system gives a notification that the registration operation was successfully done after completing the two verifications in this task. The following Figure 5.2 illustrates the user registration Activity diagram and its states.

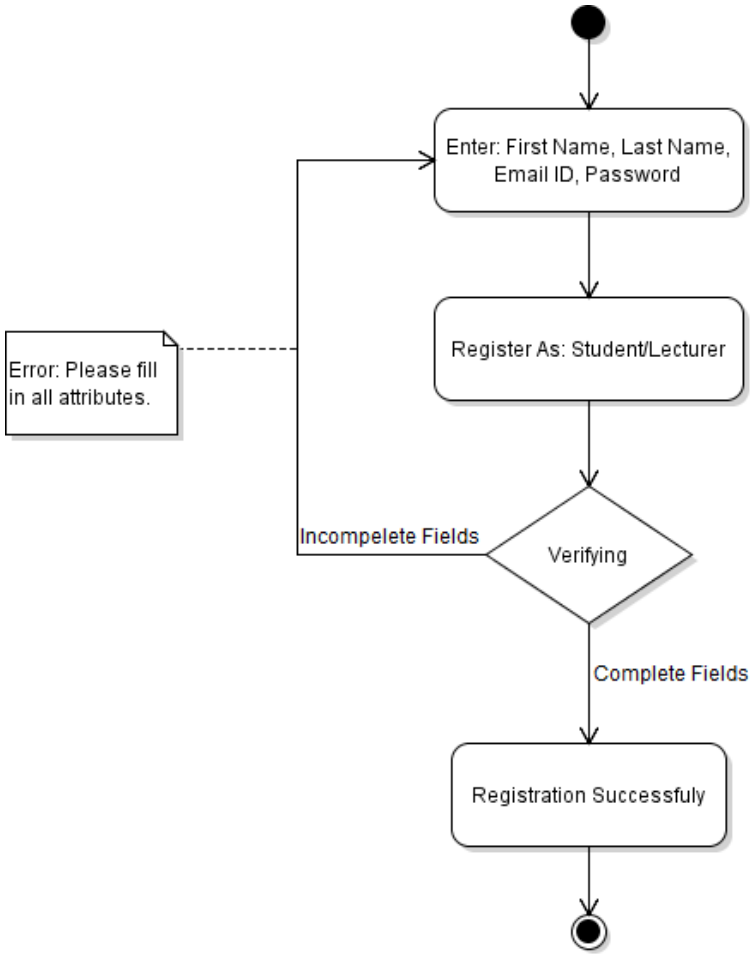

Figure 5.2: Register User Activity Diagram for CML Model

5.2.2.2 User Log In

The sequencing process that allows a registered user to enter the system is the user login. It begins with filling up the user's information including the user's email ID and password that have been chosen in the task of signing up. Email ID represents a unique name that cannot be repeated by any other user and similarly the password should be different from other users' passwords. Moreover, the user's type must be selected to determine whether the intended login user is a lecturer or a student. Then, the next action

is to search for the entered user's information in the system's database in order to match the user's information and allow the user to log in the system if the information is matched. After applying all conditions correctly, the system will confirm the login task successfully. Basically, activity diagram was used for modeling a big activity's sequential workflow by focusing on action sequences and respective action initiating conditions. It is related to processes flow plans (flowcharts) and used to illustrate activities of the app. The Activity diagram of the current model is presented in Figure 5.3 as follows:

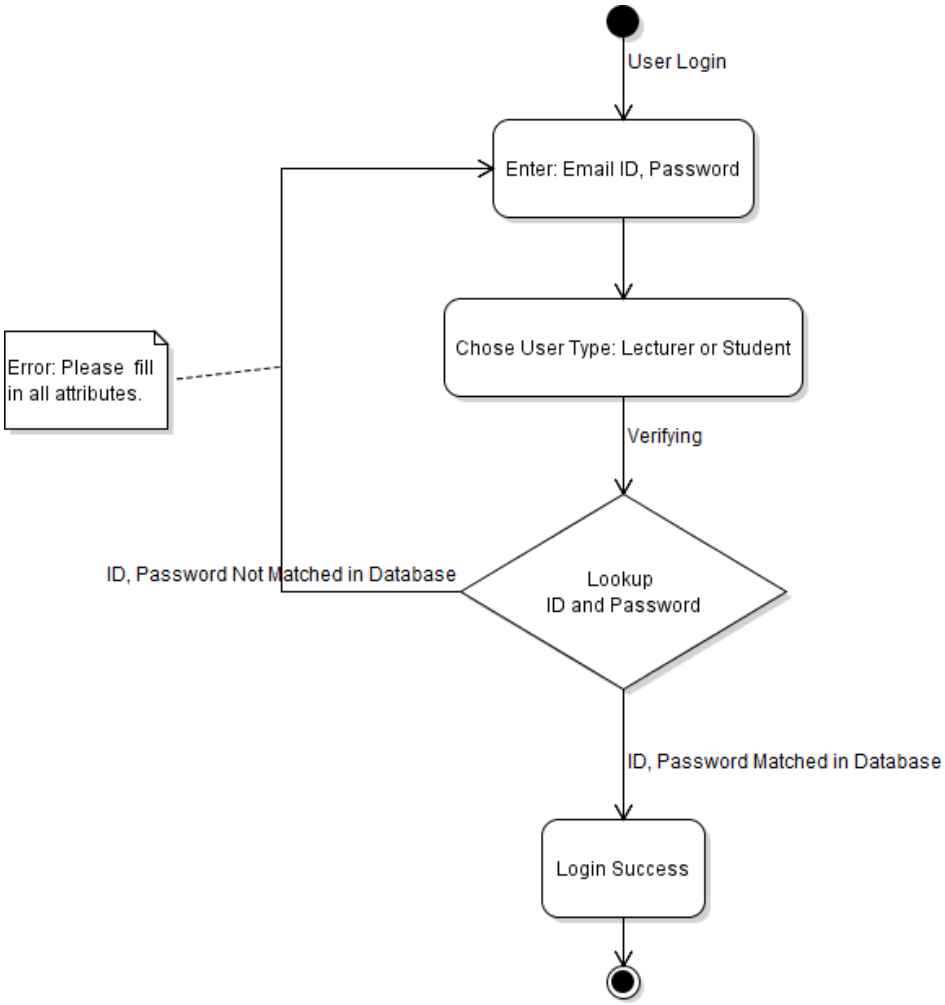

Figure 5.3: Log In Activity Diagram for CML Model

5.2.2.3 Manage Group

Group management is the main gate for the rest functions because most of the functions depend on the group formation first. The UML Activity diagram illustrates the logic work for the users' type about creating a new group or going to view group members' names. Consistent with Figure 5.4, the first procedure is to verify whether the groups' admins were assigned by the lecturer or not, that is because the lecturer is responsible for selecting the groups' admins. Then, the user's type will be verified also since there are three user's types deal with the system after assigning the groups' admins, they are: the lecturer, group admin or normal group member. As for the admin, the issue is unique so that he can create group in case that there is no group as well as having two functions which are either to view the group members or delete group after its creation. Secondly, if he is a student as group member, then he will go directly to the function of viewing group members. If the entered user is the lecturer, then he should choose the group name firstly then go to enter a certain group, since a lecturer may have more than one group in one class.

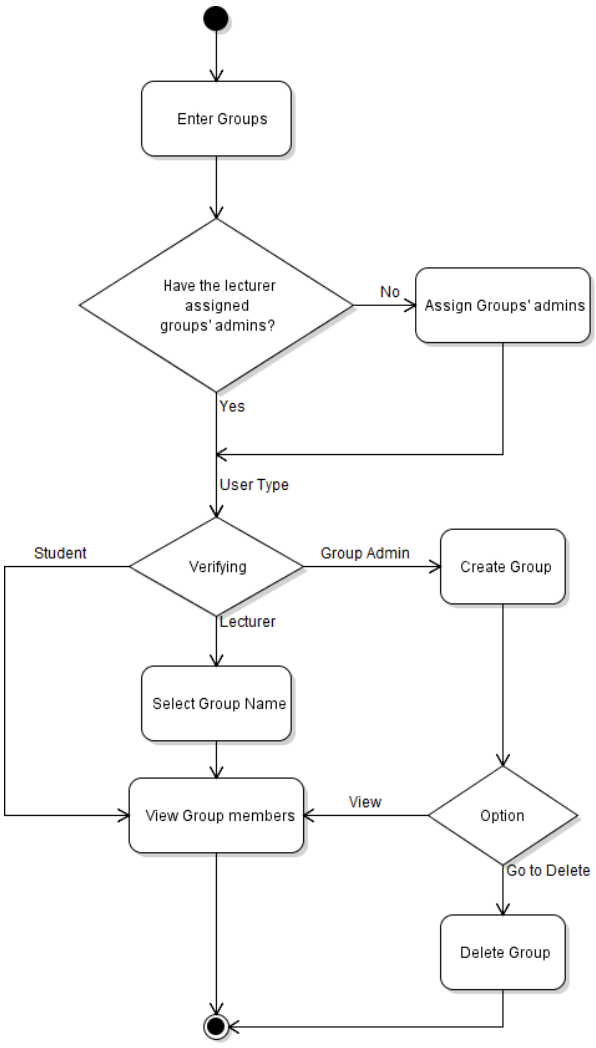

Figure 5.4: Manage Group Activity Diagram for CML Model

5.2.2.4 Manage Wall

Group announcement requires a place to inform the group members about every new group task, a new event or a new subject. The announcement designed as a post will be visible to all group members including the lecturer to view the latest group news. Exclusively, the group's admin is responsible for making the whole wall post. Each post has uncountable comment lines giving the group members a chance to comment. Also, the lecturer can be one of the commenters whose comment can be utilized as feedback for

the group. Logically, the group admin and the rest members would have to go directly to enter their group wall; however, the lecturer has to choose the group name before entering the group wall and then go to view or comment on the posts. This is attributed to one lecturer who has many groups in one class. The next Figure 5.5 shows the manage wall Activity Diagram and its states.

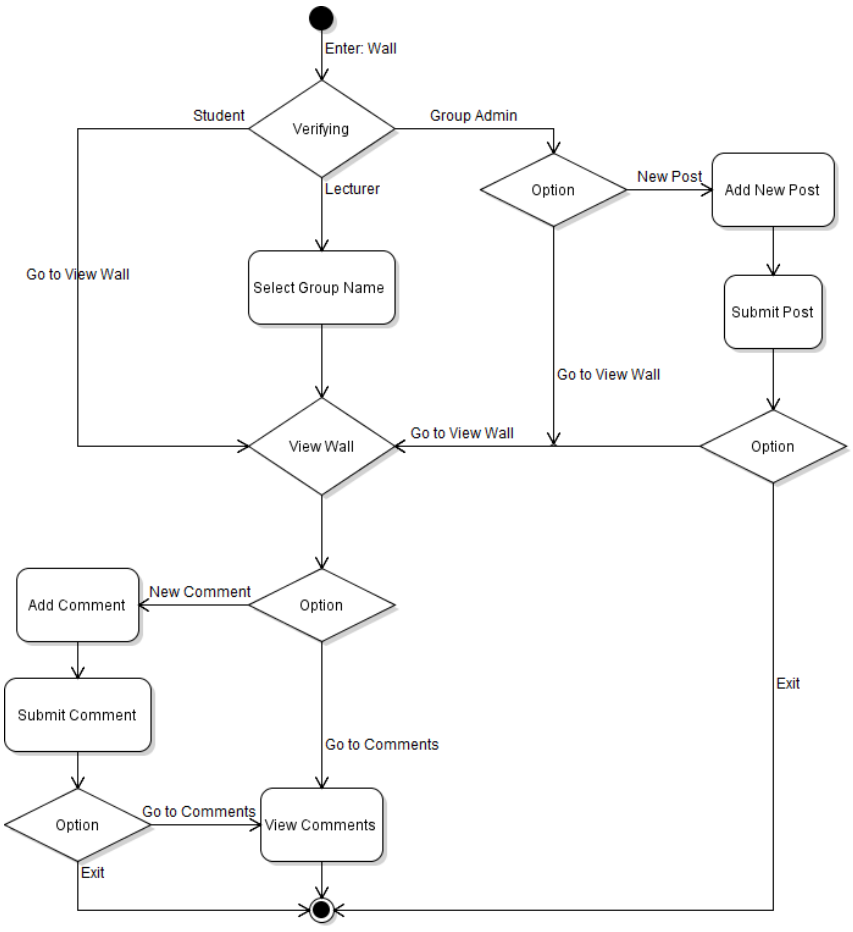

Figure 5.5: Manage Wall Activity Diagram for CML Model

5.2.2.5 Manage Chat

The chat Activity Diagram presents the essential feature of using the Collaborative Learning in mobile technology. It describes the interaction among all group members including their admin and lecturer. According to Figure 5.6, the system will check the entered user whether he is the lecturer or group member representing the two main users' categories; the difference between them lies in the procedure that enables the lecturer to choose the group name before going to the conversation in the chat interface. However, the group members (including the group admin) can go directly to view the chat interface since there is no limitation or action before entering the group chat. The next state is chatting using text among two or more members in addition to their lecturer. Another feature is file sharing that would be for sharing various types of files utilizing many resources (e.g. internal device files and cloud source files) then sending these files to group members. Last but not least, the authorizations of chat function equally for all, then they can access the sent file to view and further options according to the file type features.

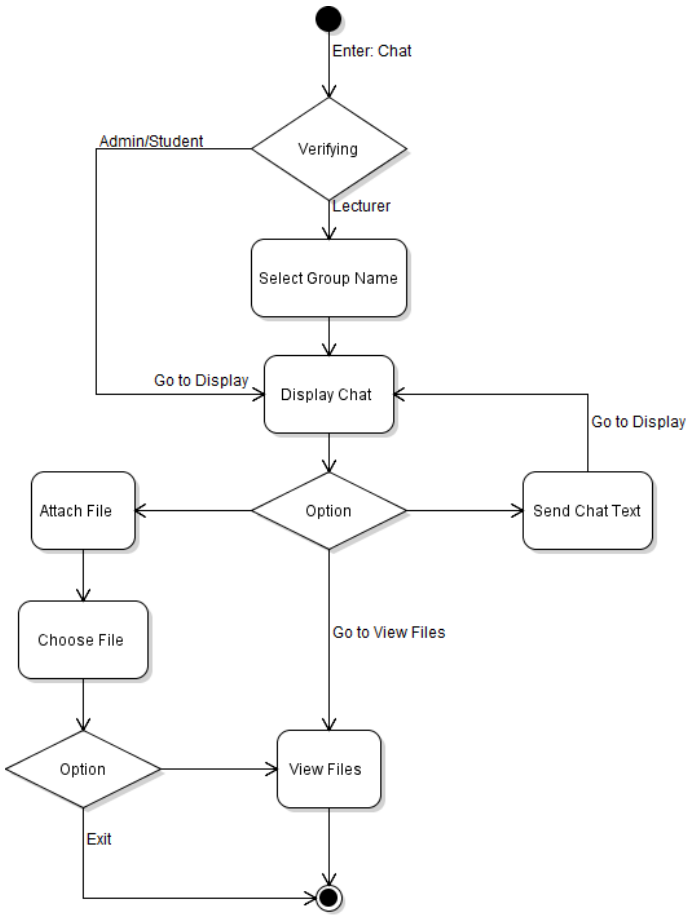

Figure 5.6: Manage Chat Activity Diagram for CML Model

5.2.2.6 Manage Files

Activity diagram of the CML model begins with verifying the user type since the major two files opinions are to delete files or view them. Here, the verifying operation is to determine the user so that each one has a different authority except for viewing files. Regarding the lecturer, he has to choose the group name firstly before going to view files. However, as a general feature for all, view files function would be used by all users by

condition of selecting and opening only one file. Then, the system will respond by displaying the selected file content. Exclusively, the group admin has the files delete option, in that regard the group admin must choose the unnecessary file to submit the deletion process.

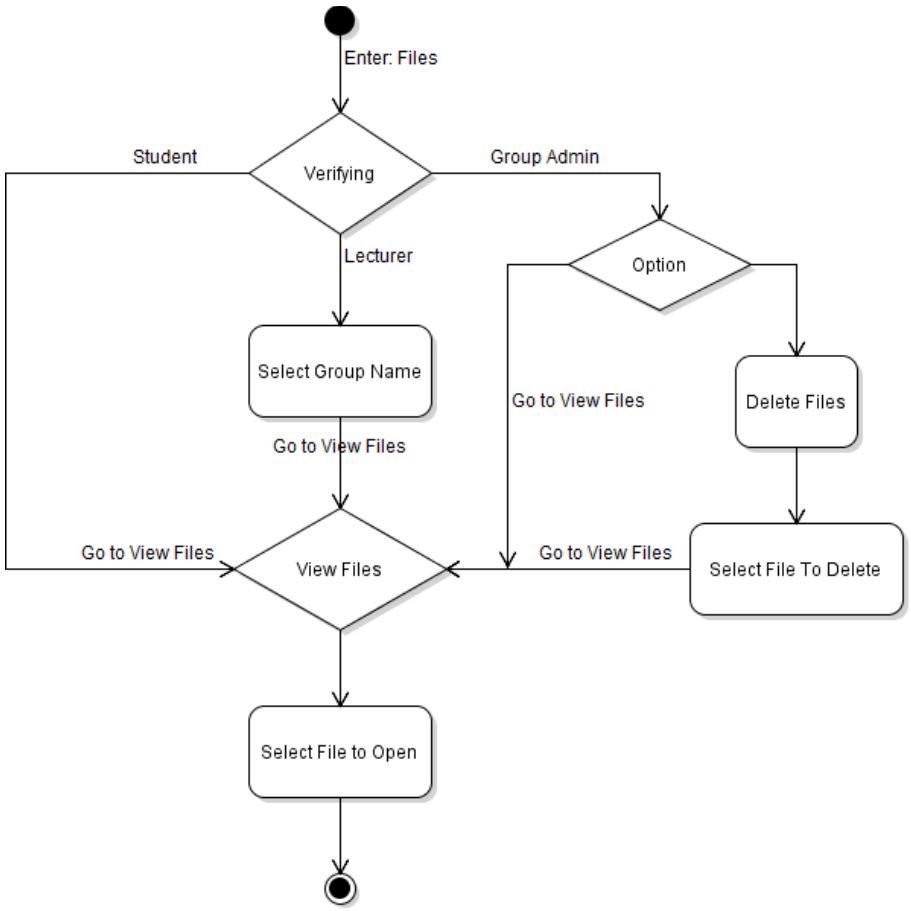

Figure 5.7: Manage Files Activity Diagram for CML Model

5.2.2.7 Manage Messages

The single message between two members is one of the CML functions as a private communication. According to Figure 5.8, all users have the same preliminary step. The user has two options; firstly, he can send a message including writing the message contents and then select the send message function. On the other hand, the user can view the message by selecting the function of view message then selecting the message name and sender to open the message.

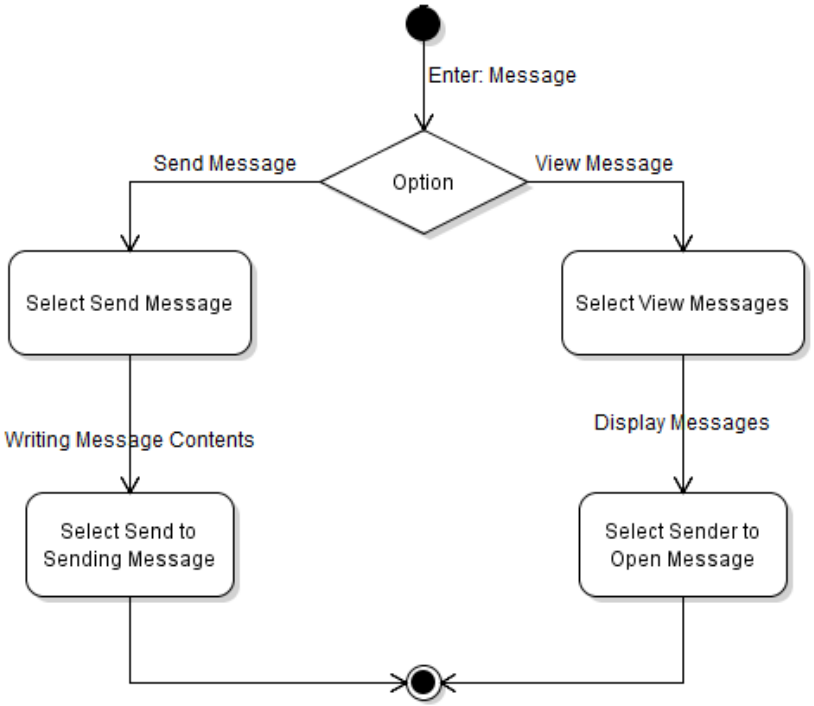

Figure 5.8: Manage Messages Activity Diagram for CML Model

5.2.2.8 Manage Profile

Edit users' profile is a function that presents the possibility of updating the existing user's information. Equally, all users can edit their information, for instance, they can change their first name, last name and password. referring to Figure 5.9, entering this function begin with selecting profile button to display the user's information that is intended to be modified, editing the user's information, and then selecting update function in order to save the new changes.

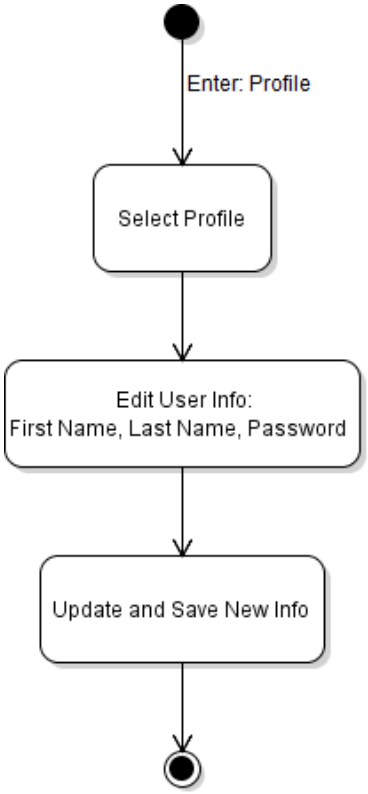

Figure 5.9: Manage Profile Activity Diagram for CML Model

5.2.2.9 Class Diagram

Figure 5.10 represents the class diagram for the CML model. The class diagram gives an overview as static model of the objective application. The diagram outlines the main classes and describes their names, attributes and operations. Additionally, class diagram clarifies the relationship between the objects inside the CML model. It provides a wide assortment of uses, for example, displaying the information structure and points of interest outline of the objective application. The Figure 5.10 demonstrates the classes of application and the relationship between them.

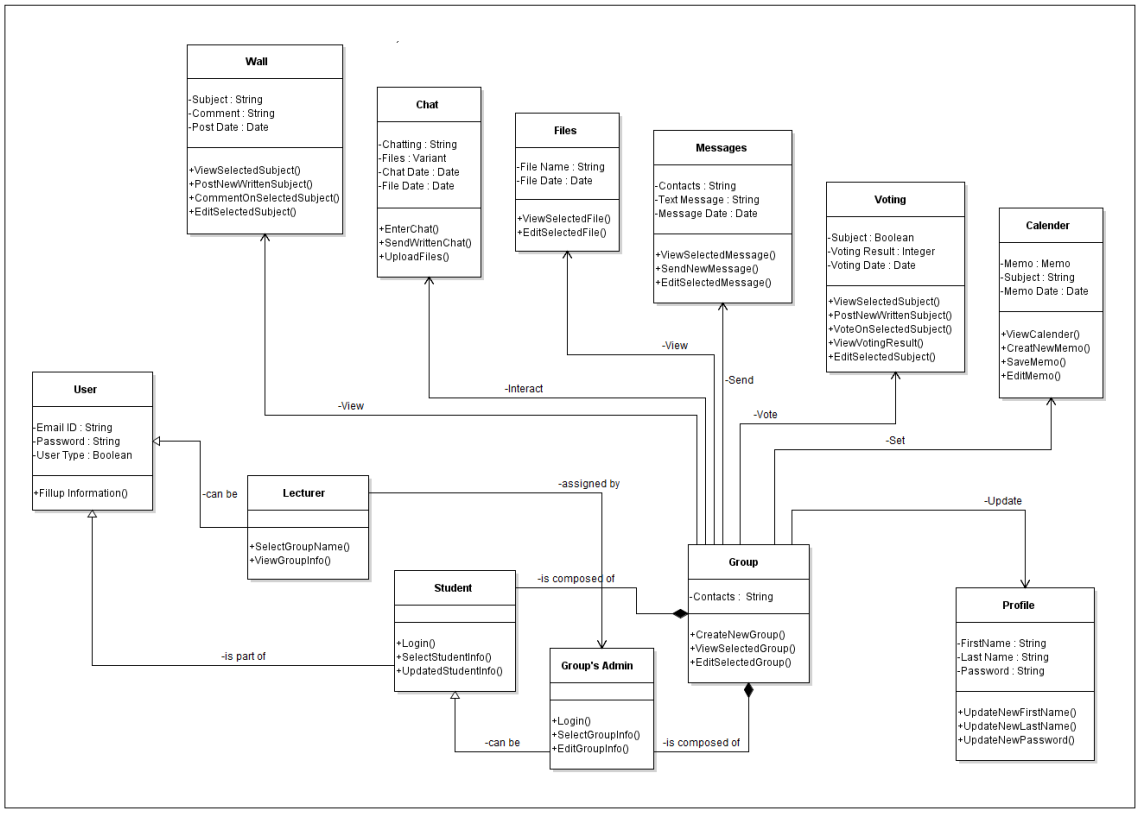

Figure 5.10: Class Diagram for CML Model

The contents of the CML Class diagram include the end functionalities, which have been analyzed through the Use Case and Activity Diagrams. The purpose of the Class diagram is to know the classes', their types, and their properties, as well as, to clarify the correlations between classes so that each class represents its functionality according to the designed map that puts it. Beginning with the model scenario, the User class represents the main class of the sub-classes, such as the Student, Lecturer, and Admin classes, which are belong to the User class. All classes contain information that indicates its attributes and behavior. The main class that connects all the other classes is Group. Through it, all classes can reach all functions. Accordingly, Group class has different relationship with the functionalities' classes.

Referring to Figure 5.10, the main relationship between Group and Wall classes is to view the contents in Wall as it is the notification area for the application. Meanwhile, the association of the Group class is to interact with the Chat class. The Files class indicates the process of file management, and the view association is the relation with Group class. Thus, Messages class consists of messages' management, and the major association with the Group class is to send messages between different users. Next, the Voting class includes information about the voting function attributes as logical components. The basic relationship from Group class is to vote for this class. The neighboring class is Calendar, which is responsible to work on time schedules. Therefore, the association from Group class is to set an event or memo that can be individually done by any user. Lastly, is the Profile class, which stores information about users that could always be updated. The updated words represent the essential association with the Group class.

5.3 Expert Review

Aiming to validate the CML designs, four UML experts revised the CML model and UML designs. The expert review used to help the developer concerning the aforementioned UML diagrams as the logical design; as well, to ensure that the model of CML adjusted to its specifications and each requirement is available in the right amount. According to Paavilainen, Korhonen, and Saarenpää (2011), the expert review method is widely adopted as a usability assessment method for evaluating such educational model. The experts are lecturers in College of Arts and Sciences, Universiti Utara Malaysia (UUM). In addition, they are specialists in the field of software engineering. During the assessment, the CML model and UML diagrams were displayed to them one by one. With their prior expertise, they fed back valuable comments and clarifications. Table 5.1 details the experts' recommendations for improvement upon the three diagrams.

Table 5.1

Expert Review and Recommendations

Experts No.	Use-Case Diagram	Activity Diagrams	Class Diagram
E1	Remove the Logout case since it is not functionality.	In User Login, decision nodes need more clarifications.	Attribute Date missing in Messages class. Then, need to mention.
E2	User Login's case needs to correct to be after User Registration's case.	Remove Save Info's activity of Register User's diagram.	Remove some repetitions of the Lecturer and Student's classes.

E3	Update “extend” of Chat and Messages cases to be only single cases.	Remove transitions in Register User’s diagrams	Remove database and controller classes since they out of the scope.
E4	Correct User Login’s case as it not “include” association.	Need to reflect the Use Case names and correct some text mistakes.	Update the classes’ names according the Use Case corrections.

Consequently, the UML diagrams of the CML model corrected and adopted to be the base for the CML prototype development in the next stage.

5.4 Prototype Development

In this phase, the prototype approach was used to develop the proposed model. The CML requirements as functionalities and non-functionalities issues were determined to be the foundation of implementing the CML prototype. The model was successfully and completely implemented including all the model requirements. Java Development Tools (JDT) including JCreatore and Java Server Pages (JSP) were utilized to build server system with Tomcat Web server, in addition to MySQL server for the application database to store and retrieve all information. Next, the Android development environment (Android Studio) used for prototype development (see Table 5.2). According to the process of the Rapid Application Development (RAD) method that was determined as methodology for this implementation, the prototype approach includes three stages which incorporate building starting model, demonstrate, and refine as a prototype cycle. Every progression of the prototype approach includes sub steps and

results, the initial step results lead to the following step and so on. Consequently, the second and third steps can be rehashed achieving the model constructing. The prototype is named as CML application representing acronym of the Collaborative Mobile Learning. In detail, the screenshots in the following sub-sections illustrate the samples of the CML user interfaces.

Table 5.2

Prototype Development Requirements

Tool	Description
Rapid Application Development (RAD)	Development Methodology
Android and SDK Java tools	Development Environment
Java Server Pages (JSP)	Java Programming Language
MySQL	Database
Tomcat	Web Server
JCreator Pro	Java Environment
Android 4.4.2 and Windows 7,8,10	Operating System

5.4.1 Logo and Registration Interfaces

Figure 5.11 is the first interface in the CML prototype. It provides information about the application logo that illustrates a group of learners consists of three persons as a minimum number of group members as mentioned earlier in this study for group of

learners. Regarding the name of the application, CML refers to the Collaborative Mobile Learning. The first interface has two buttons; which are sign up and login. These two buttons are used after filling up the Server IP to connect the application with the database that was created in external PC to store and retrieve the application information. Definitely, the new user has to make a new account by the registration task. Figure 5.11 shows the registration steps which is started by filling up the new user's information such as the first name, last name, email and password in addition to choose the type of user whether a user or a lecturer. Next, after providing the required information, sign up button must be tapped to complete the registration task.

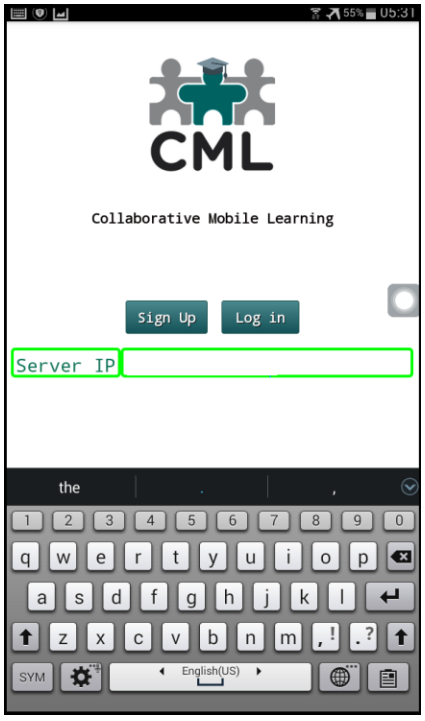

Figure 5.11: Logo interface

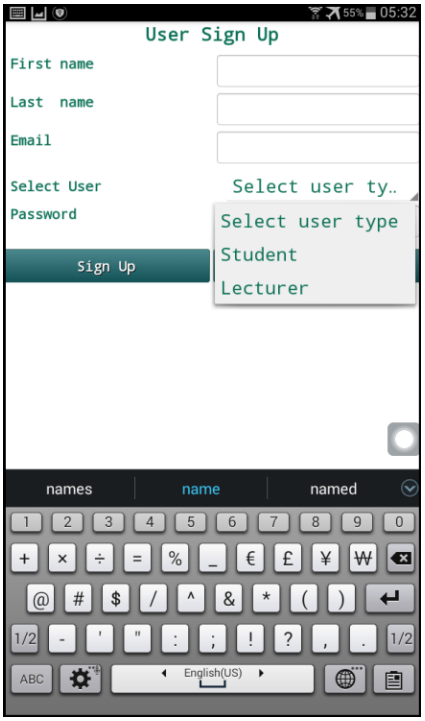

Figure 5.12: User Sign Up interface

5.4.2 Login Interface

The process of user login was described in Figure 5.11. However, after completing the task of signing up and choosing Login button shown in the previous interfaces, the registered user has to fill his/her information in the next interface since s/he cannot login without filling the user's information (see Figure 5.13) including email, password and selecting the user type assigned in the early registration. Then, login button should be tapped to enter the system and view the internal functions after typing the right information as well as selecting the correct user type. The prototype will give login feedback informing whether the entered information is correct or not. In case the user login information is correct and matches the user's information in the database system, the user will log in the CML prototype; otherwise, the user must reenter the correct log in information. Another option in this interface is that the user can clear all login fields when incorrect information is entered by using Clear button.

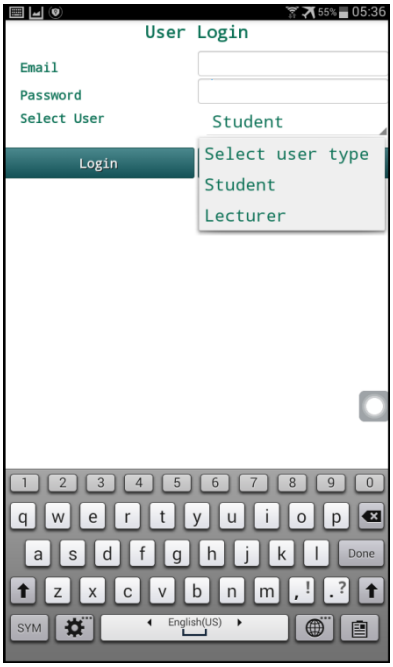

Figure 5.13: User Login interface

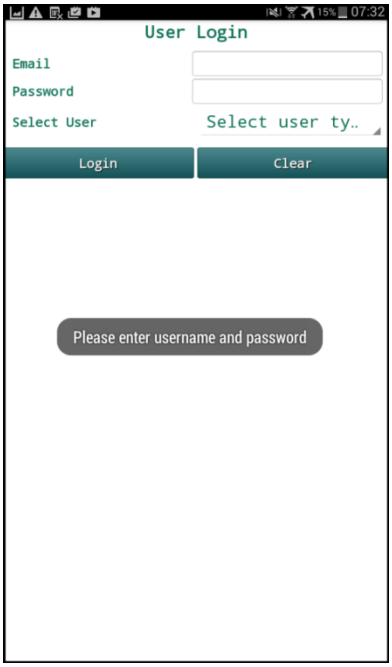

Figure 5.14: Error Login interface

5.4.3 Main Menu

Figure 5.15 shows the main page of the CML application that contains all functions. This interface has nine buttons each one refers to a function that is relevant to enter it. The functions include groups, wall, chat, files, messages, voting, calendar, profile and logout. Typically, the functions have sub-functions or options to manage and conduct their tasks to achieve the intended process.

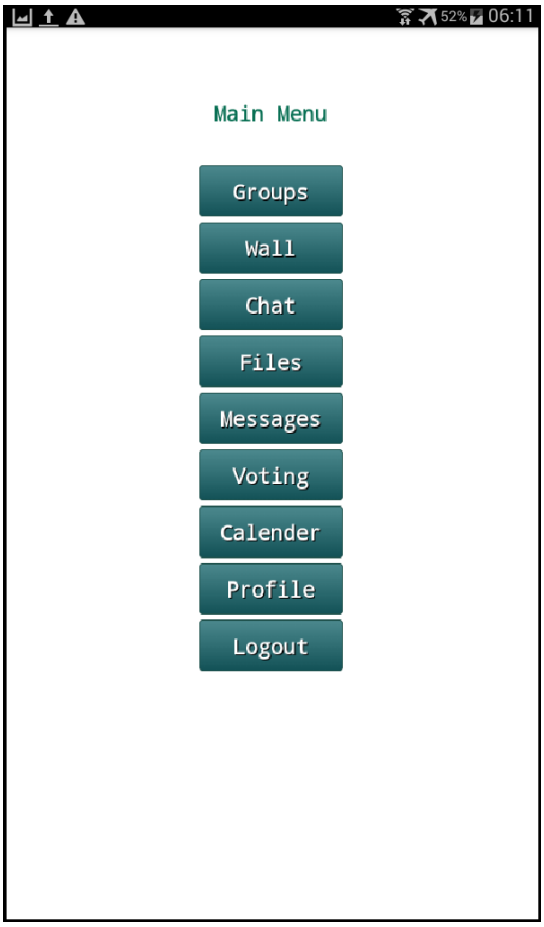

Figure 5.15: Main Menu interface

5.4.4 Manage Group

Basically, the purpose of group's part is to create, delete and view groups and members. Figure 5.16 illustrates the buttons that lead to each function related to groups in order to view its job when the user enters groups department. This interface contains a label explaining the department work as a whole that is "Manage Group" label which simplifies this interface topic. The rest contents are four buttons, including: Create group, Delete Group, View Members and Main Menu. The last button moves the users quickly to the Main Menu, the three rest buttons have various jobs differ from each other. The following sub-sections explain about each function related to the Manage Group interface.

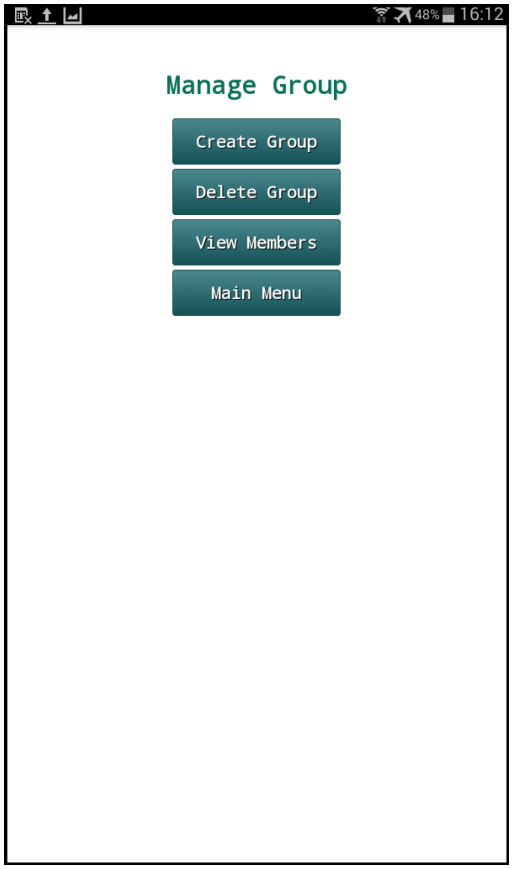

Figure 5.16: Manage Group interface

5.4.4.1 Create Group

The main gate to all functions is the Create Group since the users cannot utilize the rest functions without using this feature by the group admin as the CML prototype basically focuses on the groups of learners. The function of Create Group is relevant to the group admin as the group leader. Thus, after tapping this button, the system will display a new interface as shown in Figure 5.17. Create Group interface contains group name field that should be filled by the group admin and then to select the group members intended to involve in that group. Figure 5.18 shows that the group admin has to use the Create button to form a new group that consists of 3-6 users as limitation which was mentioned earlier in this study. Following, two options are provided including Create button to complete the process and Back button to cancel the group creation.

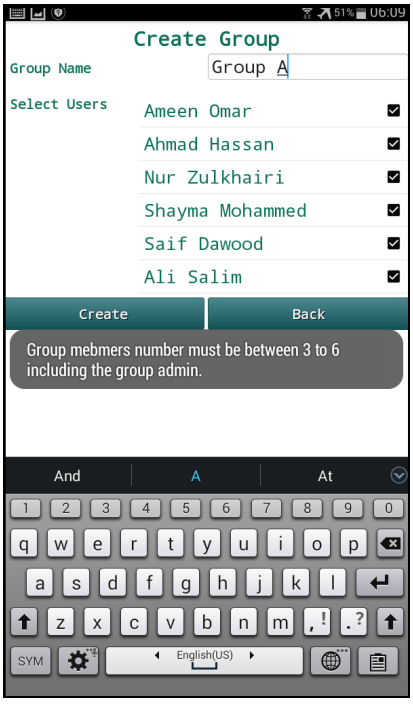

Figure 5.17: Create Group Limitation

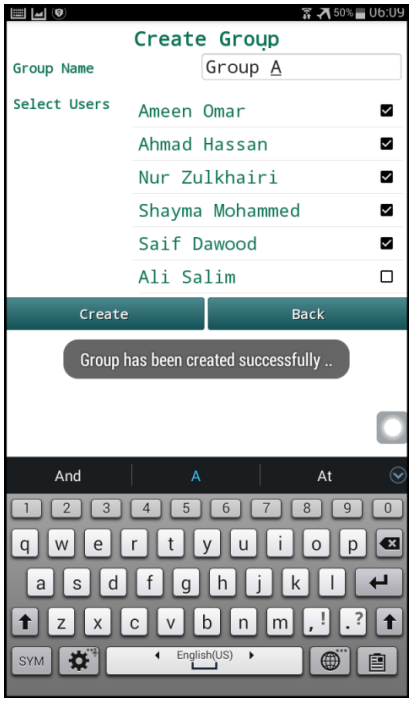

Figure 5.18: Create Group Successfully

5.4.4.2 Delete Group

Figures 5.19 and 5.20 describe the group deletion process. The group can be deleted after its creation for many reasons. However, the unique user who is responsible for this option is the group admin. The functionality of deletion starts with choosing Delete Group button (see Figure 5.16). In Figure 5.19, the interface shows the confirmation process for deleting the existing group by giving the group name to select it in order to complete this job. After group creation, Figure 5.20 shows that Delete Group button is transformed to red color which means it becomes inactive for the rest users including lecturer while it is active for the group admin only. Additional button is offered for returning the user to the main menu.

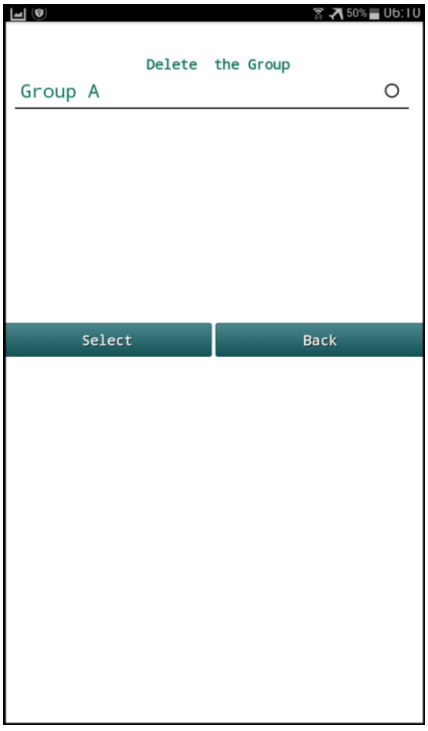

Figure 5.19: Delete Group conformation

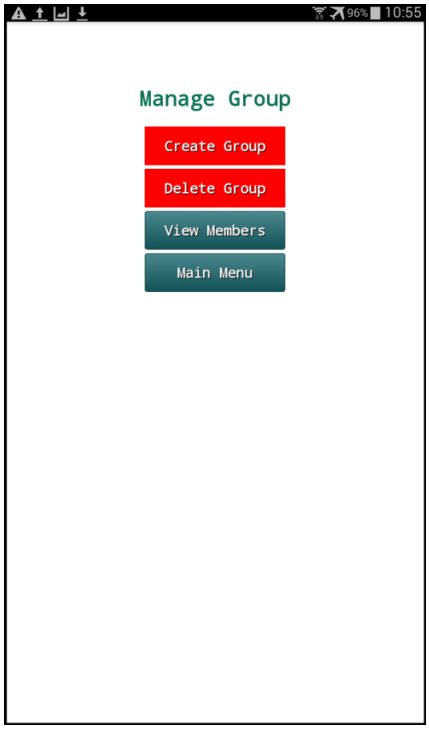

Figure 5.20: Delete Group inactivation

5.4.4.3 View Members

The third main function of manage group is the View Members function (see Figure 5.20). This function allows all users in each group to view the group members by displaying their group members' names. Figure 5.21 illustrates the Group Members' interface that is displayed after tapping the View Members button. Nonetheless, the lecturer has further options. One of them is to view all the groups' members, but group by group, since one lecturer may have many groups. Figure 5.22 explains the lecturer's choices when s/he taps the View Group Members button and then to view the chosen group name. Furthermore, there is one more button in the group Members' interface that is Back which is used for returning to the Main Menu.

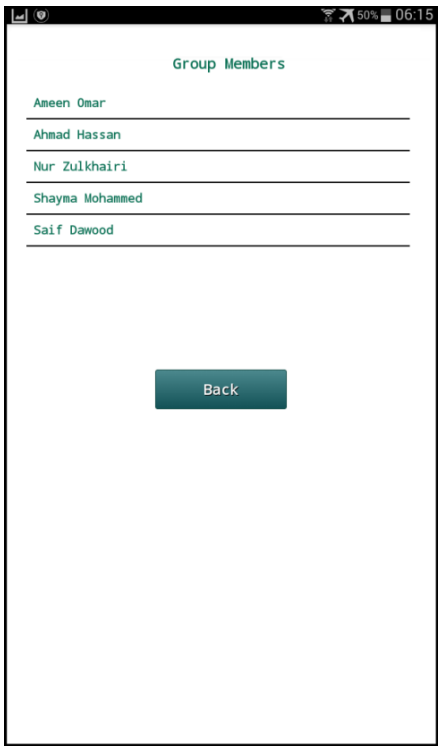

Figure 5.21: View Group Members

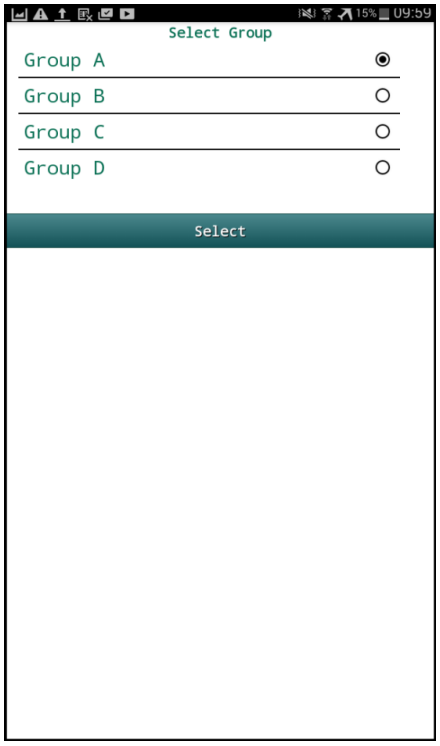

Figure 5.22: Select Group Name

5.4.5 Manage Wall

The second main function is managing the Wall. As shown in Figure 5.23, this function has three buttons which are Add Post, View Wall and Main Menu. The Wall function represents the notification area characterized by Wall department in the Manage Wall interface. Simply, the Wall function consists of posts and their replies. The post is a collection of words informing about certain subject in order to notify the group members. The wall post must be done by the group admin who is the exclusive user who can post the group wall subjects. The group members and lecturer would provide comments as replies on each post, they can view all group wall subjects to comment on them as well as viewing all comments related to those subjects. Figure 5.24 shows some posts and their options.

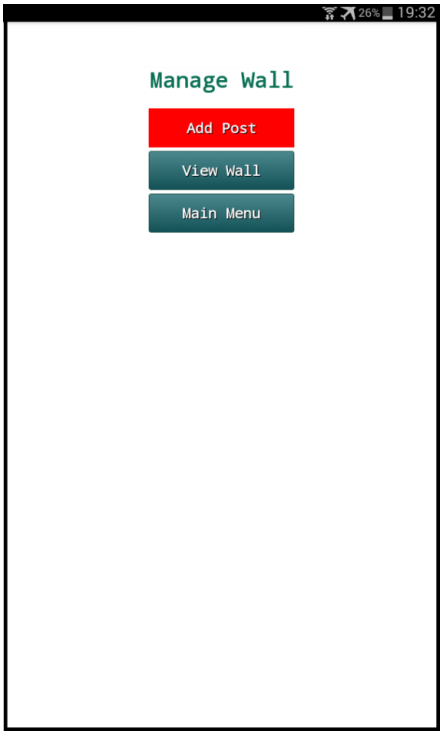

Figure 5.23: Manage Wall

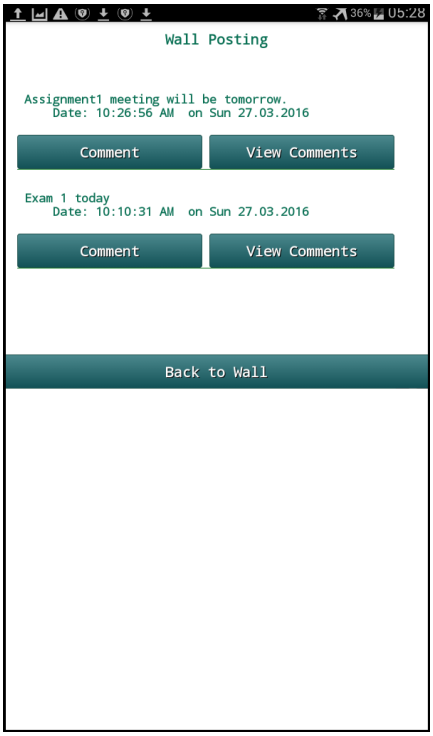

Figure 5.24: View Wall

5.4.6 Chatting and Sharing Files

This is the online chatting department of the CML prototype for the groups. Equally, all members have the possibility of sending a text chat that appears to all members in one place and one group only. Figure 5.25 illustrates the chatting interface including the display chat area and four buttons which are Send, Attach, View Files and Back. View Files button represents one of the Files functions which is related to the next main functions in the Main Menu. Orderly, Send button functions to send the text chat in order to display the typed text on the chat area and Attach button is used to open a place that contains files (see Figure 5.26). This feature deals with many file types and various sources, after that one file is selected to be attached and sent to the files department (next function) that can be accessed by View Files button. Additionally, there is one more button named as Back used for returning to the Main Menu.

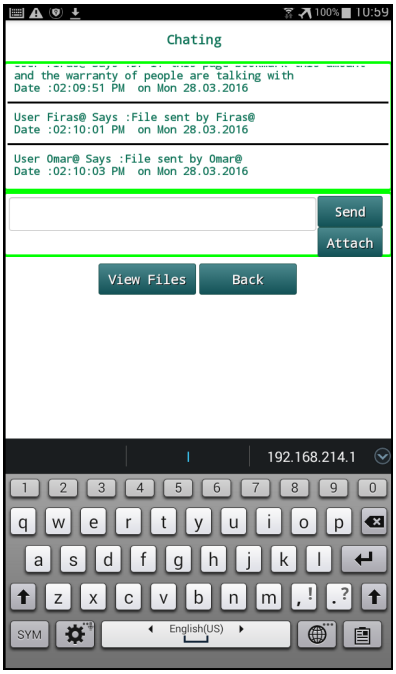

Figure 5.25: Manage Chat

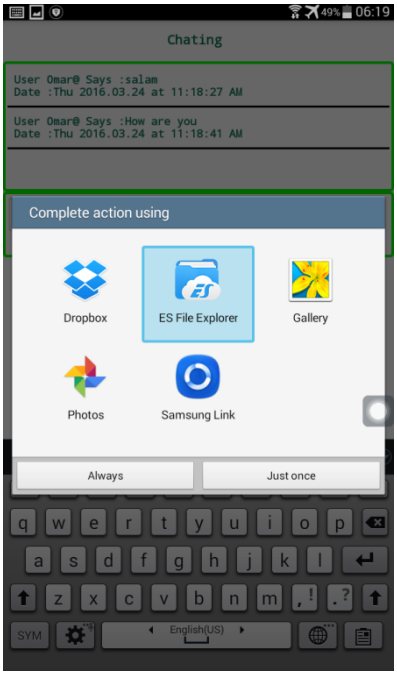

Figure 5.26: Attach and Select File

5.4.7 Manage Files

The unit that represents the store area for group is the Manage Files function. Figure 5.27 shows the Manage Files interface that has three buttons, firstly the Delete Files button which is related to the group admin. This button resembles some actions designed only for the group admin and it is used to delete file. Secondly, the function used in the chat section is the View Files, it has a shortcut button in the Chat function. The last button in this interface as its name refers to move quickly to the Main Menu. After tapping the Delete files or View Files, the next interface has similar design. Figure 5.28 illustrates Select the File interface which displays the group files to be opened or deleted after choosing the desired function. Moreover, there are two more buttons in the group in the Select File interface that is Back to Files which means going to Files function and the Chat button which moves to the Chat function.

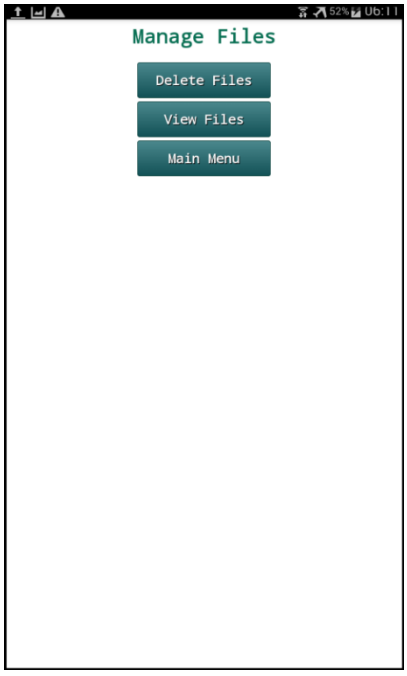

Figure 5.27: Manage Files interface

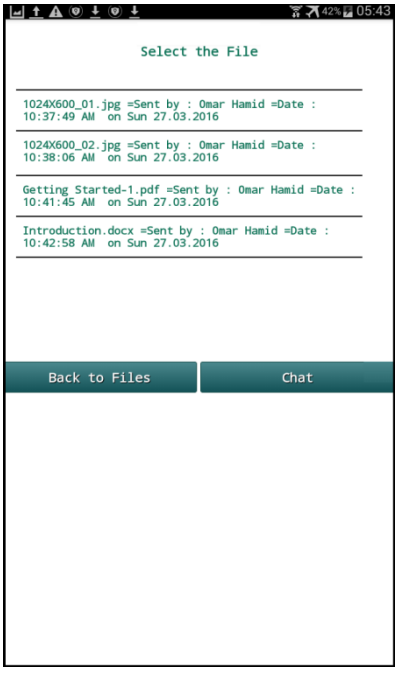

Figure 5.28: View/Delete Select File interface

5.4.8 Manage Message

In the CML prototype, the Messages function is one of the functionalities topics. All users in the group including the lecturer can send a message as a private connection between two users. Figure 5.29 indicates the Manage Message interface. It has three major buttons which deal with the CML prototype message; they are Send Message, View Messages and Main Menu. Regarding the first button, when the user taps the button of Send Message, new interface will open and display the message form that consists of some fields similar to normal message manner. The new interface is called Send Message that guides the user to prepare the message content in order to send it. Referring to Figure 5.30, the user should fill all the fields, namely the name of receiver, subject and message text, and then choose send button to send the message. Next, the prototype gives hint text indicating that the message has been successfully sent on condition that all content messages were written correctly (see Figure 5.31).

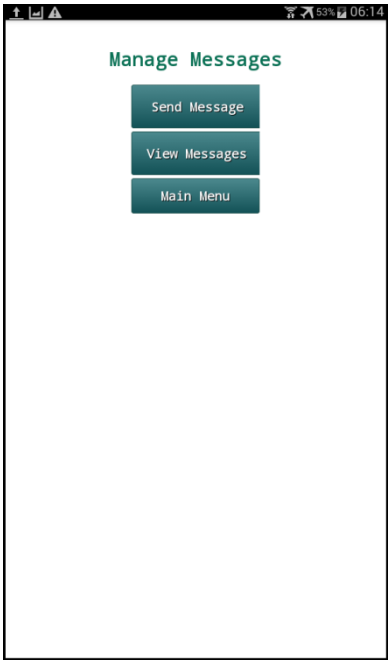

Figure 5.29: Manage Message Interface

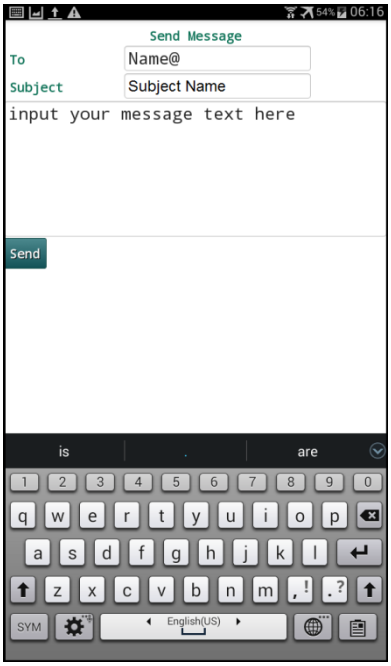

Figure 5.30: Send Message Interface

On the other side, Figure 5.32 shows how the receiver can view the message name and from whom. The View Message interface contains the sender name and the message topic. Thus, one tap on this information will open the message and show its contents. In the CML prototype, the Messages function is one of the functionalities points. Similarly, every user in the group including the lecturer can communicate other group members as a private message between two group members even their lecturer. Also, in Figure 5.32, the Back to Message button can return the user to the Message Function as a shortcut button.

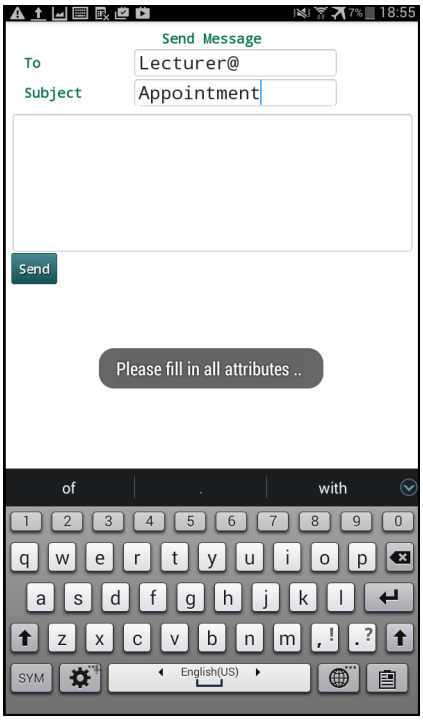

Figure 5.31: Incorrect Message Interface

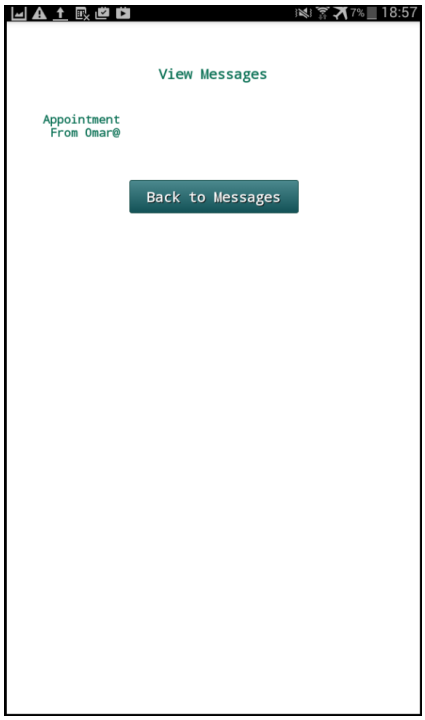

Figure 5.32: View Message Interface

5.4.9 Manage Voting

As a sixth main function, this is the voting function in the CML prototype. Regarding its function, it is used to make a right decision by the group members. In this function, all group members will collaborate to choose an option that refers to certain subject, problem or decision to decide the best solution from some options. As shown in Figure 5.33, it describes the contents of Voting interface that has four buttons, including: Add Subject, Vote, View statistics and Main Menu. The first button is related to the group admin who is the only eligible user to make a new voting subject. So, a new interface will open to the group admin to write and post the voting subject and its options to choose one of them. As well, the Add Subject interface displays some instructions that guide the group admin to make the subject correctly (see Figure 5.34). Also, two buttons available for the group admin only, they are Submit button for the subject submission and Back button as back tab button.

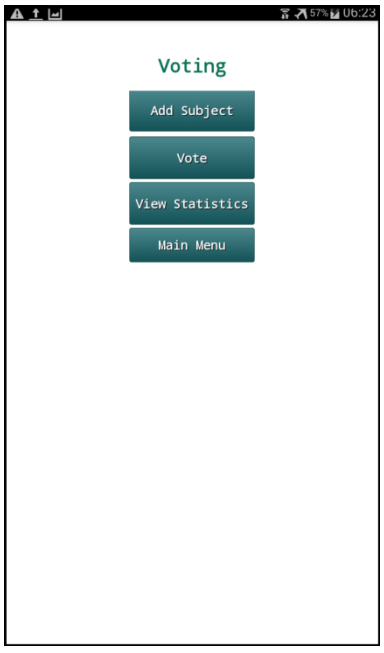

Figure 5.33: Voting Interface

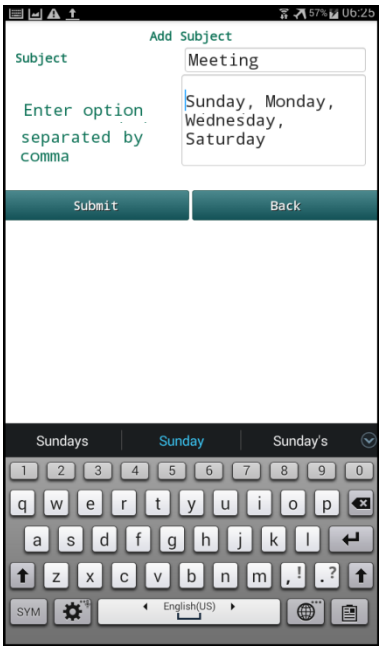

Figure 5.34: Add Subject Interface

Next, the Vote button is for voting answers by the group members so that group members can view list of voting subjects and then open one by one to display the voting subject content. Following, Figure 5.35 explains the voting options after opening a subject of voting, the subject content is the Voting Topic interface that holds the name of the subject and its options. The responsibility of the group member here is to choose one option from many options maybe, then tapping the Select button to complete the voting task. According to the design constraints, the Select button can be used one time only like the vote action which is used one time only. Figure 5.36 clarifies the Voting Statistics interface after group members voted and the voting results that will be available for all group members and their lecturer can be viewed to realize the outcomes. The Voting Statistics interface presents each selected option with the estimation number of users who chose it. Furthermore, the last button in this function is the Back to Voting that returns the user to the interface of managing voting as the home of Voting function.

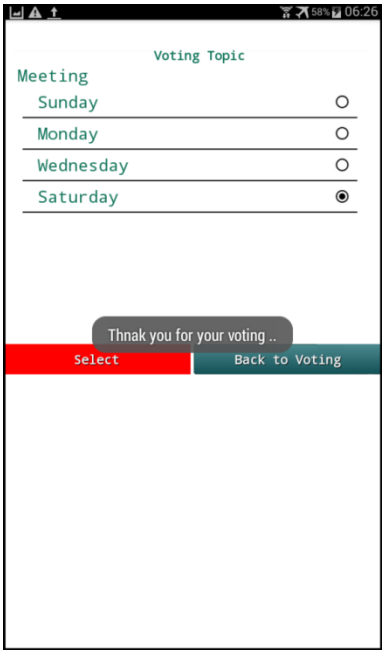

Figure 5.35: Voting Topic Interface

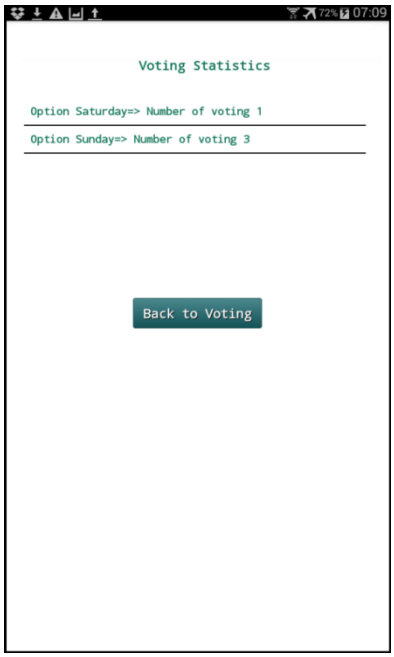

Figure 5.36: Voting Statistics Interface

5.4.10 Calendar

This function is provided for all users to set a calendar memo. Figure 5.37 shows how this function works and its details. Originally, this function is one of the Android system functions that belong to the device operating system. The Calendar function is one of the CML model requirements, it is used to control and arrange the user's time. Choosing the Calendar button in the CML prototype will move the user to the actual phone system calendar in order to set certain subject in addition to edit its options as the user desires.

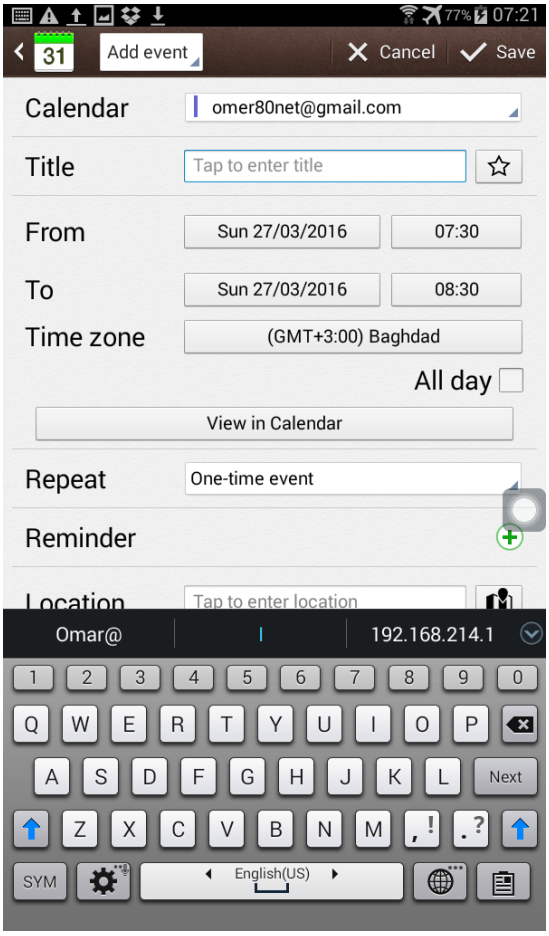

Figure 5.37: Calendar Interface

5.4.11 Manage Profile

The last function in the CML prototype is the Profile button. The changes on the user's information can be viewed by tapping the Profile button to display and edit the user's information. Figure 5.38 shows the User Info interface and its contents. The user's information that can be changed is the first name, last name and password. The figure indicates the information fields that would be updated. Thus, choosing Update button is enough to send and save the new information to the system database. Back functions to move the user to the main Menu interface that has the Logout button leading to exit from this application. Figure 5.39 shows the Main Menu interface that includes the Logout button.

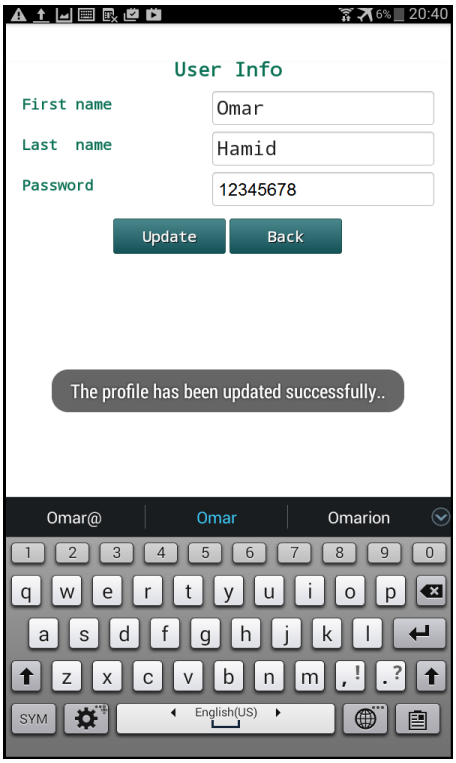

Figure 5.38: User Info Interface

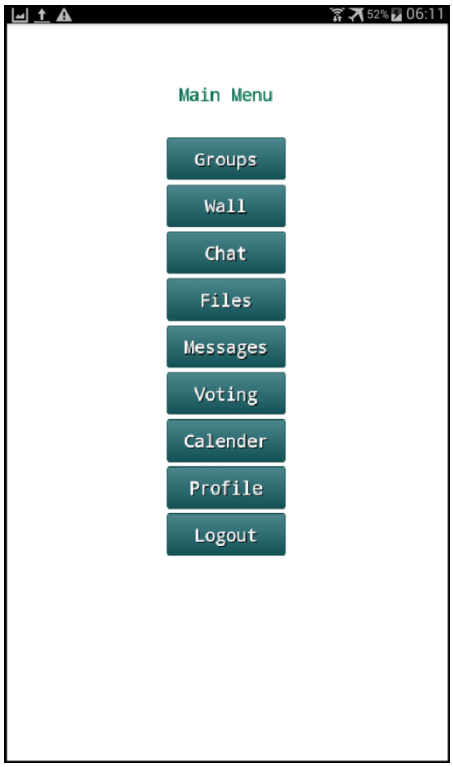

Figure 5.39: Logout in Main Menu Interface

5.5 Summary

In this Chapter, the design and development phases are described. Firstly, the UML designs including Use Case diagram, Activity diagrams and Class diagram have been drawn and discussed to ensure that the CML model was designed correctly. All the diagrams of UML design were shown to expert review to validate them, guide the developer to the right way, and decrease the mistakes for implementing the CML prototype. The process of constructing the CML prototype involved adoption of the UML outputs to be the base of the prototype implementation. The method of Rapid Application Development (RAD) was followed in accordance with the early research design. Hence, the CML prototype was built and explained in this chapter with its screenshots figures that illustrated the prototype interfaces and clarified their functions. The next chapter focuses on the prototype evaluation.

CHAPTER SIX

PROTOTYPE EVALUATION

6.1 Introduction

This chapter presents the evaluation phase of the CML prototype. After completing the implementation phase of the prototype, the testing processes were employed to evaluate it. The evaluation phase represents the third objective in this study. The following sections will explain in detail the whole evaluation phase enhanced by illustrations in the form of tables, figures and statistics to clarify this phase.

6.2 Prototype Evaluation Procedure

Aiming to achieve the last objective in this study, this phase is to evaluate the CML prototype. Two methods used for the prototype evaluation were employed in this phase. Firstly, the developer himself tested all the prototype functions using the test cases technique to ensure their work. Basically, the test cases were used to find and distinguish the errors in the prototype in order to fix them before proceeding to the next test using the test case method (Hussain, Jomhari, Kamal, & Mohamad, 2014). Then, the study respondents experienced the prototype as groups of learners with their lecturer. Amid the testing, Thinking Out Loud technique was utilized when the respondents were asked to highlight the unclear things about the prototype work which they misunderstood. After completing the prototype test, the respondents have answered all questions in the questionnaire which was adopted from Technology Acceptance Model (TAM) with a specific end goal to evaluate the usability test and collaborative learning achievement using the CML prototype which represented the M-learning. The consequences of the

survey questionnaire were utilized to demonstrate whether the examination goals were achieved or not.

6.2.1 Prototype Test Cases

In order to validate the CML prototype, one of the techniques that enhanced the researcher to obtain the prototype functionality validation was the test case method. The test case technique was expressed by tables divided into sections to facilitate and diagnose the error as well as understand the functionality work correctly. Amid this testing, the prototype has to work as was desired and the functionality test done step by step orderly to verify the sequence work of the CML prototype. Then, all the results were written in their test scripts tables to document the test details for each one of them. In this way, all test scripts of the functions were completed. The testing results were arranged by the developer of the CML prototype. The testing incorporated all capacities in the model (clarified in section 6.3.1).

6.2.2 Prototype Usability Test

This test was provided to evaluate the perceived usefulness, ease of use, and collaborative learning of the CML prototype utilized as a fundamental indicate guarantee (through providing the functions that are required for developing the CML requirements as explained in Chapter 4). Along these lines, the CML prototype's perceptions were related to the usefulness and easiness in addition to the collaborative learning using the mobile technology. The study involved a respondents' sample consist of 43 undergraduate IT students studied in Universiti Utara Malaysia (UUM) chosen to perform their collaborative related activities to evaluate the CML' prototype usability. The evaluation of this prototype was done in the computer labs of School of Computing in UUM.

According to the research scope, the participants' ages were ranged 18-44 year old in addition to their lecturers. Two classes involved in this assessment in order to cover the required number of participants, particularly those who use the Android mobile devices.

6.3 Results

The obtained outcomes from the functionality test and survey questionnaire were tested by the use of test cases and usability tests under TAM model; the results are explained in this section. Since they were completed independently, these outcomes were examined independently as well. The results of the functionality test were clarified initially, followed by the usability test which includes the perceived usefulness, ease of use and collaborative learning.

6.3.1 Result of the Functionality Test Cases

This section focuses on the functionality test outcomes of the CML prototype. Systematically, the functions in this prototype were examined one by one to ensure their effective and correct work; in addition to the respondents' test which contributed to decrease the technical errors of this prototype as much as possible. Conducting the test case method before testing the prototype among the respondents in the next phase would influence their experience positively. The primary experiment was to acquire information from the prototype test cases concentrating on whether the CML prototype succeeded or failed. Each function, sub-function and options were tested in this phase so that the prototype was tested accurately to find the unknown errors that may occur during the sequence step test. In case of encountering any error, the developer has to fix it and find the related expected errors. The test cases results were documented one by one for each

function and its steps. The test script tables (in Appendex C) demonstrate the results of each function in the CML prototype explained according to the functionality test cases.

6.3.2 Result of the Usability Test

In this section, the usability test was used to evaluate the prototype in terms of perceived usefulness, ease of use and collaborative learning. This test involved two phases; firstly, testing the prototype by the respondents in the form of groups. Regarding the participants, two classes of undergraduate students in the field of Information Technology (IT) were involved in this study, they experienced the prototype class by class in the computer labs of Universy Utara Malaysia (UUM). Secondly, the students were divided into groups since the prototype focused on the groups of learners, after that they experienced the prototype. Concerning the results, the users accepted to use the CML prototype according to their information in measuring three factors of the destributed questionnaire. Consistent with their responses, the repondents believed that the prototype use would enhance the work of groups of learners. In the following subheadings, the results of this section are separated in accordance with the parts of questionnaire (see Appendix A) and then discussed with providing the clarification tables.

- Demographic Profile of Respondents
    - Gender of Respondents.
    - Age Groups of Respondents.
    - Respondents' Level of Education.
- Perceived Usefulness.
- Ease of Use.
- Collaborative Learning.

6.3.2.1 Demographic Profile of Respondents

A. Gender of Respondents

This section presents the first part of the general information in the questionnaire for the respondents. In that regard, Table 6.1 shows the respondents' gender, frequency and percentage. According to this table, the male respondents are 20 (46.5%) while the female ones are 23 (53.5%). It is clear that the female percentage is higher than that of male. The other information represents the frequent number of the respondents indicated in the frequency column. The number of female respondents is larger than that of male respondents as the frequent number of female respondents is 23, whereas the frequent number of male respondents is 20 as listed in the table. In sum, 43 respondents represented the total number of both genders and 100.0% represented the percentage as shown in Table 6.10 which represented the demographic profile of respondents.

Table 6.1

Gender of Respondents

Gender	Frequency	Percent
Male	20	46.5%
Female	23	53.5%
Total	43	100.0%

B. Age Groups of Respondents

In this section, Table 6.2 illustrates the age groups of the respondents. So, the respondents' age groups included three groups (18-24), (25-34) and (35-44). The frequent value and the percentage information are included in this result. Table 6.11 clearly shows that the high percentage is for the dominant group age (18-24) by 95.3%, while the other two groups ranging between (25-34) and (35-44) are resembled in having the same percentage of 2.3%. Mostly, the frequent number is the highest for the group age 18 to 24 represented by 41, followed by 1 for the two age group respectively. Totally, the frequent number for all groups is 43 as shown below in Table 6.2.

Table 6.2

Age Groups of Respondents

Age Groups	Frequency	Percent
18-24	41	95.3%
25-34	1	2.3%
35-44	1	2.3%
Total	43	100.0%

C. Respondents' Level of Education

As far as the respondents' level of education was concerned in the CML prototype evaluation, Table 6.3 indicates the highest percentage for the Bachelor degree represented by 95.3% having the most frequent number of 41 respondents.

Concerning PhD level, it was the lowest percentage represented by 4.7% of respondents who are two only.

Table 6.3

Respondents' Level of Education

Level of Education	Frequency	Percent
Bachelor	41	95.3%
PhD	2	4.7%
Total	43	100.0%

6.3.2.2 Perceived Usefulness

In relation to the second section of the questionnaire, the first task focused on the perceived usefulness consisting of six questions on the usefulness of subjects included in the CML prototype. Table 6.4 shows the descriptive statistics of the seven perceived usefulness questions. Then, the results were discussed for all questions using 5 Likert Scale to rate the questions from 1 (strongly disagree) to 5 (strongly agree) (as shown in Appendix A). The results showed that most of the respondents were pleasant with the use of CML prototype as indicated by their answers to the questions using the scales of agree and strongly agree. This represented high mean score = 4.26 and standard deviation = 0.492. In contrast, some respondents were less comfortable when using the CML prototype; they symbolized mean score = 3.84 and standard deviation = 0.652.

Table 6.4

Descriptive Statistics of the Perceived Usefulness

Measure	No. of Participants	Mean	Std. Deviation
Perceived Usefulness _Q1	43	4.26	.492
Perceived Usefulness _Q2	43	4.16	.531
Perceived Usefulness _Q3	43	4.07	.669
Perceived Usefulness _Q4	43	3.84	.652
Perceived Usefulness _Q5	43	3.98	.597
Perceived Usefulness _Q6	43	4.02	.597
Valid N (listwise)	43		

6.3.2.3 Ease of Use

Table 6.5 below shows the descriptive statistics for the third section of the CML questionnaire which focused on the usefulness measure. In this study, the results of usefulness questions show that most participants' answers were ranging between agree and strongly agree with mean score = 4.26 and standard deviation score = 0.727. However, some participants felt uncomfortable using CML prototype representing mean score = 3.77 and standard deviation = 0.649.

Table 6.5

Descriptive Statistics of the Ease of Use

Measure	No. of Participants	Mean	Std. Deviation
Easy_to_Use_Q7	43	4.09	.718
Easy_to_Use_Q8	43	4.09	.648

Easy_to_Use_Q9	43	4.19	.699
Easy_to_Use_Q10	43	4.19	.588
Easy_to_Use_Q11	43	3.91	.648
Easy_to_Use_Q12	43	3.95	.785
Easy_to_Use_Q13	43	3.77	.649
Easy_to_Use_Q14	43	4.16	.652
Easy_to_Use_Q15	43	4.26	.727
Easy_to_Use_Q16	43	3.86	.601
Valid N (listwise)	43		

6.3.2.4 Collaborative Learning

Table 6.6 presents the descriptive statistics for the collaborative learning factor. Statistics such as Mean and Standard Deviation were utilized in the current study. The Mean and Standard Deviation results for all questions were reviewed and examined. Most of the respondents believed that using the CML prototype has enhanced the collaborative learning groups who answered the questions with mean score = 4.19 and standard deviation score = 0.627. In the meantime, some participants were less supportive for collaborative learning using the CML prototype (mean score = 3.88 and standard deviation = 0.793). The tabulated results revealed that all questions have high mean score close to, or greater than, 4. Moreover, the standard deviations were small as being less than 1. These scores highlighted the respondents' feedback of the collaborative learning using the CML prototype that obtained from the data collected through the questionnaire

sections. Hence, all statements concerning the CML prototype in the questionnaire were approved by the subjects with a very small bias or a limited influence of other factors.

Table 6.6

Descriptive Statistics of the Collaborative Learning

Measure	No. of Participants	Mean	Std. Deviation
Collaborative_Learning_Q17	43	4.19	.627
Collaborative_Learning_Q18	43	4.00	.655
Collaborative_Learning_Q19	43	3.88	.793
Collaborative_Learning_Q20	43	4.02	.556
Collaborative_Learning_Q21	43	4.16	.615
Valid N (listwise)	43		

6.3.2.5 Usability Test Descriptive Statistics

In general, Table 6.7 shows the descriptive statistics for all factors of the CML questionnaire as the usability test. So, the descriptive statistics of the usefulness, easy to use and collaborative learning were included in this table. The statistic results were represented by mean and standard deviation. Moreover, the Mean and Standard Deviation results for all questions were reviewed and examined. All questions have a high mean score close to, or greater than, 4 in accordance with the tabulated results. Additionally, the standard deviations were small represented by less than 1. These scores highlighted the respondents' feedback obtained from the data collected through the questionnaire sections. Hence, all statements in relation to the CML prototype in the questionnaire were

approved by the subjects with a very small bias or a limited influence of other factors. Consequently, Table 6.7 demonstrates the descriptive statistics for the usefulness measure. Concerning the usefulness, easy to use and collaborative learning questions, the results showed that most answers were ranging between agree and strongly agree with that statement represented by the mean score = 4.26 and standard deviation = 0.492. Meanwhile, some participants felt uncomfortable in using the CML prototype represented by mean score = 3.77 and standard deviation = 1.059.

Table 6.7

Descriptive Statistics

Questions	No. of Participants	Minimum	Maximum	Mean	Std. Deviation
Q1	43	3	5	4.26	.492
Q2	43	3	5	4.16	.531
Q3	43	3	5	4.07	.669
Q4	43	3	5	3.84	.652
Q5	43	3	5	3.98	.597
Q6	43	3	5	4.02	.597
Q7	43	3	5	4.09	.718
Q8	43	3	5	4.09	.648
Q9	43	3	5	4.19	.699
Q10	43	3	5	4.19	.588
Q11	43	3	5	3.91	.648
Q12	43	1	5	3.95	.785
Q13	43	2	5	3.77	.649
Q14	43	3	5	4.16	.652
Q15	43	3	5	4.26	.727
Q16	43	3	5	3.86	.601
Q17	43	3	5	4.19	.627
Q18	43	3	5	4.00	.655
Q19	43	2	5	3.88	.793
Q20	43	3	5	4.02	.556
Q21	43	3	5	4.16	.615
Valid N (listwise)	43				

6.4 Reliability

Generally, one of the most reliable coefficients used in such study is Cronbach's Alpha (Peterson & Kim, 2013). Using SPSS version 20, Cronbach's alpha value was used in this study to calculate and determine the reliability of the entered questionnaire data. Therefore, 21 items were measured and the obtained result was (0.904). The total reliability statistics of the usefulness, easiness of use and collaborative learning were presented in Table 6.8.

Table 6.8

Reliability Result

Cronbach's Alpha	No. of Items
.904	21

6.4.1 Reliability for Perceived Usefulness

Table 6.9 shows that the results of the reliability test in the Cronbach's alpha for six items is 0.759, which is greater than 0. 6. Thus, the total items are accepted in the current study.

Table 6.9

Reliability for Perceived Usefulness

Cronbach's Alpha	No. of Items
.759	6

6.4.2 Reliability for Ease of Use

Table 6.10 presents the reliability test for Easy to Use in using the CML prototype. Ten items were measured and the obtained result was 0.847. Therefore, these measures fulfill the internal reliability criterion.

Table 6.10

Reliability for Ease of Use

Cronbach's Alpha	No. of Items
.847	10

6.4.3 Reliability for Collaborative Learning

The results of the reliability test in Table 6.11 show that the Cronbach's alpha for five items is 0.740, which is greater than 0. 6. Thus, the total items are accepted in the current study.

Table 6.11

Reliability for Collaborative Learning

Cronbach's Alpha	No. of Items
.740	5

6.5 Summary

This chapter focuced on the evaluation phase of the CML prototype. The methods of test cases have been adopted and used in order to evaluate the functionality of the prototype. The usability test has been conducted in this Chapter, then the results were mentioned and illustrated in the tables, figures and statistics. The evaluation phase covered the required information, and summarised the user's perspective in relation to the prototype. The aspects of both functionality and usability tests were explained in detail in terms of procedures and results. The procedures were employed correctly and the results were reliable. The prototype was perceived by the respondents to be useful and easy to use based on the results shown in this chapter. The next chapter will discuss the findings of this study and recommendations for future research.

CHAPTER SEVEN

DISCUSSION & CONCLUSION

7.1 Introduction

This chapter discusses the findings of this study and the achievement of its objectives. It discusses the issues of the existing works related to CML model, improvement of the selected models, and evaluation of the functionality of CML prototype. Then, the proposed model problems and limitations are highlighted, in addition to suggestions of the future work for the CML Model.

7.2 Objectives Achievements

Having carried out the activities of the research methodology, which have been outlined in Chapter 3, and applied in Chapters 4 and 5, this study has achieved all the objectives stated in Chapter 1; they are discussed in the following subsections. The objectives of this study divided into three, firstly, identifying the limitations of the existing CML models from the literature, then interviews with the sample of this study. Secondly, using system analysis and expert review to evaluate the CML design. Thus, the modeling followed by developing the CML prototype based on the obtained information, and finally evaluating the developed prototype. The following discussions focus on the achievements of these objectives.

7.2.1 Existing Works and Related CML Models

This research identified the required information about modeling Collaborative M-learning (CML). Based on the findings, the required information was collected from literature review represented by the existing works and related model, in addition to the

interviews as described in Chapter 4. Evidently, the analyzed data revealed that the required information of CML model were related to group formation, group notification, group chatting, group files sharing, group make decisions and group arrangement. These findings indicated the importance and usefulness of the mentioned information in modeling collaborative mobile learning for the groups of learners, especially in managing their related activities.

Moreover, the findings of this study have similarities with those of other studies, particularly studies of Cheng and Yu (2015) and Wald et al. (2014). While, Power (2013) highlighted that the collaboration opportunity enhanced learning and suggested to include a new technology in the collaborative M-learning design, in addition to applying the learning activity situated in a realistic context. The CML model involved learners' engagement with educational content which has, in turn, decreased monotony and made learning more meaningful. As well, Nam and Jang (2013) expressed another similarity in information required for modeling the CML that are learning activities need to follow arrangement processes, particularly within a group of learners, so that they should be addressed within the instructional context. Based on the similarities in some of the findings, it can be concluded that there were common factors of various issues represented the required needs of the same information.

7.2.2 Improvement of the Existing Models

The development of the CML prototype has been accomplished and it has been tested in terms of its perceived usefulness and easy to use. Based on the derived common elements gathered in Chapter 4, the design of the CML model has been outlined. Therefore, the second objective focused on design analysis and developing a prototype based on the

information required in the prior phases. As an interactive system, it has been designed showing the classes and interaction through the Use Case, Activity and Class diagrams.

In addition, the CML prototype has been built including the functions of manage groups, manage notification wall, interactive group chatting, manage files, service of messages, make decision by voting and users' profile setting that supported the functionalities of the CML. After accomplishing the design, a working prototype translation was created and elucidated in detail in Chapter 5. This is to enable the respondents to use the constructed prototype, which derived in Chapter 4. This step is important because the groups of learners as respondents cannot understand the model without a working prototype. All the design issues that gathered based on CML modeling requirements, as explained in Chapter 4, were incorporated in this prototype.

7.2.3 Evaluation the Functionality and Usability of CML Prototype.

Regarding the third objective, it was to evaluate the CML prototype. Based on the results, it can be concluded that most of the CML respondents believed that the prototype is useful and collaborative, as well as rich with information that are related to their needs. Particularly, most of the respondents agreed on the usefulness, ease to use, and enhancement of collaborative learning using this product, which deals with their other information. The results were not influenced by any technical effects because, before testing the perceptions, the functions in the prototype were first tested to ensure that they work well as intended. Based on the above, the results of information needs evaluation reflected that the CML prototype was useful, especially in managing the groups of learners' related activities, and considered as a positive contribution for the M-learning area.

7.3 Problems and Limitations

In spite of its successfulness in many respects, the implementation and the evaluation of the CML environment revealed a number of critical issues. Consequently, the main limitations encountered in modeling the CML prototype not related to the CML model specifically, but more generally, to the existing literature and design of the CML model. One of the major limitations is the limited literature available for reviewing the studied field. The prototype was built and applied for the Android operating system only. Moreover, the prototype interface language focused on using English language because of the limited time. Another limitation was the unpublished application in the Android shop represented by the Google Play since the study conducted on the preliminary application symbolized by the prototype of CML model.

7.4 Recommendations for Future Studies

The present study has accomplished its desired objectives concerning the modeling Collaborative M-learning (CML). A lot of effort has been made to determine the requirements of the CML model and develop an appropriate prototype based on the obtained information in this study. However, there are few recommendations and suggestions that need to be considered as future work. In that regard, the study has raised some ideas and suggestions for future work that can be developed in further studies. Perhaps, the following points represent some issues which may be considered as future work and could be improved in future:

1. The scope of this study is limited for undergraduate IT students. Thus, further developments have to be made to cover other groups of respondents.

2. This study focused only on English language, but it can be applied using any foreign language by following the same steps.
3. Since the focus was on the Android platform, the model could be designed for any other mobile operating system such as Apple IOS, BlackBerry and Windows Phone.

Thus, the obtained information other than those regarded in the current study can be utilized in the prototype development in relation to, for example, the groups of learners.

7.5 Summary

This chapter discussed the findings of this study and compared them with the findings of previous studies. This study confirmed the significance of its contributions after discussing the objectives' achievement. It collected inputs from a variety of sources towards providing a significant contribution to the field of the related literature through the proposed model. In future, researchers could utilize the proposed prototype towards further enhancement. Apart from this, the study contributed to M-learning area by means of the developed prototype in providing an improvement model to developers and designers, assisting them in modeling the studied subjects and focusing on the collaborative needs of group learners. Ultimately, this innovation will result in enhancing the higher functionality of the CML prototype. These groups will have more attractive and productive learning with the whole learning society benefitting from their contributions. Finally, this study has accomplished its stated objectives. As addressed in the previous section, a number of future considerations should be taken into account towards improving this initiative.

REFERENCES

Alarcon, R., Guerrero, L. A., Ochoa, S. F., & Pino, J. A. (2012). Analysis and design of mobile collaborative applications using contextual elements. *Computing and Informatics*, *25*(6), 469–496.

Al-Huneidi, A. M., Al-Huneidi, A. M., & Schreurs, J. (2012). Constructivism Based Blended Learning in Higher Education. *International Journal: Emerging Technologies in Learning*, *7*(1), 4–9. doi:http://doi.org/10.3991/ijet.v7i1.1792

Alkhazali, A. R. M. (2012). *Application of Mobile Tourism for Kedah*. Retrieved from doi:http://etd.uum.edu.my/2920/

Allen, S., Graupera, V., & Lundrigan, L. (2010). *Pro smartphone cross-platform development: iPhone, blackberry, windows mobile and android development and distribution*. Apress.

Almutairi, S., Bell, G., & Chen, F. (2013). An enhanced Use Case diagram to model Context Aware Systems. *Science and Information Conference (SAI), 2013* (270–274).

Al-Rahimi, W. M., Othman, M. S., & Musa, M. A. (2013). Using TAM Model To Measure The Use Of Social Media For Collaborative Learning. *International Journal of Engineering Trends and Technology*, *5*(2), 90–95.

Al-rahmi, W. M., Othman, M. S., & Mi Yusuf, L. (2015). Social Media for Collaborative Learning and Engagement: Adoption Framework in Higher Education Institutions in Malaysia. *Mediterranean Journal of Social Sciences*, *6*(3), 246–252. doi:http://doi.org/10.5901/mjss.2015.v6n3s1p246

Al-Shemarry, M. S. J. (2010). *Requirement Model for E-Courses Management System in Iraqi Universities: A Case Study at Thi-Qar Universiti*. Universiti Utara Malaysia.

Ameller, D., Franch, X., & Cabot, J. (2010). Dealing with non-functional requirements in model-driven development. *Requirements Engineering Conference (RE), 2010 18th IEEE International* (189–198).

Arnold, N., & Paulus, T. (2010). Using a social networking site for experiential learning:

Appropriating, lurking, modeling and community building. *The Internet and Higher Education*, *13*(4), 188–196. doi:http://doi.org/10.1016/j.iheduc.2010.04.002

Baran, E., Correia, A.-P., & Thompson, A. (2011). Transforming online teaching practice: critical analysis of the literature on the roles and competencies of online teachers. *Distance Education*, *32*(3), 421–439. dio:http://doi.org/10.1080/01587919.2011.610293

Barker, D., Quennerstedt, M., & Annerstedt, C. (2013). Inter-student interactions and student learning in health and physical education: A post-Vygotskian analysis. *Physical Education and Sport Pedagogy*, (ahead-of-print), 1–18.

Biel, B., Grill, T., & Gruhn, V. (2010). Exploring the benefits of the combination of a software architecture analysis and a usability evaluation of a mobile application. *Journal of Systems and Software*, *83*(11), 2031–2044. dio:http://doi.org/10.1016/j.jss.2010.03.079

Boticki, I. Wong, L. & Looi, C.-K. (2013). Designing Technology for Content-Independent Collaborative Mobile Learning. *IEEE Transactions on Learning Technologies*, *6*(1), 14–24. doi:http://doi.org/10.1109/TLT.2012.8

Bozkurt, A., Ozbek, E. A., Yilmazel, S., Erdogdu, E., Ucar, H., & Guler, E. (2015). February – 2015 Trends in Distance Education Research : A Content Analysis of Journals 2009 - 2013. *The International Review of Research in Open and Distributed Learning*, *16*(1), 330–363.

Brähler, S. (2010). *Analysis of the Android Architecture*. *Os.Ibds.Kit.Edu*. Retrieved from http://os.ibds.kit.edu/downloads/sa_2010_braehler-stefan_android-architecture.pdf

Causevic, a., Sundmark, D., & Punnekkat, S. (2012). Test case quality in test driven development: a study design and a pilot experiment. In *16th International Conference on Evaluation & Assessment in Software Engineering (EASE 2012)* (223–227). dio:http://doi.org/10.1049/ic.2012.0029

Chang, K.-E., Wu, L.-J., Lai, S.-C., & Sung, Y.-T. (2014). Using mobile devices to enhance the interactive learning for spatial geometry. *Interactive Learning*

Environments, *4820*(January), 1–19.

Cheng, X. (2015). Designing of a Mobile Collaboration Application for Student Collaborative Group Work : Evidence from China. In *IEEE CONFERENCE PUBLICATIONS* (544–551). doi:http://doi.org/10.1109/HICSS.2015.72

Cheng, X., Li, Y., Sun, J., & Zhu, X. (2014). Easy Collaboration Process Support System Design for Student Collaborative Group Work: A Case Study. *System Sciences (HICSS), 2014 47th Hawaii International Conference on*. http://doi.org/10.1109/HICSS.2014.64

Cheng, X., & Yu, J. (2015). Designing of a Mobile Collaboration Application for Student Collaborative Group Work: Evidence from China. *System Sciences (HICSS), 2015 48th Hawaii International Conference on*.doi:http://doi.org/10.1109/HICSS.2015.72

Cheong, C., Bruno, V., & Cheong, F. (2012). Designing a Mobile-app-based Collaborative Learning System. *Journal of Information Technology Education Innovations in Practice*, *11*, 97–119.

Cowan, P., & Butler, R. (2013). Making geography mobile : using location aware technology to improve student performance in physical geography. *Jounal of Research and Didactics in Geography*, *1*(2), 85–105. doi:http://doi.org/10.4458/0900-09

Creswell, J. W. (2009). *Research Design*. *SAGE Publications*. doi:http://doi.org/10.4135/9781849208956

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *Internet and Higher Education*, *15*(1), 3–8. doi:http://doi.org/10.1016/j.iheduc.2011.06.002

Daud, N. M. N., Bakar, N. A. A. A., & Rusli, H. M. (2010). Implementing Rapid Application Development (RAD) methodology in developing practical training

application system. *Proceedings 2010 International Symposium on Information Technology - System Development and Application and Knowledge Society, ITSim'10*. doi:http://doi.org/10.1109/ITSIM.2010.5561634

Dewitt, D., & Siraj, S. (2010). World Journal on Educational collaborative m-learning module. *World Journal on Educational Technology*, *2*(3), 169–185. Retrieved from www.world-education-center.org/index.php/wjet

DeWitt, D., Siraj, S., & Alias, N. (2014). Collaborative mLearning: A module for learning secondary school science. *Special Issue: Game Based Learning for 21st Century Transferable Skills: Challenges and Opportunities*. JSTOR. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc11&NEWS=N&AN=2014-06607-009

Donnelly, R. (2010). Harmonizing technology with interaction in blended problem-based learning. *Computers and Education*, *54*(2), 350–359. doi:http://doi.org/10.1016/j.compedu.2009.08.012

Egbokhare, F. A. (2014). Causes of Software/Information Technology Project Failures in Nigerian Software Development Organizations. *African Journal of Computing and ICT*, *7*(2), 107–110.

Espada, J. P., Crespo, R. G., Martínez, O. S., G-Bustelo, B. C. P., & Lovelle, J. M. C. (2012). Extensible architecture for context-aware mobile web applications. *Expert Systems with Applications*, *39*(10), 9686–9694.

Fazlina, S., Manap, A. A., & Rias, R. M. (2013). Mobile learning awareness among students at higher learning institutes : A case study. *Proceedings - 2013 International Conference on Informatics and Creative Multimedia, ICICM 2013* (226–229). doi:http://doi.org/10.1109/ICICM.2013.46

Følstad, A., Box, P. O., Law, E. L., Hornbæk, K., & Copenhagen, S. (2012). Analysis in Practical Usability Evaluation : A Survey Study (2127–2136).

Garcia, I. A., & Cano, E. M. (2014). Designing and Implementing a Constructionist Approach for Improving the Teaching-Learning Process in the Embedded Systems

and Wireless Communications Areas. *Computer Applications in Engineering Education*, *22*(October), 481–493. doi:http://doi.org/10.1002/cae.20574

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *Internet and Higher Education*, *19*, 18–26. doi:http://doi.org/10.1016/j.iheduc.2013.06.002

Goggin, G. (2012). *Cell phone culture: Mobile technology in everyday life*. Routledge.

Green, S. B., & Salkind, N. J. (2010). *Using SPSS for Windows and Macintosh: Analyzing and understanding data*. Prentice Hall Press.

Hasan, L., & Abuelrub, E. (2013). Usability testing for IAJIT openconf journal management system. *Journal of Software*, *8*(2), 387–396. doi:http://doi.org/10.4304/jsw.8.2.387-396

Hussain, A., Jomhari, N., Kamal, F. M., & Mohamad, N. (2014). mFakih : Modelling Mobile Learning Game to Recite Quran for deaf Children. *International Journal on Islamic Applications in Computer Science And Technology*, *2*(2), 8–15.

Itu. (2013). *International Telecom Union Annual Report 2013: Measuring the Information Society*.

Järvelä, S., & Järvenoja, H. (2011). Socially Constructed Self-Regulated Learning and Motivation Regulation in Collaborative Learning Groups. *Teachers College Record*, *113*(2), 350–374.

Khader, A., & Almasri, M. (2014). the Influence on Mobile Learning Based (Tam), Mobile Readiness (Mr) and Perceived Interaction (Pi) for Higher, *1*(1), 5–11.

Khan, A. U. R., Othman, M., Madani, S. A., & Khan, S. U. (2014). A survey of mobile cloud computing application models. *IEEE Communications Surveys and Tutorials*, *16*(1), 393–413. doi:http://doi.org/10.1109/SURV.2013.062613.00160

Kirschner, F., Paas, F., Kirschner, P. a., & Janssen, J. (2011). Differential effects of problem-solving demands on individual and collaborative learning outcomes. *Learning and Instruction*, *21*(4), 587–599. doi:http://doi.org/10.1016/j.learninstruc.2011.01.001

Klassen, A. C., Creswell, J., Clark, V. L. P., Smith, K. C., & Meissner, H. I. (2012). Best practices in mixed methods for quality of life research. *Quality of Life Research*, *21*(3), 377–380.

Ko, E. H. T., Chiu, D. K. W., Lo, P., & Ho, K. K. W. (2015). Comparative Study on m-Learning Usage Among LIS Students from Hong Kong, Japan and Taiwan. *The Journal of Academic Librarianship*, *41*(5), 567–577.

Koh, Y. H., Rawi, M. F., & Zhang, W. (2011). Learning Anytime, Anywhere: An Ipod Touch Mobile Learning Experience @ Yusof Ishak (YI) Secondary School, Singapore. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications* (Vol. 2011, pp. 3035–3042). Retrieved from http://www.editlib.org/p/38292/

Koole, M., McQuilkin, J. L., & Ally, M. (2010). Mobile learning in distance education: Utility or futility. *International Journal of E-Learning & Distance Education*, *24*(2).

Kooloos, J. G. M., Klaassen, T., Vereijken, M., Van Kuppeveld, S., Bolhuis, S., & Vorstenbosch, M. (2011). Collaborative group work: Effects of group size and assignment structure on learning gain, student satisfaction and perceived participation. *Medical Teacher*, *33*(12), 983–988. doi:http://doi.org/10.3109/0142159X.2011.588733

Laal, M., & Laal, M. (2012). Collaborative learning: what is it? *Procedia-Social and Behavioral Sciences*, *31*, 491–495.

Laal, M., Naseri, A. S., Laal, M., & Khattami-Kermanshahi, Z. (2013). What do we Achieve from Learning in Collaboration? *Procedia-Social and Behavioral Sciences*, *93*, 1427–1432.

Lai, C., Wang, Q., & Lei, J. (2012). What factors predict undergraduate students' use of technology for learning? A case from Hong Kong. *Computers & Education*, *59*(2), 569–579. doi:http://doi.org/10.1016/j.compedu.2012.03.006

Lai, H.-C., Chang, C.-Y., Wen-Shiane, L., Fan, Y.-L., & Wu, Y.-T. (2013). The implementation of mobile learning in outdoor education: Application of QR codes.

British Journal of Educational Technology, *44*(2), E57–E62. doi:http://doi.org/10.1111/j.1467-8535.2012.01343.x

Lan, Y.-F., Tsai, P.-W., Yang, S.-H., & Hung, C.-L. (2012). Comparing the social knowledge construction behavioral patterns of problem-based online asynchronous discussion in e/m-learning environments. *Computers & Education*, *59*(4), 1122–1135.

Lee, D., Moon, J., Kim, Y. J., & Yi, M. Y. (2014). Antecedents and consequences of mobile phone usability: Linking simplicity and interactivity to satisfaction, trust, and brand loyalty. *Information & Management*, *52*(3), 295–304. doi:http://doi.org/10.1016/j.im.2014.12.001

Lee, Y. H., Waxman, H., Wu, J. Y., Michko, G., & Lin, G. (2013). Revisit the effect of teaching and learning with technology. *Educational Technology and Society*, *16*(1), 133–146.

Liu, I.-F., Chen, M. C., Sun, Y. S., Wible, D., & Kuo, C.-H. (2010). Extending the TAM model to explore the factors that affect Intention to Use an Online Learning Community. *Computers & Education*, *54*(2), 600–610. doi:http://doi.org/10.1016/j.compedu.2009.09.009

Loncar, M., Barrett, N. E., & Liu, G. Z. (2014). Towards the refinement of forum and asynchronous online discussion in educational contexts worldwide: Trends and investigative approaches within a dominant research paradigm. *Computers and Education*, *73*, 93–110. doi:http://doi.org/10.1016/j.compedu.2013.12.007

McNaughton, D., Light, J., & Naughton, D. M. C. (2013). The iPad and mobile technology revolution: Benefits and challenges for individuals who require augmentative and alternative communication. *Augmentative and Alternative Communication*, *29*(2), 107–116. doi:http://doi.org/10.3109/07434618.2013.784930

Moser, M. (2011). Open Source Android Development Tools. *Online][Cited: Julio, 2011.] Http://assets. En. Oreilly. com/1/event/61/Open% 20Source% 20Android% 20Development% 20Tools*.

Nam, C. W., & Jang, S. (2013). The development of an ID model for collaborative learning in mobile learning environments. *Teaching, Assessment and Learning for Engineering (TALE), 2013 IEEE International Conference on* (207–212).

Ng, J. W. P., Zemerly, M. J., & Hammadi, O. A. Al. (2011). Context-aware collaborative mlearning in an intelligent campus environment. In *2011 IEEE GCC Conference and Exhibition, GCC 2011* (63–64). doi:http://doi.org/10.1109/IEEEGCC.2011.5752620

Ostrowski, \Lukasz, & Helfert, M. (2011). Commonality in various design science methodologies. *Computer Science and Information Systems (FedCSIS), 2011 Federated Conference on* (317–320).

Paavilainen, J., Korhonen, H., & Saarenpää, H. (2011). *Comparing two playability heuristic sets with expert review method: A case study of mobile game evaluation*. *Media in the Ubiquitous Era: Ambient, Social and Gaming Media*.

Pahl, G., & Beitz, W. (2013). *Engineering Design: A Systematic Approach* (Vol. 11). doi:http://doi.org/10.1007/978-1-84628-319-2

Pegrum, M., Oakley, G., & Faulkner, R. (2013). Schools going mobile: A study of the adoption of mobile handheld technologies in western australian independent schools. *Australasian Journal of Educational Technology*, *29*(1), 66–81. doi:http://doi.org/10.1234/ajet.v29i1.64

Peters, V. L., & Hewitt, J. (2010). An investigation of student practices in asynchronous computer conferencing courses. *Computers & Education*, *54*(4), 951–961.

Peterson, R. A., & Kim, Y. (2013). On the relationship between coefficient alpha and composite reliability. *Journal of Applied Psychology*, *98*(1), 194.

Popov, V., Biemans, H. J. A., Brinkman, D., Kuznetsov, A. N., & Mulder, M. (2013). Facilitation of computer-supported collaborative learning in mixed- versus same-culture dyads: Does a collaboration script help? *The Internet and Higher Education*, *19*(December), 36–48. doi:http://doi.org/10.1016/j.iheduc.2013.08.002

Power, R. (2013). Collaborative Situated Active Mobile (CSAM) learning strategies: a

new perspective on effective mobile learning. *Learning and Teaching in Higher Education: Gulf Perspectives*, *10*(2), 1– 18. Retrieved from http://lthe.zu.ac.ae/index.php/lthehome/article/view/137

Ravitch, S. M., & Riggan, M. (2011). *Reason & rigor: How conceptual frameworks guide research*. Sage.

Sarrab, M., & Elgamel, L. (2013a). Contextual M-learning system for higher education providers in Oman. *World Applied Sciences Journal*, *22*(10), 1412–1419. doi:http://doi.org/10.5829/idosi.wasj.2013.22.10.571

Sarrab, M., & Elgamel, L. (2013b). M Obile L Earning (M-L Earning) and. *International Journal of Distributed and Parallel System*, *3*(4), 31–39. doi:http://doi.org/10.3991/ijim.v3i4.986

Seliaman, M. E., & Al-Turki, M. . (2012). Mobile Learning Adoption in Saudi Arabia. *World Academy of Science, Engineering, and Technology*, *6*(9), 356–358.

Shaltout, M. S. A.-F. (2013). Proposed Model for the Learning Resource Center Based on Cloud Computing. *E-Learning "Best Practices in Management, Design and Development of E-Courses: Standards of Excellence and Creativity" , 2013 Fourth International Conference on*. doi:http://doi.org/10.1109/ECONF.2013.73

Sironi, M., & Tisato, F. (2013). Capturing Information Flows inside Android and Qemu Environments. *arXiv*, 1–13. Retrieved from http://arxiv.org/abs/1302.5109

Small, M. L. (2011). How to Conduct a Mixed Methods Study: Recent Trends in a Rapidly Growing Literature. *Annual Review of Sociology*, *37*(1), 57–86. doi:http://doi.org/10.1146/annurev.soc.012809.102657

Song, Y. (2014). Methodological Issues in Mobile Computer-Supported Collaborative Learning (mCSCL): What Methods , What to Measure and When to Measure ? .*Educational Technology & Society*, *17*(4), 33–48.

Strijbos, J. W. (2011). Assessment of (Computer-Supported) Collaborative Learning. *IEEE Transactions on Learning Technologies*, *4*(1), 59–73. doi:http://doi.org/Doi 10.1109/Tlt.2010.37

Syriani, E., & Ergin, H. (2012). Operational semantics of UML activity diagram: An application in project management. In *2012 2nd IEEE International Workshop on Model-Driven Requirements Engineering, MoDRE 2012 - Proceedings* (1–8). doi:http://doi.org/10.1109/MoDRE.2012.6360083

Ting, Y.-L., & Tai, Y. (2013). A New Social Aspect in Collaborative Mobile Learning: Design Challenges and Learning Effects. *2013 IEEE 13th International Conference on Advanced Learning Technologies*. doi:http://doi.org/10.1109/ICALT.2013.13

Violet UML Editor. (n.d.). Retrieved March 6, 2016, from http://alexdp.free.fr/violetumleditor/page.php

Vygotsky, L. S. (1934). 1962. Thought and language. *Trans. E. Hanfmann and G. Vakar. Cambridge: MIT Press*.

Vygotsky, L. S. (1978). Interaction between learning and development. *Mind in Society: The Development of Higher Psychological Processes*. doi:http://doi.org/10.1016/S0006-3495(96)79572-3

Vygotsky, L. S. (1978). Mind in society: The development of higher mental process. Cambridge, MA: Harvard University Press.

Wald, M., Li, Y., & Draffan, E. A. (2014). Synote: Collaborative mobile learning for all. *Procedia Computer Science*, *27*, 240–250.

Wasserman, A. I. (2010). Software engineering issues for mobile application development. *Proceedings of the FSE/SDP workshop on Future of software engineering research* (397–400).

Wong, L. H., & Looi, C. K. (2011). What seams do we remove in mobile-assisted seamless learning? A critical review of the literature. *Computers and Education*, *57*(4), 2364–2381. doi:http://doi.org/10.1016/j.compedu.2011.06.007

Wong, S. H. R. (2012). Which platform do our users prefer: website or mobile app? *Reference Services Review*, *40*(1), 103–115. doi:http://doi.org/10.1108/00907321211203667

Wu, Y., Luo, J., & Luo, L. (2010). Porting mobile web application engine to the Android

platform. *Computer and Information Technology (CIT), 2010 IEEE 10th International Conference on* (2157–2161).

Yusoff, Z., & Dahlan, H. M. (2013). Mobile based learning: An integrated framework to support learning engagement through Augmented Reality environment. *2013 International Conference on Research and Innovation in Information Systems (ICRIIS)* (251–256). doi:http://doi.org/10.1109/ICRIIS.2013.6716718

APPENDICES

APPENDIX A

Research Questionnaire
For
Modeling Collaborative Mobile Learning (CML)

I am Omar Hamid, MSc student in Information Technology (IT); currently I am conducting this questionnaire as a part of my study under the Mobile Learning (M-learning) area.

The existing questionnaire will be mainly to measure and the evaluation of user acceptance about the modeling Collaborative Mobile Learning (CML) for perceived usefulness and ease of use as well as the collaboration.

The CML model is an Android application designed for group learning to share, interact and facilitate the group learning tasks. I hereby would like to invite you to participate in this survey by completing the attached questionnaire.

This questionnaire will be separated into two parts (Section A, and B). Section A will be illustrated the general information of the respondents. While section B will be for measuring the perceive of usefulness and the perceive of ease of use in addition to the collaborative learning of the application.
Please answer **ALL** questions from each section.

Your participation and contribution are highly appreciated

Yours sincerely

Omar Hamid
0187876771
omer80net@gmail.com

Section A: General Information

This part is about your background information. Please fill up the blank and mark [√] where appropriate.

1. Please indicate your gender

✕ Male ✕ Female

2. Please indicate your age group

✕ 18-24 ✕ 25-34
✕ 35-44 ✕ 45-54
✕ 55 and over

3. Level of education

✕ Bachelor Degree
✕ Master
✕ Ph.D.
✕ Others (specify)…….

Section B: Application acceptance

Please rate the usefulness, ease to use and collaborative learning of the CML application by tick an appropriate box.

No	Questions	Evaluation Rate				
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Perceived Usefulness						
Q1	I believe that using CML application is a useful learning tool.					
Q2	I feel that using the CML application will help me to learn with my group.					
Q3	It saves my time and effort when I use the CML application.					
Q4	The CML application gives me more control over its activities.					
Q5	The CML application makes the things I want to accomplish easier to get.					
Q6	The CML application addresses my collaborative learning related needs.					
Ease to Use						
Q7	The CML application is easy to use.					
Q8	The CML application is flexible use.					
Q9	The CML application is simple to use.					
Q10	The CML application is user friendly.					
Q11	By the CML application I always felt I knew what it was possible to do next.					

Q12	I can use the CML application without written instructions.					
Q13	I can recover from mistakes quickly and easily by using the CML application.					
Q14	I learned to use the CML application quickly.					
Q15	I easily remember how to use CML application.					
Q16	CML application feedback: It is helpful in the error message.					
Collaborative Learning						
Q17	I felt that using the CML application for collaborative learning was effective.					
Q18	I was able to develop learning skills through peer collaboration.					
Q19	My collaborative learning would be difficult without the CML application.					
Q20	Using the CML application increases my collaborative learning productivity.					
Q21	I was able to develop new skills and knowledge from the group members.					

Do you have any other comments about the CML application?

Note : ----------

Thank you for your time and assistance

APPENDIX B

Interview Questions

1. Do you have learned within learning group?
2. How do you communicate your classmates within learning group after finished school?
3. Do you have any experienced in using the collaborative learning application on a mobile phone?
4. If a new mobile application on collaborative learning will be proposed, what are the functions you hope to be implemented in the application?
5. What do you think the best way to organize the collaborative learning through mobile technology?

Answers

1.

2.

3.

4.

5.

Thank You for Your Time

APPENDIX C

Functional Requirements

In the application design, the functional requirements refer to the implementation of a certain operation that happens after particular events. According to Al-Shemarry (2010), functional requirements are intended to capture the anticipated behavior of the system. It is a named procedure that performs a distinct service; the CML model requirements contain many functions for the application work. The functions represented the important issues that were collected under the research topic which combined the Collaborative Learning with the M-learning concepts. It is of instructional significance that the study adopted the two concepts since they are closely connected with instructional principles that emphasize on evolving many aspects in the learning area and achieving the main target which is utilizing the new learning tools. The functions are listed in the following Table 4.5 which consists of six classifications as follows:

1. Requirement ID.
2. Requirement Description.
3. Member authorization.
4. Admin authorization.
5. Lecturer authorization.
6. Priority, where:
    - H: High priority.
    - M: Medium priority.
    - L: Low Priority.

Table C.1

Functional Requirements

Requirement ID	Requirement Description	Member	Admin	Lecturer	Priority
	Register				
CML_1	The application allows new user to sign up with new email ID and password.	√	√	√	H
	Login				
CML_2	The application allows user to login with correct email ID and password.	√	√	√	H
	Manage Group				
CML_3	In Main Menu, the application allows user to enter manage group.	√	√	√	H
	Create Group				
CML_3_1	The application allows user to create new group.		√		H
	Delete Group				
CML_3_2	The application allows user to delete the existing group.		√		M
	View Members				
CML_3_3	The application allows user to view members of the existing group.	√	√	√	H
	Manage Wall				
CML_4	In Main Menu, the application allows users to enter the wall.	√	√	√	H
	Add Post				
CML_4_1	The application allows user to post a new subject.		√		H
	View Discuss Wall				
CML_4_2	The application allows user to view and discuss the posted group wall subject.	√	√	√	H
	Manage Chat				
CML_5	In the Main Menu, the application allows user to enter and view the group chat and its content.	√	√	√	H
	Chatting				
CML_5_1	The application allows user to write and send online interactive conversation.	√	√	√	H
	Chat Sharing				
CML_5_2	The application allows user to attach, send and view various	√	√	√	H

	files types.				
	Manage Files				
CML_6	In the Main Menu, the application allows user to enter the files department.	√	√	√	H
	View Files				
CML_6_1	The application allows user to view the shared group files in one sorted place.	√	√	√	H
	Delete File				
CML_6_2	The application allows user to delete the shared group files.		√		M
	Manage Voting				
CML_7	In the Main Menu, the application allows user to enter the Voting department.	√	√	√	H
	Add Subject				
CML_7_1	The application allows user to post the subject that needs to make decision/solve problem.		√		H
	Vote				
CML_7_2	The application allows user to view and vote on the group's voting subject.	√	√		H
	View Statistics				
CML_7_3	The application allows user to view statistics of the group's voting subject.	√	√	√	H
	Manage Messages				
CML_8	In the Main Menu, the application allows user to enter the Message department.	√	√	√	H
	Send Message				
CML_8_1	The application allows user to send a private users' messages.	√	√	√	H
	View Messages				
CML_8_2	The application allows user to view a private users' messages.	√	√	√	H
	Calendar				
CML_9	The application allows user to view and/or edit own device calendar.	√	√	√	M
	Manage Profile				
CML_10	The application allows user to update own profile information.	√	√	√	H

Non-Functional Requirements

In the modeling of CML application, non-functional requirements represented the most important properties since they determined the main criteria obtained from the collected and analyzed data. According to Ameller, Franch and Cabot (2010), they formed attractive target among researchers in the requirements engineering. Non-functional features used to measure some subjects that are responded by the application such as performance, quality of operations, quality attributes, security, accuracy, modifiability, and performance in the application jobs. Table 4.6 details the most important non-functionalities issues, which considered in the modeling CML application. The table information categorized as follows:

1. Requirement ID.
2. Requirement Description.
3. Priority, where:
    - H: High priority.
    - M: Medium priority.
    - L: Low Priority.

Table C.2

Non-functional Requirements

Requirement ID	Requirement Description	Priority
CML_11	**Usability**	
CML_11_1	The application should be simple to use, does not need training and has understandable interfaces.	H
CML_11_2	The application should provide the right options and soft-key features to users which are included throughout the application and easily usable.	

CML_12	**Security**	
CML_12_1	The application should have a username and password to users' login.	H
CML_12_2	The application must be secure, for instance, it does not allow changing its contents by external users.	
CML_13	**Privacy**	H
CML_13_1	Some of users' information in this application must be confidential.	
CML_14	**Availability**	H
CML_14_1	The application should be highly available anytime and anywhere for the user.	
CML_15	**Reliability**	
CML_15_1	The application must reload again in case any kind of problems happened for the application such as a crash.	H
CML_15_2	The rate of failure occurrence for the application should be very low.	
CML_16	**Efficacy**	
CML_16_1	The application must have the power to retrieve the information.	H
CML_16_2	The application must have high performance.	
CML_17	**Compatibility**	H
CML_17_1	The application should be compatible with the phablet type of mobile device.	

APPENDIX D

Test Scripts

Table D.1

Functionality of the Registration

Test Script One: Register process to the CML prototype	**Priority(H, L):** High
Test Objective: The process of register.	
Test Description: This test Script clarifies the process of user's registration and filling in all the fields of information, which are required for	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls.	
Test step/Pre Condition: 1. The test case starts when the user taps on the "Sign Up" button. 2. The prototype displays the registration form. 3. The user fills the registration form. 4. The user submits this form by tapping the "Sign Up" button. • The user should fill all attributes.	
Actions: The entire fields are filled by the user.	**Expected Results:** The user registers in the CML and then logs in.
Pass: Yes	**Fail:** No.
Problem/ Issue: Nil.	
Notes: Successfully Accomplished.	

Table D.2

Functionality of Login

Test Script Two: The login process to the CML prototype	**Priority(H, L):** High
Test Objective: The login process helps all users to perform their needs.	
Test Description: This test Script explains the login process. The registered users can access into the prototype. Hence, authenticity filter is necessary.	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls	
Test step/Pre Condition: 1. This test case starts when the user taps on the "Log In" button. 2. The prototype displays the login interface. 3. The user inputs his/her username, password and chooses user type. 4. The user submits the form by tapping on the "Log In" button. 5. The prototype will open his/her account. 6. The user must have already registered and have username, password and user type to login to the CML prototype.	
Actions: The user must enter the username, password and choose the user type correctly.	**Expected Results:** After verifying the username, password and user type, the user logs in the CML prototype.
Pass: Yes	**Fail:** No
Problem: Nil.	
Notes: Successfully Accomplished.	

Table D.3

Functionality of Manage Group

Test Script Three: The group creation, deletion or Viewing the Group Members process of the CML prototype	**Priority(H, L):** High
Test Objective: Create and delete group process in addition to view group members in the CML prototype.	
Test Description: This test Script explains the group creation and deletion process. The group admin user can choose the group name and members into the prototype. Hence, new group was created. Then, this new group can be deleted by the group admin. As well as, all users can view group members.	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls.	

Test step/Pre Condition:

1. This test case starts when the group admin user taps on the "Groups" button.
2. The prototype displays the "Manage Group" interface.
3. The admin group user taps "Create Group" or "Delete Group" button to create or delete group.
4. The prototype displays the "Create Group" interface in case the group admin wants to create group or the prototype displays "Delete the Group" interface and shows the group name to delete the group.
5. In group creation, the group admin names the new group and chooses the group member then either taps "Create" button to create the group or "Back" button to cancel the process.
6. For group deletion, the admin group chooses the group name, then either taps "Select" button to delete the existing group or "Back" button to cancel the process.
7. Create and delete functions are entitled to the group admin only.
8. View members for normal user by tapping the "Groups" button and then tapping the "View Members" button.
9. The prototype displays the "Group Members" interface and shows the members' names.
10. The user can choose the "Back to Group" button to return to the "Manage Group" interface.

Actions: The group admin presses "Create Group" button to make a new group, or presses "Delete Group" button to delete the selected group correctly. All users can view group members.	**Expected Results:** a new group was created in the CML prototype. By delete function, the prototype deletes the selected group. The group members' names were shown in the CML prototype.
Pass: Yes	**Fail:** No
Problem: Nil.	
Notes: Successfully Accomplished.	

Table D.4

Functionality of Manage Wall

<table>
<tr><td><u>Test Script Four:</u> Adding or viewing the wall post and its comments of the group wall in the CML prototype.</td><td><u>Priority(H, L):</u> High</td></tr>
<tr><td colspan="2"><u>Test Objective:</u> The group's wall post process helps the group admin to inform the group member about certain subject. Besides, it enables the group members to view the post and comment on it.</td></tr>
<tr><td colspan="2"><u>Test Description:</u> This test case explains posting a new wall post process of the group. The group admin user can make a new wall post in the prototype. Then, the post will be displayed to the group. Next, the group members can reply the post by comment and view it in the CML prototype.</td></tr>
<tr><td colspan="2"><u>Requirements verified:</u> Yes.</td></tr>
<tr><td colspan="2"><u>Test environment:</u> Phablet mobile device, Android system, SDK and JSP Java tolls.</td></tr>
<tr><td colspan="2"><u>Test step/Pre Condition:</u>
1. This test case starts when the user taps on the "Wall" button.
2. The prototype displays the "Manage Wall" interface.
3. The group admin taps the "Add Post" button.
4. The group admin fills the "Add Contents" field by the post contents.
5. The group admin user can either tap "Submit" button to add the post or taps "Back" button to cancel the process, then return to "Manage Wall" interface.
6. All group members can view the post and replay it by tapping "Comment" button, in addition to view all comments using "View Comments" button.
7. The user uses "Back to Wall" button to return quickly to that interface.</td></tr>
<tr><td><u>Actions:</u> The group admin taps "Add Post" button to view the group members' names and the group members choose "View Wall" to view the post subject then they reply and view all post information.</td><td><u>Expected Results:</u> The CML prototype displayed the post to the group members and the users managed the wall in the CML prototype.</td></tr>
</table>

Pass: Yes	**Fail:** No
Problem: Nil.	
Notes: Successfully Accomplished.	

Table D.5

Functionality of Manage Chat and Files

Test Script Five: Chatting, sharing and view files among the group members in the CML prototype.	**Priority(H, L):** High
Test Objective: The group's chat process helps the group members to interact online through the prototype communication; besides, allowing them to share and view various files types, as well as managing files by the group admin.	
Test Description: This test case explains the process of sending and receiving text chat and/or attaching files among the group members. The group admin can delete files in the group.	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls.	

<table>
<tr><td colspan="2"><u>Test step/Pre Condition:</u>
1. This test case starts when the user taps on the “Chat” button.
2. The prototype displays the “Chatting” interface.
3. The group members fill the field of the text chat, then tap “Send” button.
4. The prototype displays all text chat sent by the group members in a synchronized way.
5. The group members use “Attach” button to upload a file located in the mobile device to the group chat.
6. The prototype displays a notification text on the display chat area.
7. The group members tap “View Files” button.
8. The prototype displays “Select the File” interface that contains all group files.
9. The group members tap the file to open it.
10. The prototype displays a host file application.
11. The group members tap the related application and then open the file.
12. All users use “Back to Wall” to return quickly to that interface.</td></tr>
<tr><td><u>Actions:</u> The group members manage group chat and files.</td><td><u>Expected Results:</u> The CML prototype displayed the group members’ chat and files, then the users managed the chat and files in the CML prototype.</td></tr>
<tr><td><u>Pass:</u> Yes</td><td><u>Fail:</u> No</td></tr>
<tr><td colspan="2"><u>Problem:</u> Nil.</td></tr>
<tr><td colspan="2"><u>Notes:</u> Successfully Accomplished.</td></tr>
</table>

Table D.6

Functionality of Manage Messages

Test Script Six: Manage "Messages" function.	**Priority(H, L):** High
Test Objective: Help the group to send, receive and view private messages of the group in the CML prototype.	
Test Description: This test case explains the process of sending, receiving and viewing messages between the group members and their lecturer.	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls.	
Test step/Pre Condition: 1. This test case starts when the user taps on the "Messages" button. 2. The prototype displays the "Manage Messages" interface. 3. The group member taps the "Send Message" button. 4. The prototype displays "Send Message" interface. 5. The group member fills the "To" field by the receiver's contact email and fills the "Subject" field by message subject, and then writes the message text contents. 6. The group member taps the "Send" button. 7. The prototype displays "The message has been sent successfully" hint. 8. For viewing messages, the group member taps "View Message" in "Mange Message" interface. 9. The prototype displays the message subject and sender name. 10. The group member opens and views message by tapping on the message.	
Actions: All users manage message of their group in the CML prototype correctly.	**Expected Results:** The CML prototype displayed the group members' messages information and the users managed the messages in the CML prototype.
Pass: Yes	**Fail:** No
Problem: Nil.	
Notes: Successfully Accomplished.	

Table D.7

Functionality of Manage Voting

Test Script Seven: The voting function in the CML prototype.	**Priority(H, L):** High
Test Objective: Helps the group to make decision using the group's voting process in the CML prototype.	
Test Description: This test case explains voting process for the group. The group admin user can make a new voting subject with its options. Then, the vote subject will be displayed to group. Next, the group members can vote by selecting only one option after viewing all options of the voting subject in the CML prototype.	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls.	
Test step/Pre Condition: 1. This test case starts when the user taps on the "Voting" button. 2. The prototype displays the "Manage Voting" interface. 3. The group admin taps the "Add Subject" button. 4. The group admin fills the subject and options fields. 5. The group admin user can either taps "Submit" button to add the voting subject or taps "Back" button to cancel the process, then returns to "Manage Voting" interface. 6. The group members view the voting subject using "Vote" button and respond by choosing the subject name, then tapping the "Select" button. 7. The prototype displays "Voting Options" interface. 8. The group members choose only one option then tap "Select" button. 9. The group members view statistics using its button. 10. The prototype displays the voting subjects. 11. The group members choose the subject name in the "Select Voting Subject" interface and tap "Select" button. 12. The prototype displays "Voting Statistics" interface and shows the voting results. 13. All users use "Back to Voting" to return quickly to that interface.	

Actions: The group admin manages the vote subject while the group members view and respond to the voting subject then all view the voting statistics correctly.	**Expected Results:** The CML prototype displayed the voting subject and its options and the users managed the voting subject in the CML prototype.
Pass: Yes	**Fail:** No
Problem: Nil.	
Notes: Successfully Accomplished.	

Table D.8

Functionality of Calendar View

Test Script Eight: Viewing the calendar function.	**Priority(H, L):** High
Test Objective: Help the user quickly moves to and manages the actual device calendar in the CML prototype.	
Test Description: This test case explains the use of the device calendar in the CML.	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls.	
Test step/Pre Condition: 1. The use of this case starts when the user taps the "Calendar" button. 2. The prototype displays the original device calendar interface. 3. The user sets or updates the event/task and then taps "Save" button to save the calendar changes or "Cancel" button to cancel the calendar process.	
Actions: The user manages the device calendar in the CML prototype.	**Expected Results:** The CML prototype displayed the mobile calendar quickly and the users managed the calendar in the CML prototype.
Pass: Yes	**Fail:** No
Problem: Nil.	
Notes: Successfully Accomplished.	

Table D.9

Functionality of Manage Profile

Test Script Nine: The profile's function in the CML prototype.	**Priority(H, L):** High
Test Objective: helps the user to manage the profile information in the CML prototype.	
Test Description: This test case explains managing the profile information for the user. The user can update his/her information including the first name, last name and password.	
Requirements verified: Yes.	
Test environment: Phablet mobile device, Android system, SDK and JSP Java tolls.	
Test step/Pre Condition: 1. This test case starts when the user taps the "Profile" button. 2. The prototype displays the "Manage Profile" interface. 3. The user fills the information fields. 4. The user either taps "Update" button to save the new changes or "Back" button to cancel the process, then returns to "Main Menu" interface.	
Actions: The user manages his/her profile information in the CML prototype correctly.	**Expected Results:** The CML prototype displayed the profile information and the user managed the profile information in the CML prototype.
Pass: Yes	**Fail:** No
Problem: Nil.	
Notes: Successfully Accomplished.	

As shown in Tables 1.1 to 1.9, the results of the test cases were mentioned in each table starting with the table number, functionality name, and filling all information that represented the test details for everyone. Each table contained the function information indicating the functionality name that refers to the function work. The function number was mentioned orderly as the prototype designed. The function priority has two results

represented by either high or low according to its performance. Then, the test objective determines the goal of the function intended to be achieved and the test description clarifies the existing function. The part of requirement verified should be answered by yes or no, after that the test environment indicates the operating system, programs, programming language and tools' names that were employed in the implementation phase of the CML prototype.

Next, test step/pre condition represents one of the important parts in the test cases; it lists the steps of conducting the test function. Moreover, it involves mentioning the conditions of this function. The action part briefly contains the function action which was done by the user and the expected results correlate the obtained result with the expected result by the developer. In case the function has some problems, the tester must indicate the function result by either "No" in pass part and "Yes" in the fail part (if the function has a problem) or "Yes" in pass part and "No" in the fail part (if the function has no problem) and so on. The problem part should be filled by the diagnosed error name. Finally, the note part also requires providing the status of function accomplishment.