รายงานวิจัยฉบับสมบูรณ์

สิ่งแวดล้อมการเรียนรู้แบบไร้ขอบเขตโดยใช้สถาปัตยกรรมแบบมัลติเอเจ้นต์

Ubiquitous Learning Environment with Multi-Agent Architecture

โดย

ผศ.ดร. พรรณฤมล เต็มดี

งานวิจัยนี้ได้รับเงินอุดหนุนการวิจัยจากมหาวิทยาลัยแม่ฟ้าหลวง
ประจำปีงบประมาณ พ.ศ. 2552

มหาวิทยาลัย
แม่ฟ้าหลวง

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Asst. Prof. Dr. Punnarumol Temdee and Team

EXEXCUTIVE SUMMARY

Introduction

Ubiquitous learning (u-learning) becomes popular currently. Generally, U-learning has emerged because of the advent of ubiquitous computing (Weiser, M., 1991), where the presence of computers is becoming less conspicuous and blended into everyday lives. With advanced sensor technology, u-learning is the setting of education in which the learning process is happening all around the learners. The learners are situated in a context-aware learning environment and they may not even be conscious of the learning process (Li, L. and Zheng Y., 2008).

Early research in u-learning pays much attention to the development of ULEs in order to provide seamless ways of content delivery (Luckin et.al., 2003; Lonsdale et.al., 2003; Baber et.al., 2003; Chang et.al., 2005; Hwang, G.J., 2006; van't Hooft et.al., 2007). Many works focus in how to seamlessly integrate the mobile devices and the learning system to achieve the objective of anywhere and anytime learning (Barbosa et.al., 2008; Wu et al., 2008; Xu, S. and Hu, Z, 2008; Hsieh et. al., 2007; Chang et.al.,2005). Generally, ULE not only provides the anywhere and anytime learning environment to the learners, but also provides the right time, right place with the right learning resource and the right learning peer for the learners. More specifically, the ULE is generally called the context aware environment. Consequently, many current works aim to provide the context aware system to support the personalization of the learners (Scott, K. and Benlamri, R., 2010; Wang et.al., 2007; Nino, et.al., 2007). Although the context aware is widely introduced, the personalization of the learners is

normally still self-initiated by the learners (Poursaeed, B. and Lee, C.S., 2010). To serve the unconscious learning, this research proposes the ULE which is the virtual environment being able to provide the learning paths for the learners adaptively and automatically.

Objective

The objectives of this research are shown as following:

1. To develop Ubiquitous Learning Environment (ULE) using Multi-Agent based architecture.
2. To study to what extend this ULE affect learning efficiency and satisfaction of the learners.
3. To collect interaction patterns for interaction modeling for the future work.

Scope

This research aims to develop the virtual ULE. The learning objects (Los) in ULE are constructed as multi-agent architecture. The learners can access ULE by using both mobile devices and laptop computers through mobile application and web application respectively. There are two kinds of communication tools used in this ULE including webboard and email. The empirical study is conducted with 40 students from School of Information Technology, Mae Fah Luang University for the Introduction to Artificial Intelligence subject.

Research Methodology

There are 4 main parts of research methodology in this research including ULE development, ULE employment, ULE assessment, and discussion and conclusion.

Results and Discussion

The empirical study is conducted with 40 students from school of Information Technology, Mae Fah Luang University, Chiang Rai, Thailand. The students are divided into 2 groups and 20 students per each including the group studying though ULE without multi agent architecture and the group studying though ULE without multi agent architecture. Both group of students are assigned to study the special subject named "Introduction to Artificial Intelligence" having 7 LOs in 3 months. The developed ULE is evaluated for 2 aspects including learning efficiency enhancement and satisfaction of functionality and adaptability of ULE. For learning efficiency enhancement, the results show that the developed ULE is able to enhance the learning efficiencies of students both 2 groups. For the satisfaction of functionality and adaptability, the results show that the students are satisfied and very satisfied by the developed ULE by for functionality and adaptability respectively.

Conclusion

This research aims to develop the ULE promoting ubiquitous learning. The developed ULE has the LOs having multi agent architecture which 3 agents coordinate among each other. Three agents are Personal Agent, Content Agent and Representation Agent. The empirical study conducted with 40 students from school of Information

Technology, Mae Fah Luang University, and shows that the developed ULE are able to enhance learning efficiency of the students. Moreover, the students are satisfied the functionality and very satisfied the adaptability by the developed ULE respectively.

Output

There publications have been published regarding this research as following:

1. W. Tipaksorn and P. Temdee, " **Ontology-Based Approach for Content Management in Ubiquitous Learning Environment**", MFU conference, Nov.19-20, 2010.

2. W. Tipaksorn and P. Temdee, "**Collaborative Learning in Ubiquitous Learning Environment**", The 25 th International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC) 2010, Pattaya, Thailand. July 4-7, 2010.

3. W. Tipaksorn and P. Temdee, "**Smart Learning Objects for Ubiquitous Learning Environment**", International Conference & Symposium on Computer Games; Animation, Multimedia, IPTV, Edutainment & Security (CGAT 2010), Singapore, April 5-6, 2010.

สิ่งแวดล้อมการเรียนรู้แบบไร้ขอบเขตโดยใช้สถาปัตยกรรมแบบมัลติเอเจ้นต์

บทคัดย่อ

การเรียนรู้แบบไร้ขอบเขตได้เป็นที่รู้จักอย่างแพร่หลายในปัจจุบันในวงการเทคโนโลยีการศึกษา ลักษณะสำคัญของการเรียนรู้แบบไร้ขอบเขต คือการที่ผู้เรียนได้ถูกล้อมรอบด้วยสิ่งแวดล้อมที่มีความรอบรู้ในบริบทรอบตัวทั้งที่เป็นสิ่งแวดล้อมทางกายภาพและสิ่งแวดล้อมเสมือนและผู้เรียนไม่ได้ตระหนักว่าเกิดกระบวนการเรียนรู้ขึ้น งานวิจัยนี้เสนอการพัฒนาสิ่งแวดล้อมการเรียนรู้แบบไร้ขอบเขตที่เป็นสิ่งแวดล้อมเสมือนให้มีความสามารถปรับเนื้อหาให้กับผู้เรียนที่มีความสามารถต่างกันได้อย่างเหมาะสม สิ่งแวดล้อมนี้ถูกออกแบบให้ประกอบด้วยวัตถุการเรียนรู้หลาย ๆวัตถุด้วยกัน ในแต่ละวัตถุมีลักษณะสถาปัตยกรรมแบบมัลติเอเจ้นต์เพื่อทำให้เกิดความสามารถในการปรับตัวได้ วัตถุการเรียนรู้ประกอบด้วยเอเจ้นต์สามประเภททำงานร่วมกัน ได้แก่ เอเจนต์บุคคลทำหน้าที่ติดต่อกับผู้เรียนและเก็บข้อมูลในอดีต เอเจนต์เนื้อหาทำหน้าที่เสนอเนื้อหาและวัตถุการเรียนรู้ที่เหมาะสมให้กับผู้เรียน และเอเจนต์การนำเสนอทำหน้าที่นำเสนอเนื้อหาให้กับผู้เรียน การศึกษาการใช้งานสิ่งแวดล้อมที่สร้างขึ้นกับนักศึกษาจำนวนสี่สิบคนจากสำนักวิชาเทคโนโลยีสารสนเทศ มหาวิทยาลัยแม่ฟ้าหลวง กับวิชาปัญญาประดิษฐ์เบื้องต้นเป็นเวลาสามเดือน พบว่าสิ่งแวดล้อมที่สร้างขึ้นสามารถช่วยให้นักศึกษาเรียนรู้ได้ดีขึ้นและนักศึกษามีความพึงพอใจต่อฟังก์ชั่นการใช้งานและมีความพึงพอใจมากต่อความสามารถในการปรับตัวได้ของสิ่งแวดล้อมที่สร้างขึ้น

คำสำคัญ: การเรียนรู้แบบไร้ขอบเขต, สิ่งแวดล้อมการเรียนรู้แบบไร้ขอบเขต, วัตถุการเรียนรู้, ระบบมัลติเอเจ้นท์

Ubiquitous Learning Environment with Multi-Agent Architecture

Abstract

Ubiquitous learning (u-learning) has become popular nowadays in education area. The key factor of u-leaning is that the learners are situated in a context-aware learning environment both physical and virtual environment and they may not even be conscious of the learning process. This research aims to develop the virtual Ubiquitous Learning Environment (ULE) being able to provide the content to difference performance of the learners appropriately and adaptively. The ULE is designed to have several Leaning Objects (LOs) having the multi-agent architecture to achieve adaptability. LOs consist of three different agents coordinating together including a Personal Agent for keeping the users' profiles and their historic actions, a Content Agent for deciding what content and LO should be presented for the learners, and a Representation Agent for making decision how to present the content to the learners. The empirical study is conducted with 40 students from School of Information Technology, Mae Fah Luang University for a special subject named "Introduction to Artificial Intelligence" for 3 months. The results show that the developed ULE can enhance the students' learning efficiencies. Additionally, the students are satisfied and very satisfied by the developed ULE for the functionality and adaptability.

Keywords: Ubiquitous Learning, Ubiquitous Learning Environment, Learning Object, Multi-agent System

CONTENT

TABLE CONTENT

FIGURE CONTENT

CHAPTER 1

INTRODUCTION

1.1 Background

The use of education technology is dramatically growing recently. It is inevitable that this growth is continually affected by the advent of learning theories and modern technology as Information Communication Technology (ICT). Traditionally, education views learning as the provision of curriculum within bounded lessons including clearly defined contents, activities, evaluations and goals. This view is now often argued to be too limited for the new education environment where distributed massive information brings the rich possibility for knowledge acquisition to the learners.

Taking advantage of ICT, education technology has accomplished several learning supporting systems along with the evolution of technology. Figure 1-1 shows the trend of learning supporting system. From Figure 1-1, when PC becomes popular in 80', standalone systems called Computer Based Learning (CBL) are mainly used as the learning supporting systems such as Computer Aided Instruction (CAI) and Intelligence Tutoring System (TIS) (Anderson et.al, 1995; Suppes, P. & Macken, E., 1978). When the Internet and WWW becomes popular, Web based Learning (WBL) has been introduced widely. Consequently, several systems have changed from Computer Based Learning (CBL) to e-learning respectively. The introduction of e-learning (Jones, V. and Jo, J.H., 2007) epitomizes an education transformation and the

effective way of content delivery for years. Later, when mobile devices and wireless communication become available, Mobile-learning (m-learning) becomes the potential alternate of WBL. Now, the Ubiquitous Learning (u-learning) has been widely introduced in the education area because of the advance in embedment technology.

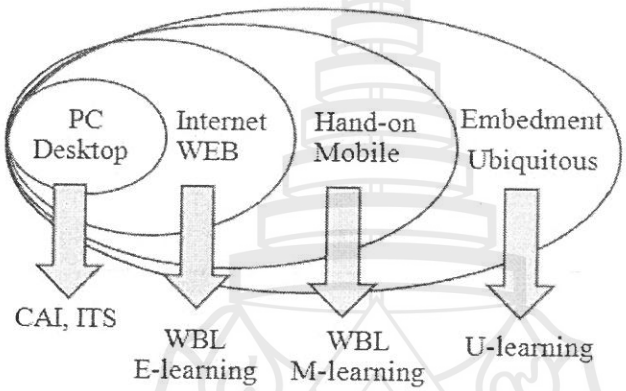

Figure 1-1 Trend of Learning Supporting System

From Cheng et.al., 2005

Generally, U-learning has emerged because of the advent of ubiquitous computing (Weiser, M., 1991), where the presence of computers is becoming less conspicuous and blended into everyday lives. With advanced sensor technology, u-learning is the setting of education in which the learning process is happening all around the learners. The learners are situated in a context-aware learning environment and they may not even be conscious of the learning process. More specifically, u-learning requires the system having the interoperability and adaptability. The interoperability means the coordination and interoperations among multiple, heterogeneous learning devices.

The adaptability means the adaptability of learning devices and learning resources to the learner's current context (Li, L. and Zheng Y., 2008).

U-learning is considered as the environment where there is the seamless integration of multiple learning resources both physical and virtual resources and the ubiquitous support of learning. Learning materials are presented in the attached/embedded objects called Learning Objects (LOs) in a ubiquitous learning environment (ULE). The learners interact with the various devices, learning objects and all among the learners. There are significant future challenges with the implementation of u-learning as new education technology (Rogers, Y. and Price, S., 2007) which extends and enhances the learning process. It is obvious that u- learning leads the learners to face new ways of information acquisition and knowledge construction.

This research is interested in developing ULE particularly for the virtual environment to support ubiquitous learning. This ULE employs the multi agent architecture to promote the adaptability concept that the different content is chosen by the ULE to different learners appropriately.

1.2 Objective

The objectives of this research are shown as following:

1. To develop Ubiquitous Learning Environment (ULE) with Multi-Agent based architecture. The developed environment consists of ULE server, communication tools and learning objects (LOs). ULE server provides the management system, course contents and data storage. The learners access ULE by using mobile devices and laptop computers. More

specifically, learning Objects (LOs) is designed and developed with multi agent architecture. Additionally, this developed system is designed to provide the personalization and collaboration support in ULE. At the same time of having individual learning privately, the learners can conduct the collaborative learning through the webboard of ULE. Figure 1-2 shows the architecture of developed ULE.

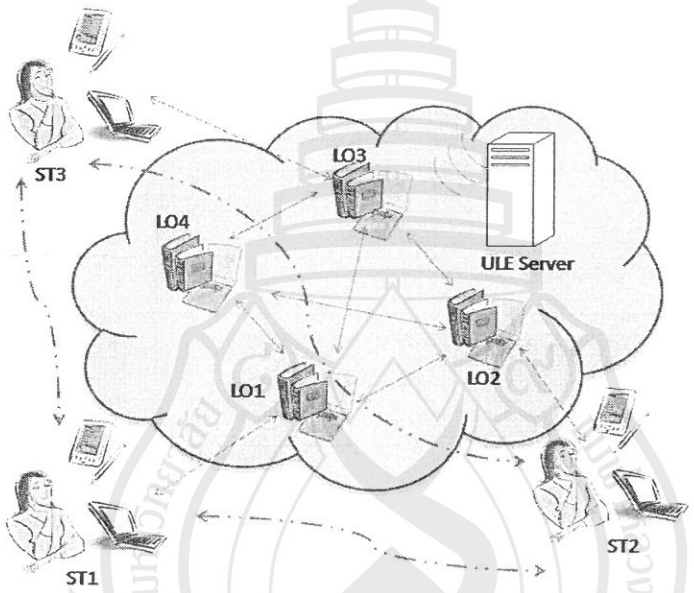

Figure 1-2 ULE Architecture

2. To study to what extend this ULE affect learning efficiency and satisfaction of the learners.

3. To collect interaction patterns for interaction modeling for the future work.

1.3 Output

This research aims to develop the ULE having the multi-agents architecture to promote new trend of learning called u-learning. There are three types of agents coordinating in this environment including Profile Agent, Content Agent and Representation Agent. The research question that to what extent this ULE affect the learning efficiency and satisfaction of the learners is studied and answered.

1.4 Scope

This research aims to develop ULE to support the u-learning. The learning objects (Los) in ULE are constructed as multi-agent based architecture. The learners can access ULE by using both mobile devices and laptop computer through mobile application and web application respectively. There are two kinds of communication tools used in this ULE including web board and email. Three kinds of interactions are collected for the future study including the interactions among learners, between learners and Los and among Los. The developed ULE is tested with the Introduction to Artificial Intelligence subject with 40 students from School of Information Technology, Mae Fah Luang University.

1.5 Terminology

Ubiquitous Learning Environment: The system is used to promote u-learning. This research mainly focuses in only developing the virtual environment.

Learning Objects (LOs): The contents proposed to the learners to complete the particular subjects. One subject consists of many LOs to work coordinating all among others. The content in LO can be represented with many types of multimedia files.

CHAPTER 2

LITERRATURE REVIEW

2.1 Ubiquitous Learning (u-learning)

As u-learning has just become popular for the recent past, the learning model (Joo, K.H. and Kim, S.H., 2009) and instruction design (Junqi et. al., 2010) in ULE are widely studied to obtain the learning standard of u-learning. Although the learning standard of u-learning is not yet concluded, the researchers have been agreed on the features supporting u-learning (Junqi et. al., 2010). These features are permanency, accessibility, immediacy, interactivity, situating of instructional activities and adaptability. The permanency means the continuous providing and recording the learning services for the learners. The accessibility means that the learners can get the learning material anywhere and anytime. The immediacy means that the learners can acquire the information immediately. The interactivity means that the learners can interact with other people synchronously or asynchronously. The situating of instructional activities means that the learners will be given the problem or situation in the natural way and effective way. This feature supports the personalization concept or self learning which many researchers have been paid much attention to (Ye, S.H. and Hung Y.C., 2010; El-Bishouty et.al., 2008). Finally, the adaptability means that the system will be able to adaptively support the different learners appropriately. This adaptability is the main feature considered in this research.

2.2 Ubiquitous Learning Environment (ULE)

Early research in u-learning pays much attention to the development of ULEs in order to provide seamless forms of content delivery (Luckin et.al., 2003; Lonsdale et.al., 2003; Baber et.al., 2003; Chang et.al., 2005; Hwang, G.J., 2006; van't Hooft et.al., 2007). Many works focus in how to seamlessly integrate the mobile devices and the learning system to achieve the objective of anywhere and anytime learning (Barbosa et.al., 2008; Wu et. al., 2008; Xu, S. and Hu, Z, 2008; Hsieh et. al., 2007; Chang et.al.,2005). Generally, ULE not only provides the anywhere and anytime learning environment to the learners, but also provides the right time, right place with the right learning resource and the right learning peer for the learners. This concept is generally called the context aware concept. Consequently, many current works aim to provide the context aware system to support the personalization of the learners through physical and virtual environments for the learners (Scott, K. and Benlamri, R., 2010; Wang et.al, 2007; Nino, et.al., 2007). Some works particularly focus on providing the situation based learning appropriately (Wu et.al., 2008). Although the context aware is widely introduced, the personalization of the learners is normally still self-initiated by the learners (Poursaeed, B. and Lee, C.S., 2010). To serve u- learning, this research proposes the ULE which is the virtual environment being able to provide the learning paths for the learners appropriately and adaptively.

2.3 Software Agent

In order to serve the idea of unconsciously learning, this research employs the concept of multi agent architecture for developing LO in ULE. Taking advantage of multi-

agent architecture, all LOs in ULE can interact among each other adaptively. The learning agent is dominated to solve this adaptive problem for decade. Software agent may form multi agent system which developed from Distributed Artificial intelligent (DAI), Distributed Problem Solving (DPS) and Parallel AI (PAI). The early research works proposed a concept of the agent, which is "A self-contained, interactive and concurrently-executing object, possessing internal state and communication capability" in 1997. Later works proposed work concentrating on macro issues such as the interaction and the communication between agents, the decomposition and the distribution of tasks, the coordination and the cooperation, the conflict resolution via negotiation, etc.

2.3.1 Definition of Software Agent

An agent is anything that viewed as perceive its environment thought sensors and acts upon that environment thought actuator which is shown in Figure 2-1. Later the properties of agenthood were also defined that any software entities exhibiting these features are considered as the agent:

1. **Autonomy:** The agent performs the task without the direct intervention of human or other agents.

2. **Social ability:** The agent is able to interact with others when appropriate.

3. **Responsiveness:** The agent perceives its environment and responds in a timely fashion.

4. **Proactiveness:** The agent is able to exhibit opportunistic, goal-directed behavior and take the initiative when appropriate.

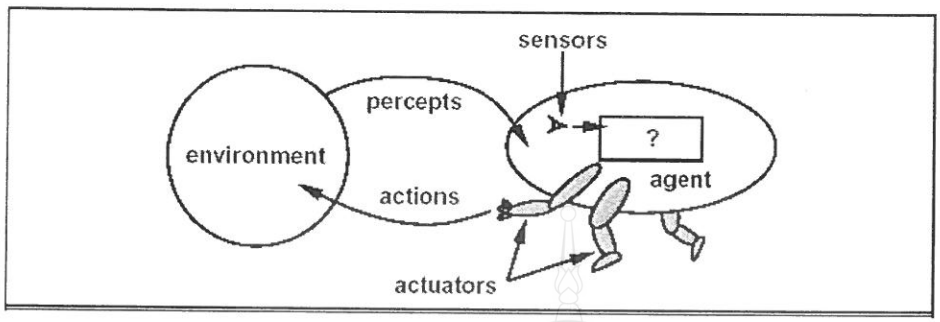

Figure 2-1 An Agent Interacting with Environment through Sensors and Actuators

From Russell, S. and Norvig, P., 2003

2.3.2 Learning Agent

The ability to learn of agent makes the agent become popular in various areas of problem solving. Agent learns by receiving the event from the environment and processes to make decisions. It can get knowledge by itself and inference engine. Following the black box concept, an agent percepts the event, it will collect an action to response to environment. Finally agents become expert system which is shown in Figure 2-2.

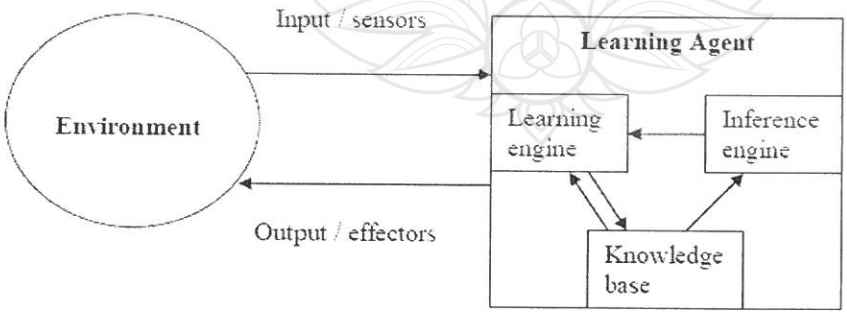

Figure 2-2 Agent as An Expert System

From Russell, S. and Norvig, P., 2003

2.4 Agent in Education Area

Actually, agents are being used in a wide variety of applications as diverse as personalized information management, electronic commerce, interface design, computer games, and management of complex commercial and industrial processes (Kosoresow, A.P. and Kaiser, G.E., 1998) as well as education domain. The early works of agent in education area mainly focuses on employing single agent to adaptively interact with the users. Generally, educational agents can be classified into three groups according to their roles and functions. Firstly, Pedagogical agents such as tutor agents (Shaw et.al., 1999; Olguin et.al., 2000; Dragsnes et.al., 2002) are designed particularly for a specific pedagogical purpose such as providing adaptive instruction appropriately to students and introducing online education material in the friendliest way (Olguin et.al., 2000; Dragsnes et.al., 2002). Secondly, Learning companion agents (Chou et.al., 2003) are non-authoritative pedagogical agents. For student, they are not a domain expert and may make the mistakes. They learn alongside with students either by the collaborative or competitive way to make the students reach higher achievement. Lastly, Personal assistant agents provide each user (instructor or student) with the individual preference information that pertains to learning activities, except involving in learning activities. For example, Student's assistant (Tian et.al., 2003) can help students to collect information to perform learning activities and represent their personnel preference models. Another example is Instructor's assistant (Whitehurst et.al., 1999) providing the instructor with all necessary information of the students.

This research aims to employ a group of agents called multi agents to coordinate all among others and to provide the learning environment that can support u-learning for the learners. The detail of proposed multi agent system is described in Chapter 3.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Research Methodology

There are 4 main parts of research methodology in this research including ULE development, ULE employment, ULE assessment, and discussion and conclusion as shown below:

1. ULE development

This process is to develop the ULE having the following characteristics:

1. This environment is accessed by the learners through mobile devices and laptop computers.

2. This environment consists of 2 databases including a courseware database and a user profile database.

3. This environment consists of many learning objects. Each learning object is designed and developed as multi agent based architecture having the following components:

- A Profile Agent is used for person identification and historic action storage.
- A Content Agent is used to contact with the learning material database.
- A Representation Agent is used to present the content for the learners.

4. There are email and web-board as the communication tools in this ULE.

2. ULE Employment

The empirical study is conducted with 40 students from School of Information Technology, Mae Fah Laung University. The experiment is conducted with Introduction to Artificial Intelligence subject having contents of 7 LOs. The students are given the mobile phone and laptop computer for completing their studies for 3 months. They are also provided with the wi-fi setting area.

3. ULE Assessment

ULE is assessed in the following aspects:

1. The student's learning efficiency after finish learning through ULE. The pre-test and post-test scores are compared and evaluated.

2. The students' satisfaction from the developed ULE in term of functionality and adaptability. The students are asked to complete a questionnaire for those aspects.

4. Discussion and Conclusion

All data is analyzed to address the research questions, which is to what extent the developed ULE enhance the learning efficiency and to what extent the student is satisfied by the ULE in terms of functionality and adaptability. The interaction data will be collected and analyzed to address these following two research questions in the future research including:

1. What patterns of interaction arise in ULE, including among students, between students and learning objects, and among learning objects?

2. How might these patterns of interaction affect learning outcomes?

3.2 System Analysis and Design

This process is to analyze and to design function and interface for the ULE before developing. The ULE is designed in order to serve 2 main users including the administrator (the teacher) and the member (the student). The administrator is authorized to be able to access any information / function in the system while the member is authorized to be able to access in some particular information / functions. Generally, there are 2 main systems in this research including the web application and mobile application. This research applies both systems from Temdee's work (Temdee, P., 2012).

3.2.1 Web Application

1. Roles

This is the system connecting the users with the server. Figure 3-1 shows the functions which are authorized for each user.

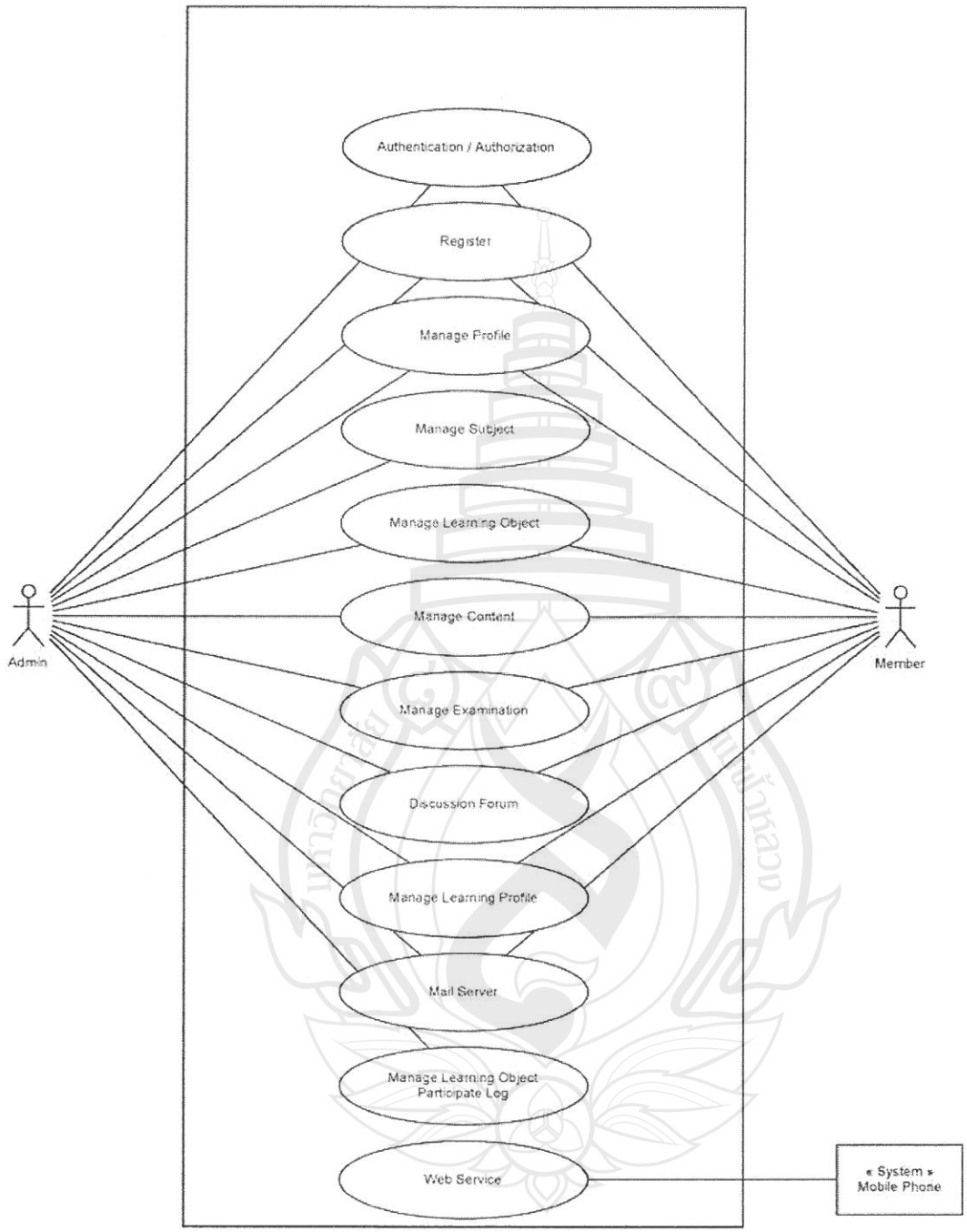

Figure 3-1 Functions for all users

Figure 3-1 shows that the member is limited for two functions including managing the subjects and learning objects participate log.

2. Operation Sequences

Three main components of this ULE are Web Browser, Learning Object and ULE Server. Figure 3-2 shows the operation sequences in ULE.

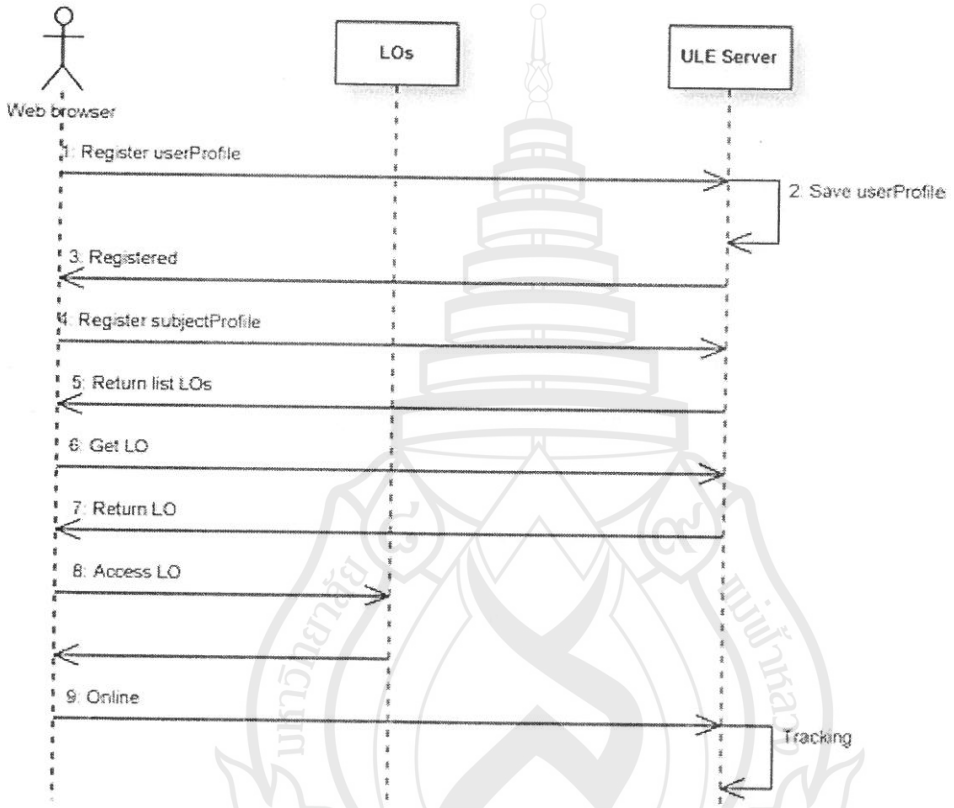

Figure 3-2 Operation Sequences in ULE

Figure 3-2 explains the operation sequences of using ULE as following:

1. The users have to register in ULE server through web browser in order to access ULE. The ULE server saves the profile, checks the authorization of the users and limits the access to the information of the registered users.

2. The authorized users are given the list of LOs after the registration.

3. After obtaining the Los address from the server, the users are able to access the LO directly.

4. The ULE server is able to track the users by keeping the path of each LO that the users have accessed.

5. At the same time, the ULE server keeps the list of LOs that the users have not completed yet for the future log in.

3. Functions

All functions in ULE and their details are shown in this session.

1 Profile Management

The functions for profile management are the functions dealing with the manipulation of registration members. Table 3-1 shows all functions, responsible roles and the definitions of those functions. Figure 3-3 shows all objects for implementing functions of profile management.

Table 3-1 Functions for Profile Management

Function	Responsible Roles	Definition
Create User Profile	Administrator Member	Creating the profile for new members
Update User Profile	Administrator Member	Updating profile of members
Delete User Profile	Administrator	Deleting the membership
View User Profile	Administrator Member	Viewing profiles of members
Search User Profile	Administrator	Searching profiles of members

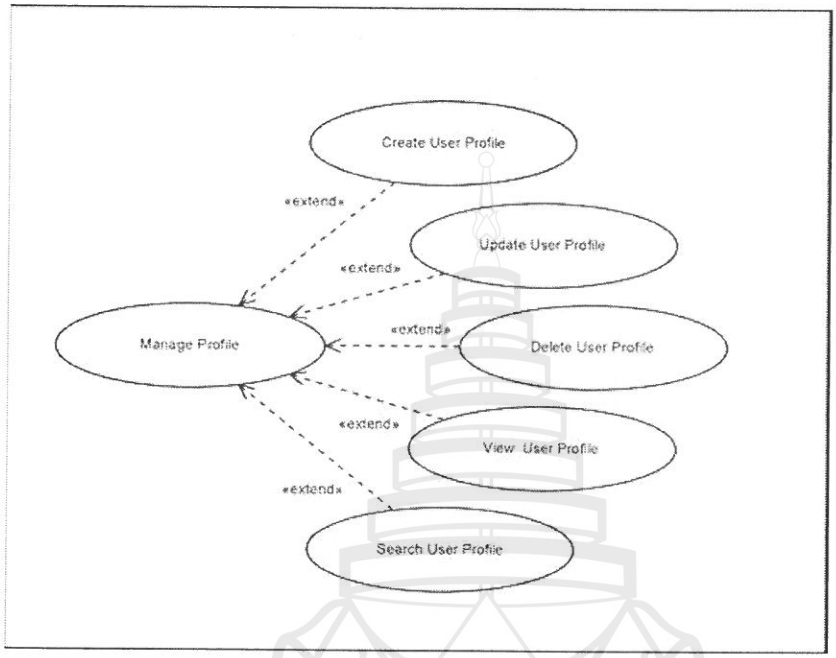

Figure 3-3 Objects of Profile Management

2. Subject Management

The functions for subject management are the functions dealing with the manipulations of all subjects provided in ULE. Table 3-2 shows all functions, responsible roles and the definitions of those functions. Figure 3-4 shows all objects for implementing functions of subject management.

Table 3-2 Functions for Subject Management

Function	Responsible Roles	Definition
Create Subject	Administrator	Creating new subject and its detail
Update Subject	Administrator	Updating subject
Delete Subject	Administrator	Deleting subject and detail

View Subject	Administrator Member	Viewing subject
Search Subject	Administrator Member	Searching subject

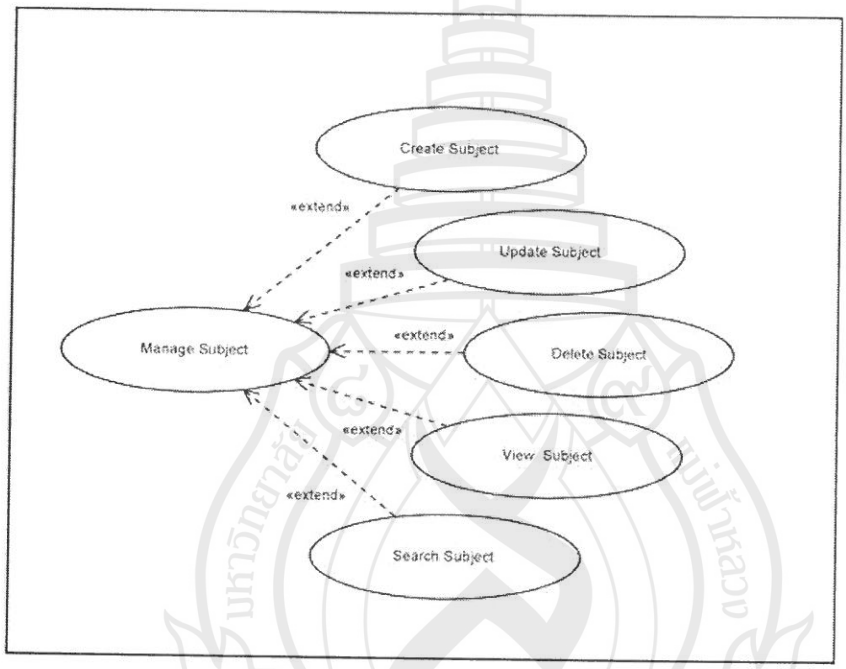

Figure 3-4 Objects of Subject Management

3. Learning Object Management

The functions for learning object management are the functions dealing with the manipulations of all learning objects provided in ULE. Table 3-3 shows all functions, responsible roles and the definition of those functions. Figure 3-5 shows all objects for implementing functions of learning object management.

Table 3-3 Functions for Learning Object Management

Function	Responsible Roles	Definition
Create Learning Object	Administrator Member	Creating new learning object and its detail
Update Learning Object	Administrator Member	Updating learning object
Delete Learning Object	Administrator Member	Deleting learning object and detail
View Learning Object	Administrator Member	Viewing learning object
Search Learning Object	Administrator Member	Searching learning object

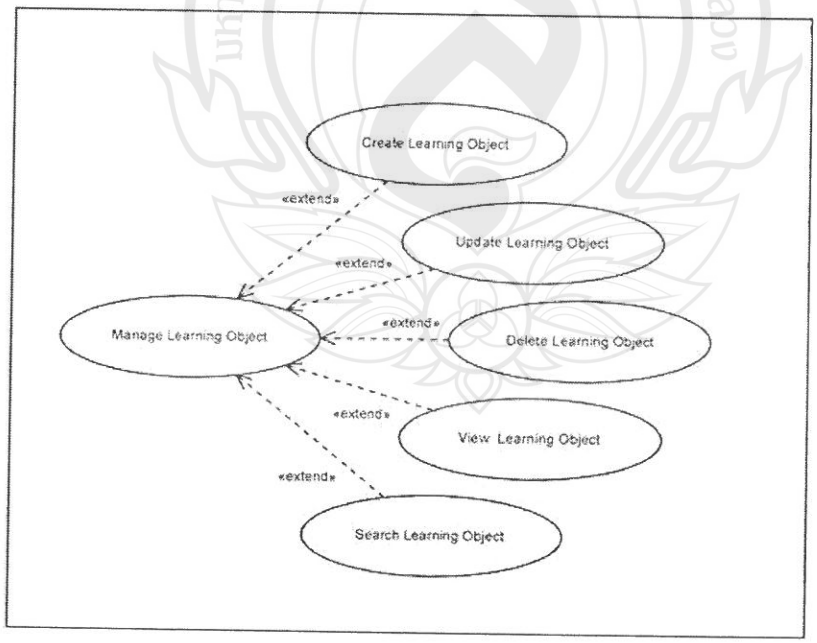

Figure 3-5 Objects of Learning Object Management

4. Content Management

The functions for content management are the functions dealing with the manipulations of all contents provided in ULE. Table 3-4 shows all functions, responsible roles and the definitions of those functions. Figure 3-6 shows all objects for implementing functions of content management.

Table 3-4 Functions for Content Management

Function	Responsible Roles	Definition
Create Content	Administrator Member	Creating new contents and updating the detail
Delete Content	Administrator Member	Deleting content
View Content	Administrator Member	Viewing content
Search Content	Administrator Member	Searching content

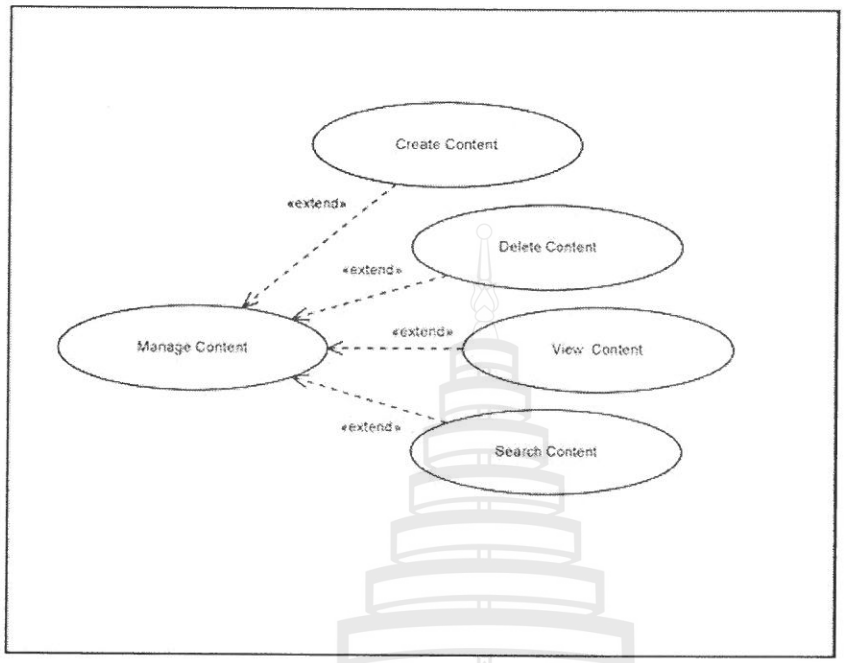

Figure 3-6 Objects of Content Management

5. Examination Management

The functions for content management are the functions dealing with the manipulations of all examinations provided in ULE. Table 3-5 shows all functions, responsible roles and the definitions of those functions. Figure 3-7 shows all objects for implementing functions of examination management.

Table 3-5 Functions for Examination Management

Function	Responsible Roles	Definition
Parse Information to Examination Format	Administrator	Transforming the documents into the examination format
Create Examination	Administrator	Creating examination

Update Examination	Administrator	Updating examination
Delete Examination	Administrator	Deleting examination
View Examination	Administrator Member	Viewing examination
Search Examination	Administrator Member	Searching examination

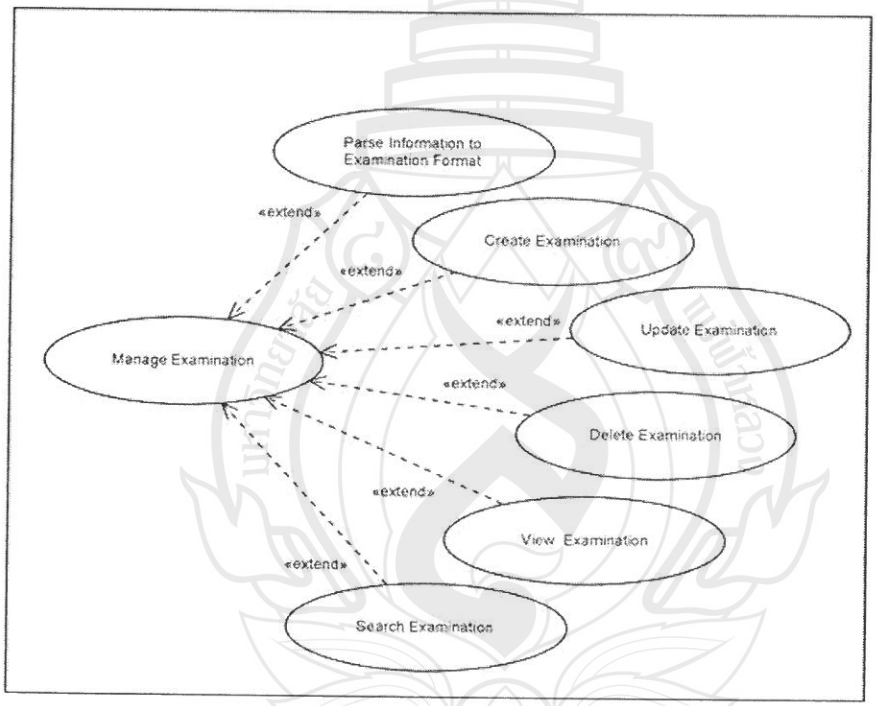

Figure 3-7 Objects of Examination Management

6. Learning Profile Management

The functions for learning profile management are the functions dealing with the manipulations of learning profile. Table 3-6 shows all functions, responsible roles and

the definitions of those functions. Figure 3-8 shows all objects for implementing functions of learning profile management.

Table 3-6 Functions for Learning Profile Management

Function	Responsible Roles	Definition
Create Learning Profile	Member	Creating new learning profile
Update Learning Profile	Member	Updating learning profile
Delete Learning Profile	Member	Deleting learning profile
View Learning Profile	Member	Viewing learning profile
Search Learning Profile	Member	Searching learning profile

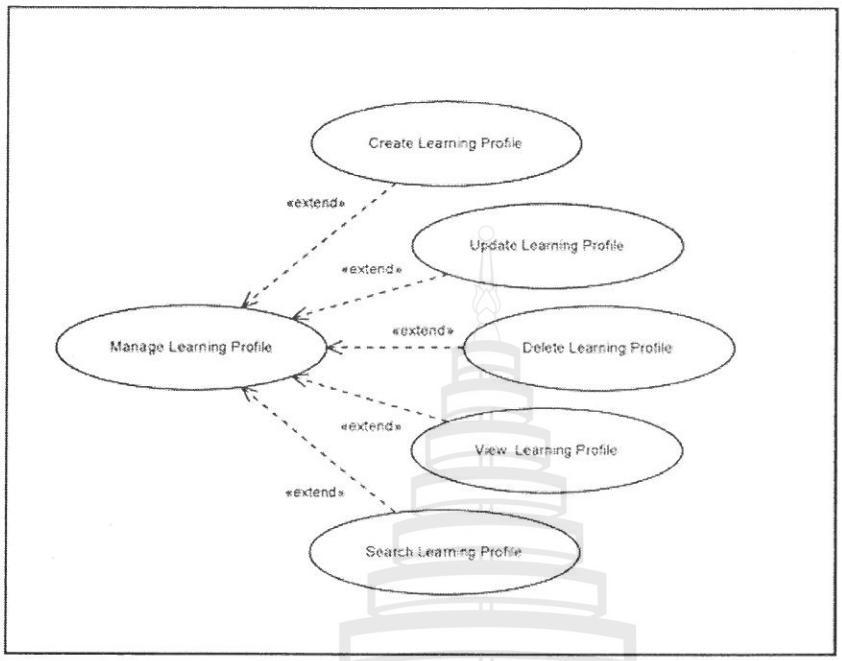

Figure 3-8 Objects of Learning Profile Management

7. Learning Object Participation Log Management

The functions for learning object participation log management are the functions dealing with the manipulations of learning object participation log. Table 3-7 shows all functions, responsible roles and the definition of those functions. Figure 3-9 shows all objects for implementing functions of learning object participation log management.

Table 3-7 Functions for Learning Object Participation Log Management

Function	Responsible Roles	Definition
Create Learning	Administrator	Creating new learning object

Object Participate Log		participation log
View Learning Object Participate Log	Administrator	Viewing learning object participation log
Search Learning Profile	Administrator	Searching learning object participation log

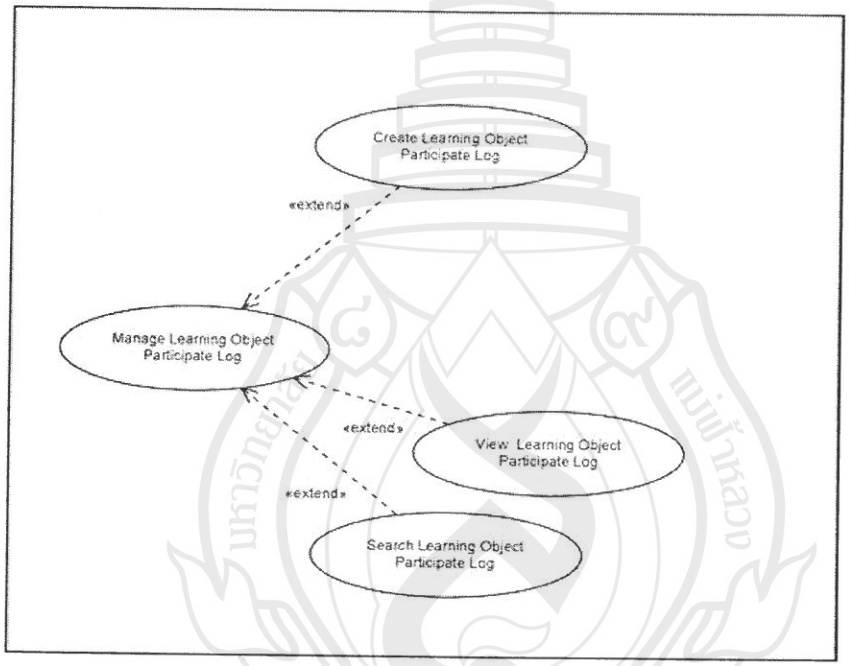

Figure 3-9 Objects of Learning Object Participation Log Management

8. Database Design

E-R diagram of this ULE is shown in Figure 3-10. The details of all fields are shown in Appendix B.

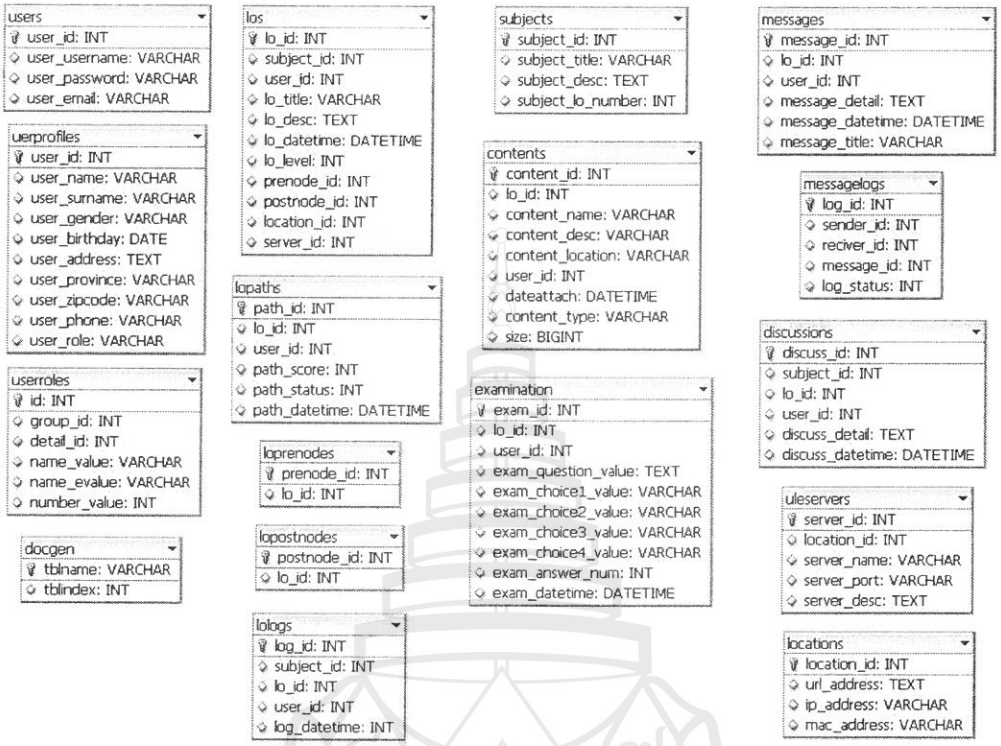

Figure 3-10 E-R Diagram of ULE

Figure 3-10 shows that there are 17 tables for this ULE as following:

1. Users is used for storing the authorization of the users.

2. Userprofiles is used for storing the basic information of the users.

3. Userroles is used for storing the roles and their functions.

4. Docgen is used for storing the tables' sequences.

5. Los is used for storing the learning objects.

6. Lopaths is used for storing the historic learning paths.

7. Loprenode is used for storing the Los' path in which the users already accessed.

8. Lopostnode is used for storing the Lo's path in which the users are going to access.

9. Lolog is used for storing the historic data of Lo accessing.

10. Suject is used for storing the subjects provided by ULE.

11. Content is used for storing the contents for all subjects.

12. Examinations is used for storing all examinations.

13. Messages is used for storing messages' details.

14. Messagelogs is used for storing the historic accessing of meaasges.

15. Discussions is used for storing the discussion of the users on the webboard.

16. Uleservers is used for storing the information of server.

17. Locations is used for storing the address detail.

3.2.2 Mobile Application

1. Navigation Diagram

Figure 3-11 shows the navigation diagram of mobile application to connect with ULE. The figure shows that after the students logging to the system, the student selects the subject that they want to study. Then the student chooses the learning material under that subject to initial study. There are both pretest and posttest for student to assess their study and the web board for discussion for student.

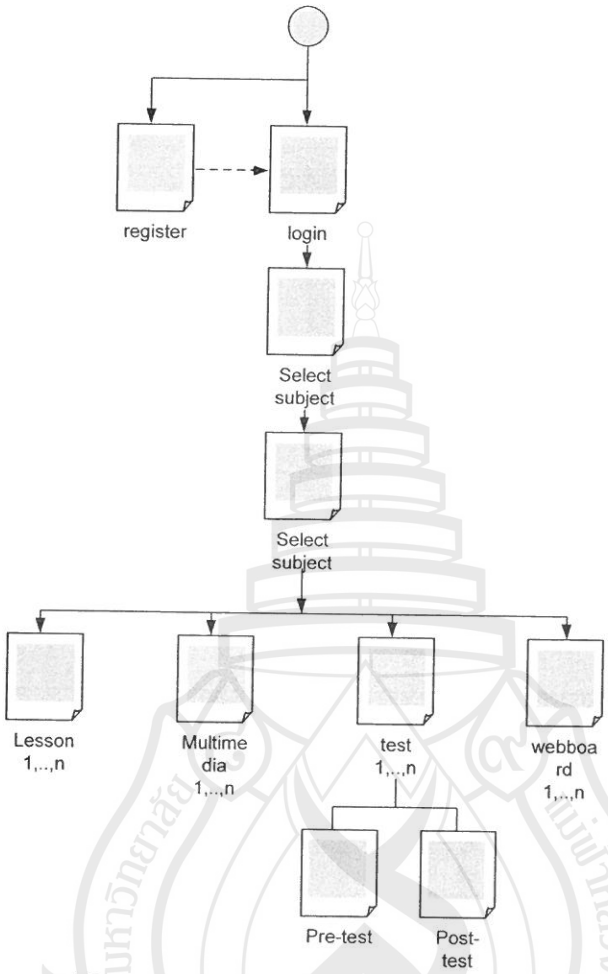

Figure 3-11 Navigation for Web Application

2. Interface Design

The interfaces are designed regarding the above navigation diagram. The detail is shown as following:

1. Registration Page

The design for registration page is shown in Figure 3-12. The information required for registration are username, password, phone number and email address.

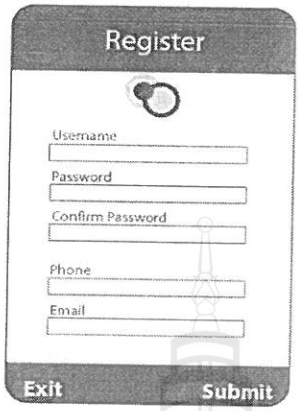

Figure 3-12 Registration Page

2. Login Page

The design of login page is shown in Figure 3-13. The information required for logging in to the system is username and password. The students will be reminded by the system if they forget the password. At the same time, the students can save the login information for convenient access.

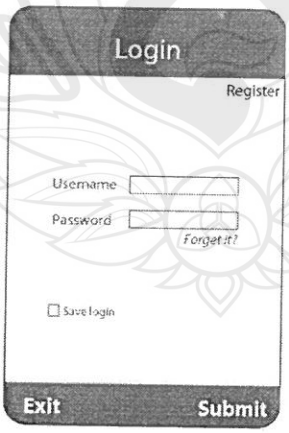

Figure 3-13 Log in page

3. Waiting page

The design of waiting page is shown in Figure 3-14 while the system is processing the command.

Figure 3-14 Waiting Page

4. Subject Selection Page

The design of subject selection page is shown in Figure 3-15. All eligible subjects are shown for the particular users. The ID of the student is also shown in this page. Under the selected subjects, the learning objects that the students can select to study are displayed as shown in Figure 3-16.

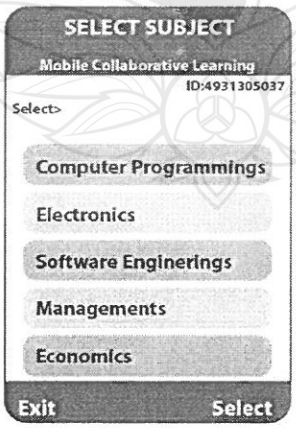

Figure 3-15 Subject Selection Page

Figure 3-16 Learning Object Selection Page

5. Learning Object Detail Page

After selecting the interested subject and LO, the detail of that LO will be displayed as shown in Figure 3-17. The main components of each subject are LOs that consists of Lessons, Multimedia, Test, and Webboard. The lesson is the content of that topic and all lessons for that LO are shown for selecting as shown in Figure 3-18. The multimedia is to represent the content such as video, presentation file, etc. All multimedia files are shown for selecting as shown in Figure 3-19. The test is used for testing the students before and after learning this LO. All tests of each LO are shown in Figure 3-20. The webboard is used to communicate to the instructor or other students. The example of the communication through the webboard is shown in Figure 3-21.

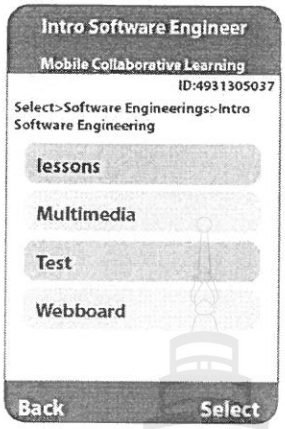

Figure 3.17 Learning Object Detail Page

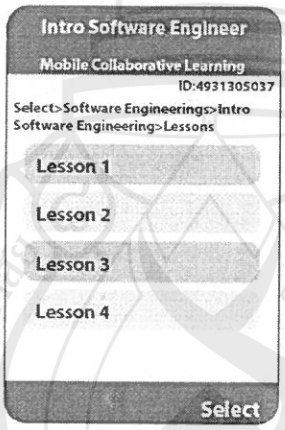

Figure 3-18 Lesson Page

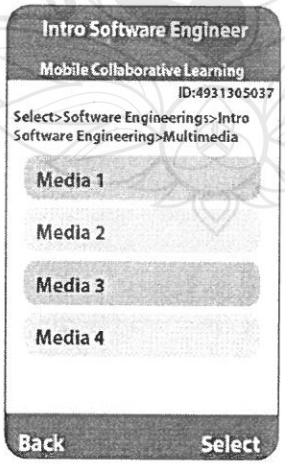

Figure 3-19 Multimedia Page

Figure 3-20 Test Page

Figure 3-21 Webboard Page

3.3 LO Connections

To identify the learning path for each student appropriately, the connections of LOs for the subject has to be done carefully. All LOs are connected by using the

consideration on content relations. This connection is designed by the instructor manually. This section described the connection of 7 LOs for this research. The suject in this research named "Introduction to Artificial Intelligence" are designed to consists of 7 LOs. The names of each LO is shown in Table 3-8.

Table 3-8 LOs for "Introduction to Artificial Intelligence" Subject

LO ID	LO Name
LO(1)	Modern Approach to AI
LO(2)	Uncertain and Reasoning Knowledge
LO(3)	Planning
LO(4)	Adversarial Search
LO(5)	AI Implementation Language
LO(6)	Problem Solving Technique
LO(7)	Introduction to AI

From Table 3-8,all LOs are designed to connect among each other as shown in Figure 3-22

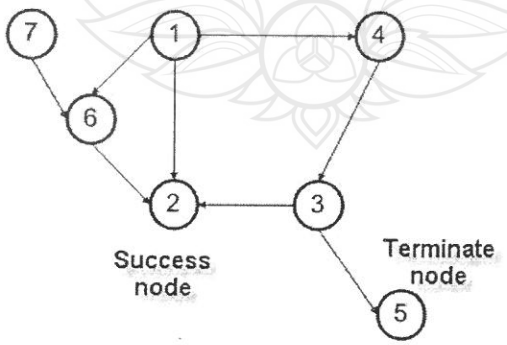

Figure 3-22 LO Connection for "Introduction to Artificial Intelligence" Subject

The figure shows that this subject consists of 7 LO. The links among those LOs are defined manually regarding to the content relation by the instructor as mentioned before. Each LO has different connection and domain. For example, LO (1) is connected with LO(2),LO(4), and LO(6). Those three LOs are called that they are in the same domain. The arrow shows the direction of next LO from each LO. For example, after finishing LO(1), the students are able to move forward to LO(2), LO(4), and LO(6) depending on their performances. However, after the students finish LO(2), the students are not able to move backward to LO(1). The students can start from any LO as their preferences Then, the students are moved to the next LO according to the pre-defined domain and the students' performances. There are two important LOs all among them including LO(2) and LO(5) which are called success node and teminate node respectively. The students who can complete LO(2) and pass the examination then this student can pass this subjects. However, if the students come to LO(5) whether they pass the test or not, these students are terminated from this subject consequently. Once the students are terminated from each LO(5), the students will be ask to start their study again manually. Then, the ULE will select the LO automatically after the first LO is initated by the students.

3.4 Subject Components

Each LO is designed to have more than one lesson. However, only one lesson per LO is implemented in this research. Besides the lessons, each LO has the pre-test and post-test questions as well as the webboard for communication. Figure 3-23 shows subject component of this research.

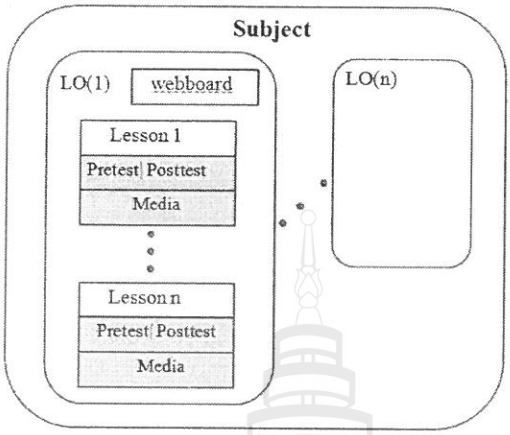

Figure 3-23 Subject Components

3.5 Learning Path Determination

This section describes how LO is selected for the students after completing the initial LO. As mentioned before there are 3 agents working collaboratively in LO. Figure 3-24 shows the interactions of LO in this ULE

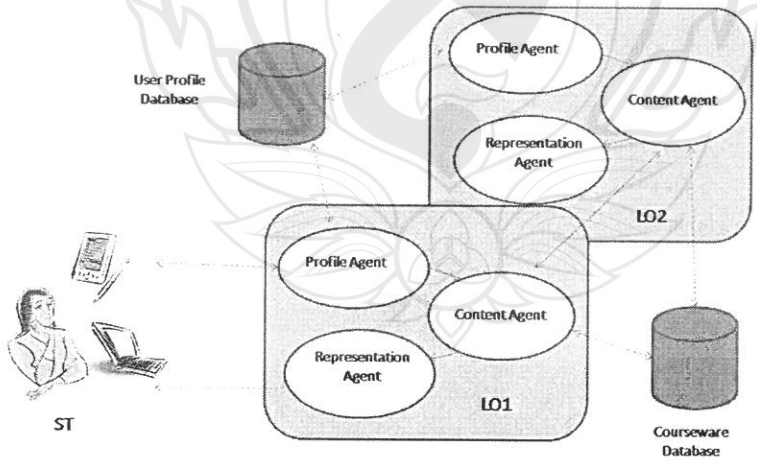

Figure 3-24 Interactions of LOs for the proposed ULE

The detail of each agent in Figure 3-24 is shown below:

1. Personal Agent: This agent interacts with the students to keep their profiles and historic actions, learned LOs, learned lesson, scores of pre-test and post-test of every lesson in every LO, and the date of accessing LO.

2. Content Agent: This agent communicates with personal agent and present the selected contents to the students. At the same time, once the students have finished the test of each LO, the content agent consider the performance of the students and then the content agent will decide the next LO for that student. The information used for making the decision of next LO are performance of the students. The performance information is measured from the score difference of pre-test and post-test of each lesson. The score difference can be determined as shown in Equation (3.1)

$$scorediff = \frac{posttest - pretest}{totalscore} * 100\% \qquad (3.1)$$

Where; scorediff is the score different of post-test and pre-test of students

totalscore is the total score of post-test and pre-test

Note: The pre-test and post-test are not the same test. However, they have the similar content and the same total score. Additionall, if the students has fail 3/4 of all lesson of each LO, the students are asked to restart learning later on. However, there is only one lesson per one LO is used in this research.

3. Representation Agent: This agent interacts with the content agent and the students in order to choose the way to represent any content for the students. This agent is very

important for representing the content through the multi-scale displays of mobile devices. More specifically, the representation agent will have to decide appropritely how to represent the content for the different mobile devices.

3.6 Decision-Making Rule

From the LOs connection in Figure 3-22, the example below shows how the content agent make decision to select new LO for the students.

Rule1: **If score differece of LO(1)>=80% then Move to LO(2)**

else 70<=score differece of LO(1)<80% then Move to LO(4)

else 50<=score difference of LO(1)< 60 then Move to LO(6)

else LO NEW SELECTION

From the aboved rule, it is obvious that LO(1) is the start LO and then LO(2), LO(4), and LO(6) are in the same domain. After the student complete LO(1), the content agent will make decision which LO is the next LO for this students. The score differece from Personal Agent refering to his/her performance is mainly considered by Content Agent. If this students can achive the score difference at least 80 %, this student will be given LO(2). If this student has the score difference between 60 % and 80% , this student will be given LO(4). If the student has the score difference between 50 % and 60% , this student will be given LO(6). However, if this student has the difference score less than 50% then this student will be ask to start new LO either the same one (LO(1)) or another LO in the subject. The terminating rule is used for re-

starting the study covering the case that the students can not pass 3/4 of LOs in the same domain and when the student has reached the terminate LO. Additionally, after terminating, the students are always asked to restart their studies manually. Then, after completing the initial LO, the next LO will be automatically selected by the ULE. Once the students have passed the success node (LO) means that the students have finished this subject on ULE.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results

This section shows the interface of ULE using the design in Chapter 3.

4.1.1 Web Interface

1. Home Page

The home page of the developed ULE is shown in Figure 4-1. There are 5 fives menus for this ULE including member page, learning page, download page, forum page and about page.

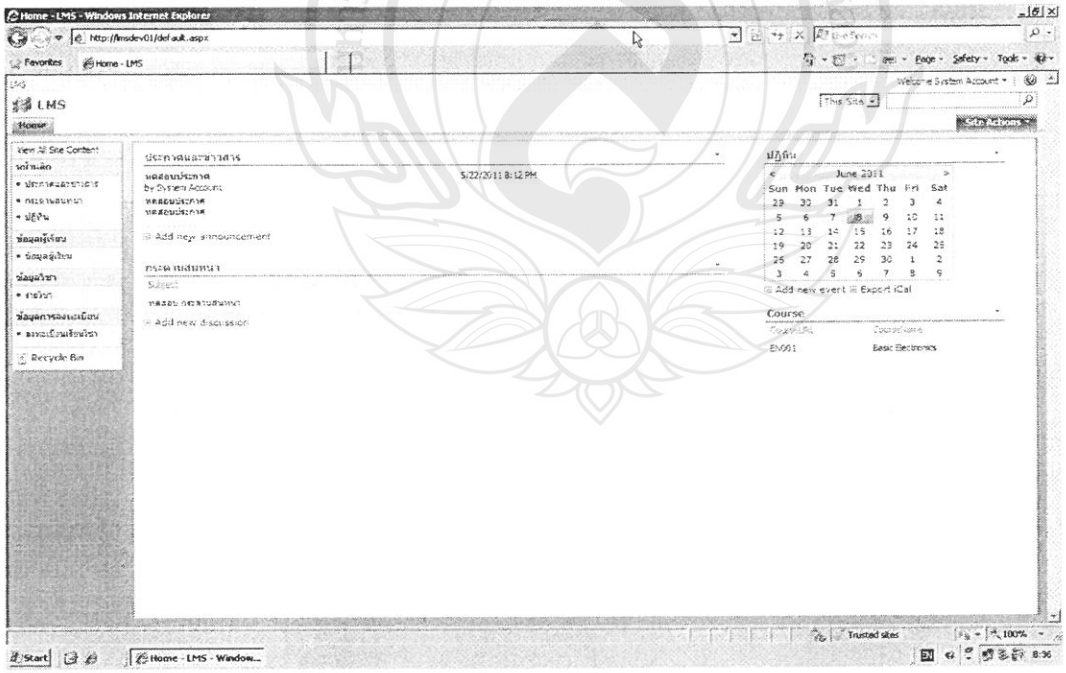

Figure 4-1 Home Page of ULE

2. Registration Page

The registration page is shown in Figure 4-2. The information of the learners required for registration.

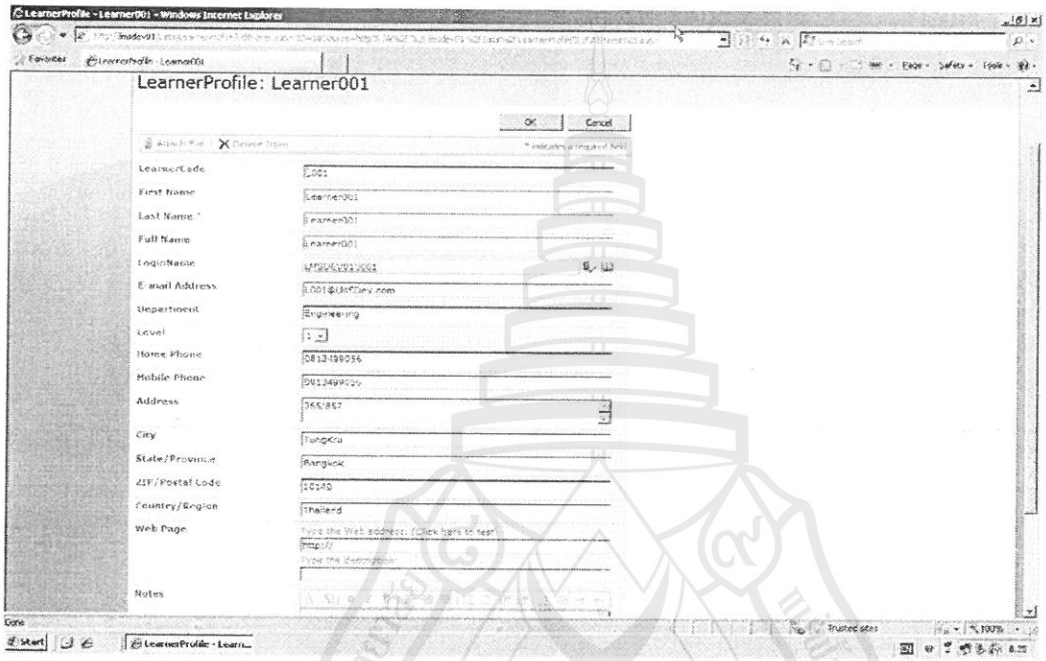

Figure 4-2 Registration Page

3. Course Information Page

After logging in, the administrator can edit the course information. Figure 4-3 shows the administration main page.

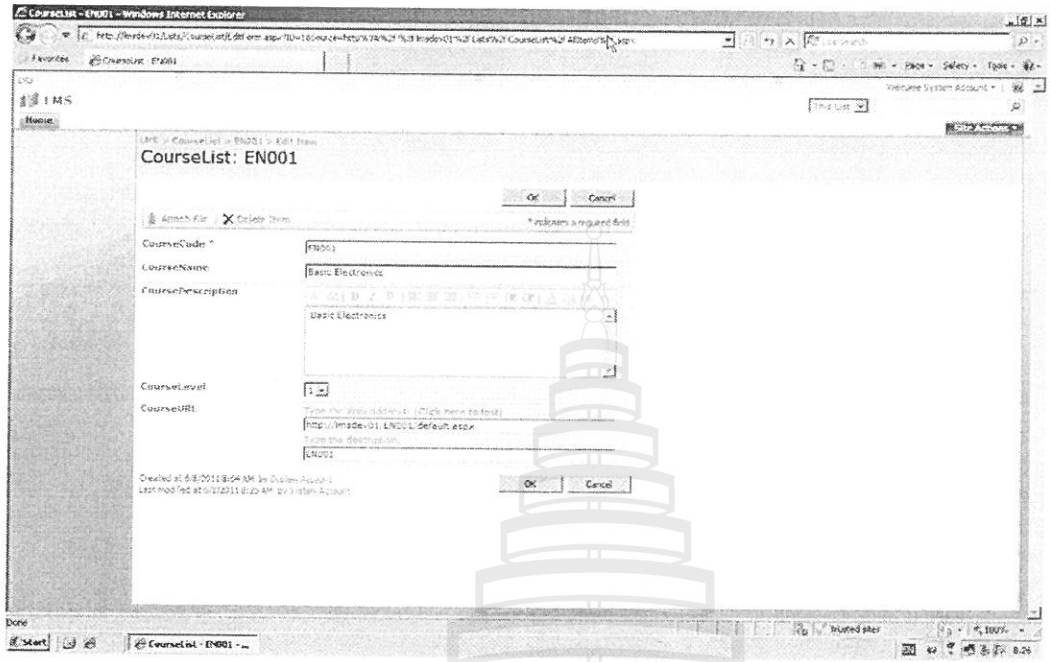

Figure 4-3 Course Information Page

4. Course Registration Page

Figure 4-4 shows course registration page for the learners to enroll.

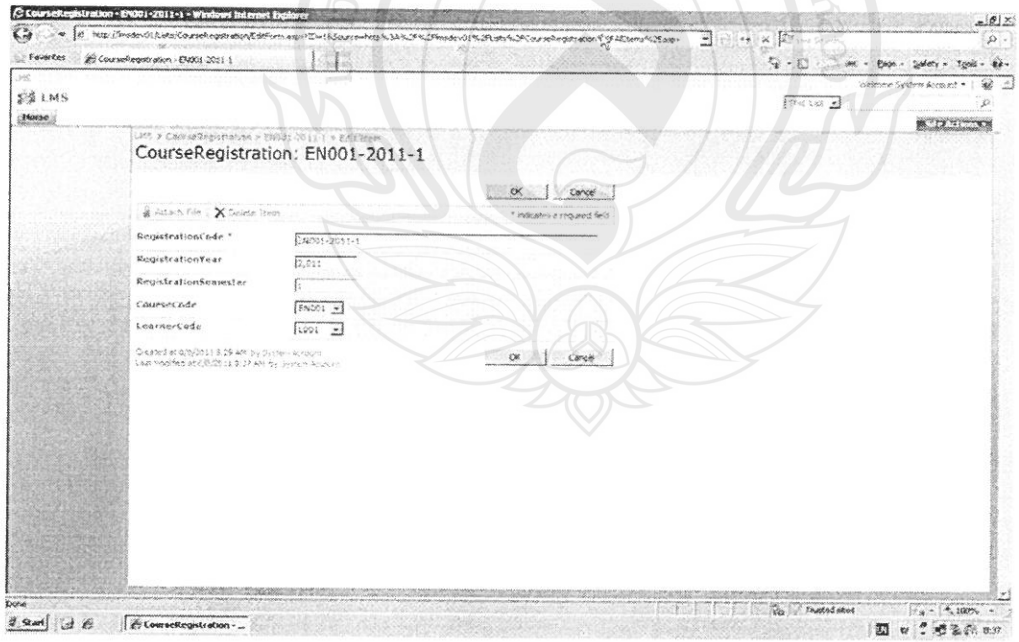

Figure 4-4 Course Registration Page

5. Course Home Page

Figure 4-5 shows the course home page of each course.

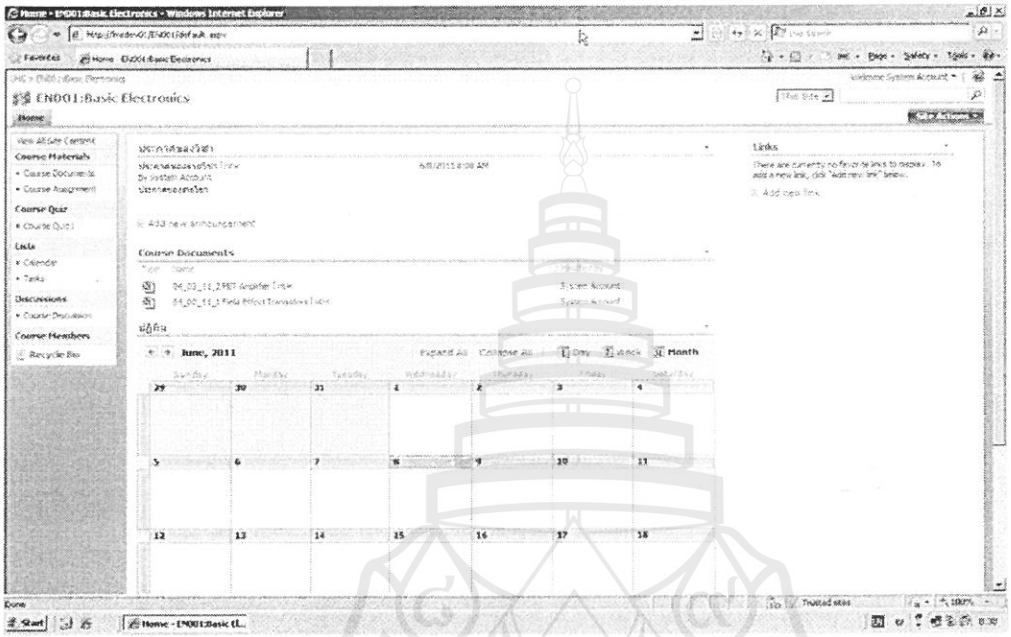

Figure 4-5 Course Home Page

6. Course Material Page

Figure 4-6 shows materials for each course.

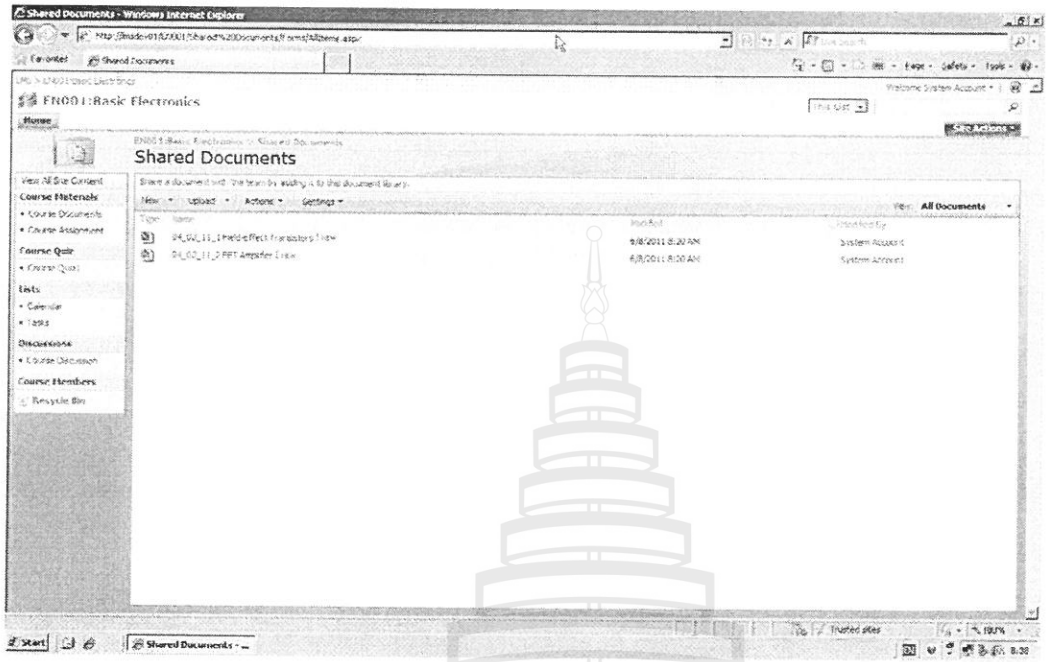

Figure 4-6 Course Material Page

7. Assignment Page

Figure 4-7 shows the course assignment page.

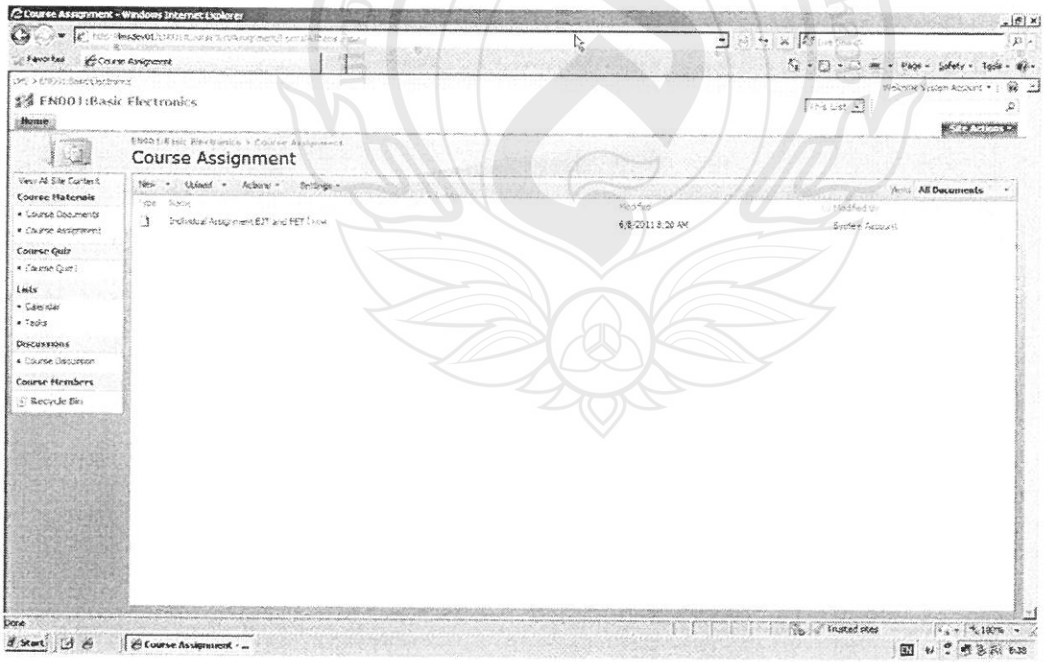

Figure 4-7 Assignment Page

8. Examination Page

Figure 4-8 shows the page for examination of each course.

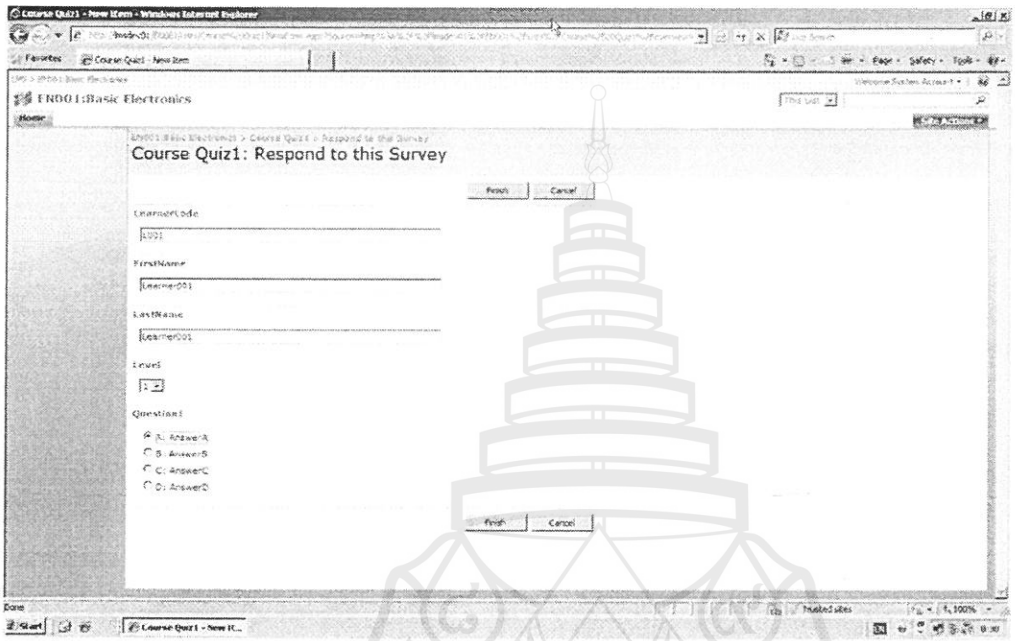

Figure 4-8 Examination Page

4.1.2 Mobile Interface

This sections show the interface with the design in chapter 3. The specification of mobile phone using in this research is shown in Appendix A.

1. Registration Page

Figure 4-9 shows the registration page for mobile application.

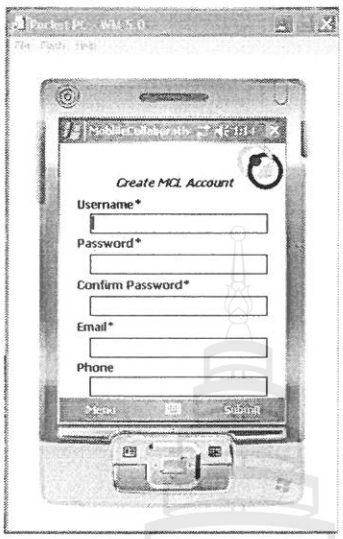

Figure 4-9 Registration Page for Mobile Application

2. Login Page

Figure 4-10 shows login page for mobile application.

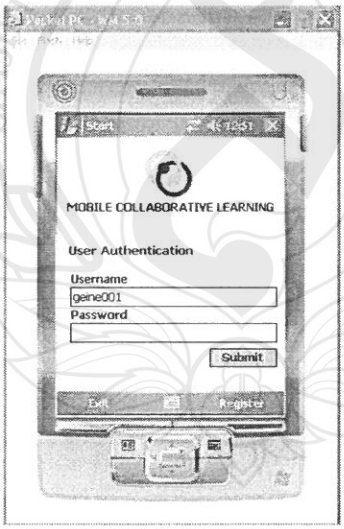

Figure 4-10 Login Page for Mobile Application

3. Learning Object Page

Figure 4.11-4.14 shows the subject detail, LO detail, examination and webboard respectively.

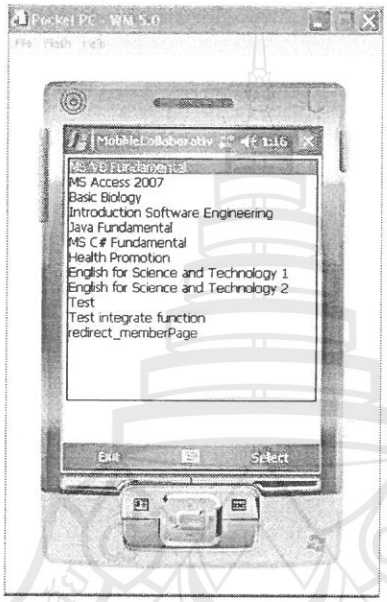

Figure 4-11 Subject Page for Mobile Application

Figure 4-12 LO Page for Mobile Application

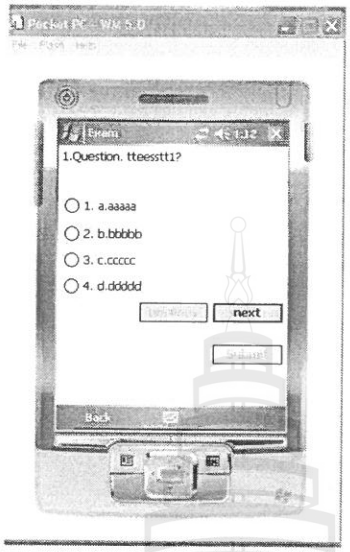

Figure 4-13 Examination Page for Mobile Application

Figure 4-14 Webboard for Mobile Application

4.2 Empirical Study

This section describes how the developed ULE is tested in this research. The research aims to study to what extent the developed ULE affect the learning efficiency and learning satisfaction of the learners. The developed ULE are designed and

implemented with 2 different LO architectures. For the first architecture, the LOs are not connected to each other. The learners can select their learning paths individually. This architecture is called without agent architecture. For the second architecture, all LOs are connected by the instructor regarding the relevance of the content of each LO as the detail of this connections are described in Chapter 3 section 3.3. Each LO is implemented with multi agent architecture. Therefore, this second architecture is called multi agent architecture. The detail of each agent and the rules for making decision for the next LO are described in Chapter 3 section 3.5.

The developed ULE are tested with 40 students with the special subject for 3 months named "Introduction to Artificial Intelligence" at Mae Fah Luang University, Chiang Rai, Thailand. Those students are the 4th year students from School of Information Technology and they have no background knowledge about artificial intelligence. Those students are divided into 2 groups with 20 students per each. The 1st group studies in ULE without agent architecture, while the 2nd group studies in ULE with agent architecture respectively. This research uses the questionnaires from Temdee's work (Temdee, P., 2012) to measure the satisfaction aspects of developed ULE.

4.2.1 Learning efficiency Measurement

Before learning through the developed ULE, the students for both groups are requested to have the pre-test about the AI subject. At the end of the course, the students are also requested to have the post-test. The pre-test and post-test are not the same test but they are similar in term of the content that the students need to know.

Moreover, these tests are not the same as those in all LOs. The score differences of pre-test and post-test are used to answer to what extent this developed ULE can make the students enhance their learning efficiencies about AI subject. After analyzing the different scores of group 1 and 2, it has been found that the students in group 2 who study in ULE with the agent architecture have higher scores than the students in group 1 who study with ULE without agent architecture. The students are given 3 months to finish the content from all Los before having the post-test. This research employs 7 Los which the content of each LO is shown in Chapter 3 section 4. the Table 4-1 shows the comparison results of learners' average scores for pre-test and post-test.

Table 4-1 Comparison of average scores of pre-test and post-test

Group	Average scores of pre-test (100)	Average scores of post-test (100)	% of score difference
G1 w/o agent	71.06	87.11	+22.57%
G2 w/ agent	69.30	87.64	+26.46%

From Table4-1, both group 1 and group 2 have improved their post-test scores. However, group 2 has higher score difference than group 1. The confidential interval used in this research is equal to 95%.

4.2.2 Students Satisfaction Measurement

At the end of the study, both two groups of students are asked to complete the questionnaire about how they satisfy the learning through ULE for its functionality

and adaptability. The students are asked to complete the questionnaire to answer whether how much they are satisfied from using ULE. The questionnaire is designed to have 5 levels rating scales. The scale durations are 0-0.9 means absolutely not satisfied, 1.00-1.99 means not satisfied, 2.00-2.99 means neutral, 3.00-3.99 means satisfied, and 4.00-5.00 means very satisfied. The mean scores of both groups for functionality and adaptability are shown in Table 4-2 and Table 4-3 respectively.

Table 4-2 Means of satisfaction scores for functionality of ULE

Question	Mean
	G1+G2
1. All content is presented suitable for the displays	4.12
2. The presence of subject/LO is suitable	3.64
3.. It is convenient to use mobile phone access ULE	3.15
4. It is more convenient to use laptop to access ULE	4.61
5. The examination is easy to use through mobile application	2.66
6. The webboard is easy to use through mobile application	2.76
7. The interface of web application is easy to use	4.31
8. The interface of mobile application is easy to use	2.97
9. It is enjoyable to study through developed ULE	4.09
10. It is easy to complete the study without help (about the function)	3.96
TOTAL	3.63

Table 4-2 shows that the students are satisfied by the developed ULE in term of functionality in the satisfy level.

Table 4-3 Means of satisfaction scores for adaptability of ULE

Question	Mean
	G2
1. All content is clear and understandable	4.12
2. The changing of content is smooth in term of content relevance	3.89
3. The content is provided suitable for my performance	4.46
4. It takes suitable time to complete the study	4.38
5. The pre-test of each LO is suitable	3.94
6. The post-test of each LO is suitable	4.07
7. The quantity of content is suitable	4.73
8. The proposed content is not confusing	3.96
9. It is better that ULE provides the content for me	4.14
10. It is easy to complete the study without help (about the content)	3.82
TOTAL	4.15

Table 4-3 shows that the students are very satisfied the developed ULE in term of adaptability.

4.3 Discussion

The results from section 4.2 shows that the developed ULE both with and without multi agent architecture can enhance the learning efficiency of students for the assigned subject. However, the ULE with multi agent architecture can enhance the learning efficiency of students more than the ULE without multi agent architecture. It can be explained that the students learning through ULE with multi agent architecture are able to have enough content to complete the post-test more than the students learning by their own. However, the developed ULE has been successfully to promote the higher learning efficiency of students for both groups.

For satisfaction aspect, there are two main aspects studied including the satisfaction of functionality of ULE and the adaptability of ULE. The results show that the students are satisfied by the developed ULE in term of functionality. However the students do not feel good with learning with mobile devices. The mobile interface and its functions including the examination and webboard are needed to be improved. For the satisfaction of adaptability, the students are very satisfied by the developed ULE in term of adaptability. Additionally, the students have found that the changing of the content is smooth, unconfused and suitable for their performance. However, the students have found the tests are not suitable and the students probably need help to complete their studies.

CHAPTER 5

CONCLUSION

5.1 Conclusion

This research aims to develop the virtual ULE that promoting u-learning. The developed ULE has the LOs having multi agent architecture which there are 3 agents coordinating among each other. Three agents are Personal Agent, Content Agent and Representation Agent. The Personal Agent is designed to interact with the students in order to keep the students' profiles and their historic actions. The Content Agent is designed to interact with the students and the Personal Agent to provide the suitable content for the students and to make decision about the next LO for the students. The information used for selecting new LO for the students are the student's performance and LO domain. The LO domain is clarified by LO connection created by the instructor manually according to the content relevance. Finally, the Representation Agent is designed represent the content for the students.

The content is this research is designed as a subject having several LOs. Each LO can have several lessons. Each lesson can be represented with many types of multimedia files. Moreover, each lesson has pre-test and post-test for the students to complete.

The students can access the developed ULE from both web application and mobile application through laptop computers and mobile devices respectively. There are two communication tools for students including email and webboard to promote both

individual learning and collaborative learning. There are 2 types of databases connecting with the developed ULE including the courseware database and the user profile database.

The empirical study is conducted with 40 students from school of Information Technology, Mae Fah Luang University, Chiang Rai, Thailand. The students are divided into 2 groups and 20 students per each including the group studying though ULE without multi agent architecture and the group studying though ULE without multi agent architecture. Both groups of students are assigned to study the special subject named "Introduction to Artificial Intelligence" having 7 LOs in 3 months. The developed ULE is evaluated in terms of the learning efficiency enhancement and the satisfaction of functionality and adaptability of ULE. For learning efficiency enhancement, the results show that the developed ULE is able to enhance the learning efficiencies of students both 2 groups although the group learning though ULE with multi agent architecture can enhance higher efficiency than the group learning through ULE without agent architecture or on their own. It can be explained that the former group is more likely to be able to familiar with the whole content more than the latter group. For satisfaction aspects, both groups are satisfied by the functionality of the developed ULE. However, there should be some improvement for mobile application. For the satisfaction of adaptability, the results show that the students are very satisfied by the ULE for this aspect. However, the content might be pretty difficult for the students and it also may need the adjustment of content relevance among LO.

5.2 Suggestion

In order to obtain more satisfaction from students, the new design and development of mobile application is required. Moreover, the content might also need the adjustment to be more relevance all among LO. Additionally, the time for questionnaire should be more than one time because the students might feel biasing for completing the questionnaire at the end of their study. The enquiry between the studying period might emerge some interesting information about the students' satisfaction over time.

5.3 Future Work

After finishing the development of ULE, all interaction patterns including the interaction among students, the interaction between students and LOs and the interaction among LOs will be collected and studied. Therefore, all data will be analyzed to address these following two research questions in the future research including:

1. What patterns of interaction arise in ULE, including among students, between students and learning objects, and among learning objects?

2. How might these patterns of interaction affect learning outcomes?

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APPENDIX A

Mobile Specification

HTC Touch Viva

1. Appearance

Figure A-1 HTC Touch Viva

2. Specification

- Quadband (GSM 850/900/1800/1900 MHz)
- Touch screen TFT-LCD 65K colors - 240 x 320 pixels (2.8")
- TouchFLO™
- 5 ways Navi-Key
- Ringtone MP3, 40 Polyphonic
- File Compatible: AAC, AAC+, eAAC+, AMR-NB, AMR-WB, QCP, MP3, WMA, WAV
- Vibration in Phone

- Windows Mobile® 6.1 Professional

- CPU : TI's OMAP™ 850, 201 MHz

- ROM 256 MB - RAM 128 MB

- Memory card: microSD

3. Connectivity

- Data Transfer

    *WiFi 802.11b/g, WLAN (Wireless LAN)

    * Bluetooth™ v2.0, mini-USB v2.0 (ExtUSB™)

    * A2DP Bluetooth™ Stereo

- xHTML, HTML (PocketIE), WAP 2.0 Browser

- Messaging

    * Email, MMS, SMS via EDGE, GPRS

    * Instant Messaging

- Java MIDP 2.0

4. Feature

- 20 million pixels Digital Camera

    * panorama mode

    * photo for phonebook

    * photo for background/theme

- Video recording & Playback

    *MMS

- 5 days weather forcasting

- Goolgle Maps

5. Batterry

- 1,100 mAh (Standard Battery)

- 270 hours Standby Time

-480 min. Talk Time

APPENDIX B

DATABASE DESIGN

Table B-1 User

Variable	Variable Type	Example	Reference	Detail
user_id	int(10)	1		User ID
user_username	varchar(20)	admin		Name
user_password	varcahr(20)	admin		Password
user_email	varhcar(20)	admin@ule.com		Email

Table B-2 User Profile

Variable	Variable Type	Example	Reference	Detail
user_id	int(10)	1		User ID
user_name	varchar(20)	warawit		Name
user_surname	varcahr(20)	kitmongkonsak		Lastname
user_gender	varhcar(6)	male		Gender
user_birthday	date	2552-10-31		Date of Birth
user_address	test	mflu		Address
user_province	varchar(20)	chriang rai		Province
user_zipcode	varchar(6)	57100		Postcode
user_role	int	1		Role

Table B-3 Userroles

Variable	Variable Type	Example	Reference	Detail
id	int(2)	1		Role ID
group_id	varchar(10)	role		Group
detail_id	int(2)	1		Detail
name_value	varchar(20)	ผู้ดูแลระบบ		Thai name
name_evalue	varcaht(20)	admin		English name
number_value	int	4		Number

Table B-4 Docgen

Variable	Variable Type	Example	Reference	Detail
Tblname	Varchar(20)	Users		Table Name
Tblindex	Int(10)	4		Index

Table B.5 Los

Variable	Variable Type	Example	Reference	Detail
lo_id	int(10)	1		LO ID
subject_id	int(10)	1		Subject ID
user_id	int(10)	1		User ID
lo_title	varchar(20)	java lesson 1		Lesson Name
lo_desc	varcaht(20)	java lesson 1		Lesson Description

Variable	Variable Type	Example	Reference	Detail
lo_datetime	datetime	2 552-10-04 23:28:00		Registration Date
lo_level	int(1)	1		Difficulty Level
prenode_id	int(10)	1		Pre-LO
postnode_id	int(10)	2		Post-LO
location_id	int(10)	1		LO Location

Table B-6 Lopaths

Variable	Variable Type	Example	Reference	Detail
path_id	int(10)	1		Learning Path ID
lo_id	int(10)	1		LO ID
user_id	int(10)	1		User ID
path_score	int(3)	80		Score
path_status	int(1)	1		Path Status
path_datetime	datetime	2 552-10-04 23:28:00		Registration Date

Table B-7 Prenodelos

Variable	Variable Type	Example	Reference	Detail
Prenode_id	int(10)	1		Pre-LO ID
lo_id	int(10)	1		LO ID

Table B-8 Postnodelos

Variable	Variable Type	Example	Reference	Detail
Postnode_id	int(10)	1		Post-LO ID
lo_id	int(10)	1		LO ID

Table B-9 Loglos

Variable	Variable Type	Example	Reference	Detail
log_id	int(10)	1		Log in ID
subject_id	int(10)	1		Subject ID
lo_id	int(10)	1		LO ID
user_id	int(10)	1		User ID
log_datetime	datetime	2 552-10-04 23:28:00		Registration Date

Table B-10 Subjects

Variable	Variable Type	Example	Reference	Detail
subject_id	int(10)	1		Subject ID
subject_title	varchar(20)	java fundamental		Subject Name
subject_desc	text	java fundamental		Subject Detail
subject_lo_number	int(10)	5		Numbers of Lessons

Table B-11 Contents

Variable	Variable Type	Example	Reference	Detail

Variable	Variable Type	Example	Reference	Detail
content_id	int(10)	18		Content ID
lo_id	int(10)	1		LO ID
content_name	varchar(100)	mercy killing slide.pptx		Content Name
content_desc	varchar(255)	mercy killing slide.pptx		Content Detail
content_location	varchar(255)	d:/ule-server/upload/content/java fundamental/java lesson 1/1255933660203_mercy killing slide.pptx		Content Location
user_id	int(10)	1		User ID
dateattach	datetime	2 552-10-04 23:28:00		Registration Date
content_type	varchar(100)	application/vnd.openxmlformats-officedocument.presentationml.presentation		Content Type
size	bigint(20)	982008		Content Size

Table B-12 Examinations

Variable	Variable Type	Example	Reference	Detail

Variable	Variable Type	Example	Reference	Detail
exam_id	int(10)	18		Examination ID
lo_id	int(10)	1		LO ID
user_id	int(10)	1		User ID
exam_question_value	text	test1?		Question
exam_choice1_value	varchar(255)	dad		Choice
exam_choice2_value	varchar(255)	oop		Choice
exam_choice3_value	varchar(255)	ooad		Choice
exam_choice4_value	varchar(255)	programming		Choice
exam_answer_num	int(1)	3		Answer
exam_datetime	datetime	2 552-10-04 23:28:00		Registration Date

Table B-13 Messages

Variable	Variable type	Example	Reference	Detail
message_id	int(10)	18		Message ID
lo_id	int(10)	1		LO ID
user_id	int(10)	1		User ID
message_detail	text	mflu		Message Detial
message_datetime	datetime	2 552-10-04 23:28:00		Registration Date

message_title	varchar(100)	mflu		Message Title

Table B-14 Messagelogs

Variable	Variable type	Example	Reference	Detail
log_id	int(10)	18		LOG ID
sender_id	int(10)	1		Sender ID
reciver_id	int(10)	1		Receiver ID
message_id	int(10)	1		Message ID
log_status	int(1)	0		LOG Status

Table B-15 Discussions

Variable	Variable type	Example	Reference	Detail
discuss_id	int(10)	18		Webboard ID
subject_id	int(10)	1		Subject ID
lo_id	int(10)	1		LO ID
user_id	int(10)	1		User ID
discuss_detail	text	mflu		Discussion Detail
discuss_datetime	datetime	2 552-10-04 23:28:00		Registration Date

Table B-16 Uleservers

Variable	Variable type	Example	Reference	Detail
server_id	int(10)	18		Server ID

location_id	int(10)	1	Location
server_name	varchar(40)	1	Server Name
server_port	varchar(5)	8080	Server Port
server_desc	text	ule	Server Detail

Table B-17 Locations

Variable	**Variable type**	**Example**	**Reference**	**Detail**
location_id	int(10)	1		Location ID
url_address	text	http://www.mfu.ac.th		URL Address
ip_address	varchar(20)	192.168.1.1		IP Address
mac_address	varchar(20)	a1-vd-12-d2-43-8j		Mac Address

CURRICULUM VITAE

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- N. Gasonpan and **P. Temdee**, "Collaborative Educational Games with Ancient Wisdom Concept for Promoting Planning Skill of Thai Primary School Student" , MFU conference, Nov.19-20, 2011.

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