NTNU

Norwegian University of
Science and Technology

Mobile Collaborative Learning System

Noble Kuadey

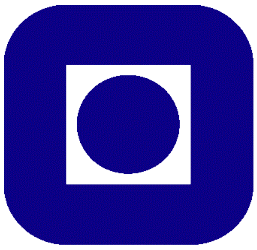
Master in Information Systems
Submission date: June 2010
Supervisor: John Krogstie, IDI

Norwegian University of Science and Technology
Department of Computer and Information Science

Problem Description

In the context of the possibilities that open up for location based mobile broadband services through the infrastructure established in wireless Trondheim, this project will implement a mobile application that will aid students learning and collaborative purposes

Assignment given: 15. January 2010
Supervisor: John Krogstie, IDI



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In the context of the possibilities that open up for location based mobile broadband services through the infrastructure established in wireless Trondheim, this project focuses on the development and evaluation of a prototype on a mobile device running in the wireless Trondheim environment for mobile collaborative learning.

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Abstract

This project work is about mobile learning system that will enable people to learn and collaborate anywhere and at anytime. It is the continuation of the work carried out in autumn 2009, by Noble and Izaz [1].

In this project work, a Mobile Collaborative Learning System (MCLS) prototype was designed and implemented. The project work has been carried out according to the design science research methodology.

An evaluation of the usability of the prototype was conducted. Mobile Services Acceptance Model (MSAM) was used to analyze factors that are influential for user adoption of the prototype.

The results from the evaluation indicated that the majority of the test users perceived the prototype to be useful and they intend to use the prototype if they have access to it. These results confirm how useful and beneficial the prototype would be to students.

Preface

This project works is a master thesis report in Information Systems at the Norwegian University of Science and Technology (NTNU).

The project has been defined in consultation with my supervisor Professor John Krogstie. In this project work, a Mobile Collaborative Learning System prototype was designed, implemented and evaluated.

Trondheim, June 11 2010

Noble Kuadey

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Chapter 1
Introduction

This chapter presents a brief introduction of the Master Thesis, focusing on the motivation for choosing this project topic, the project description, problem definition and the overview of the rest of the project report.

1.1 Motivation

Mobile technologies have become pervasive, ubiquitous and networked with enhanced capabilities for rich social interactions. With these characteristics mobile technologies are well suited in engaging end users in personal learning and collaborative experiences. The prevalence of mobile technologies is in itself a motivator to exploit them for learning and collaboration purposes.

Mobile learning is an exciting new area of research which has already witnessed notable researches such as the MOBIlearn project; a worldwide European-led research and development project that explores context-sensitive approaches to informal, problem-based and workplace learning by using key advances in mobile technologies.

Results from the survey conducted in last autumn project [1] indicated that a mobile learning device will enhance students learning and therefore the need to conduct further research on this project.

The fact that the project can assist people to learn and collaborate is enough motivation to embark on this project.

1.2 Project Scope

A survey was conducted in a project last autumn [1] in relation to Mobile Collaborative Learning System (MCLS), a prototype was designed but was not implemented. This project builds on the preliminary findings in the last autumn project resulting in the implementation of a prototype and the usability testing of the prototype.

1.3 Project Description and Context

The purpose of this project is to explore ways in which a prototype of MCLS can aid learning and collaboration. This project aims to develop a prototype of MCLS based on wireless infrastructure to enable people to learn and collaborate anywhere and at anytime. As well as evaluate the prototype based on usability metrics.

1.4 Problem Definition

The goal of this project is to design, implement and evaluate a prototype of MCLS which enable students to learn and collaborate at anytime and at anywhere. The prototype offers a number of mobile services and shall run on mobile hand held devices.

1.5 Report Outline

Chapter 2: Background presents preliminary studies conducted in last autumn project and similar existing solutions that formed the basis of this project.

Chapter 3: This chapter describes the research method used in this project

Chapter 4: Requirement specification chapter presents the functional requirements and non functional requirements of the prototype. This chapter also contains a brief evaluation of the existing similar solutions upon which this prototype was built.

Chapter 5: This chapter describes the design and the system development of the prototype.

Chapter 6: This chapter describes the results of the usability test and the user acceptance survey conducted during the evaluation of the prototype.

Chapter 7: This chapter ends the report with some concluding thoughts as well as suggestions for further development.

Chapter 2
Background

This chapter presents the main findings of the project carried out in autumn 2009 which formed the basis of this project and similar existing solutions that were reviewed.

2.1 Preliminary Study

A project was carried out in autumn 2009 on mobile collaborative learning system by Noble Kuadey and Izaz Ul Haq as part of their specialization project. A survey was carried out to find out students response to a proposed Mobile Collaborative Learning System (MLCS). Findings from the survey indicated that majority of the respondents would be interested in a mobile learning system that can aid them in their learning and collaboration purposes. The proposed MCLS provide mobile services which enable users to collaborate and learn. The mobile services are based on web services.

2.2 Summary of the Survey

A survey was conducted among a target group of 50 students of Norwegian University of Science and Technology (NTNU) from different department and different year levels. A paper based questionnaire was prepared and distributed among the students. Most of the respondents believe that developing devices which will help mobility is the demand of the era, thus a mobile learning system which will run on hand held devices such as the one proposed will enhance their learning capabilities [1].

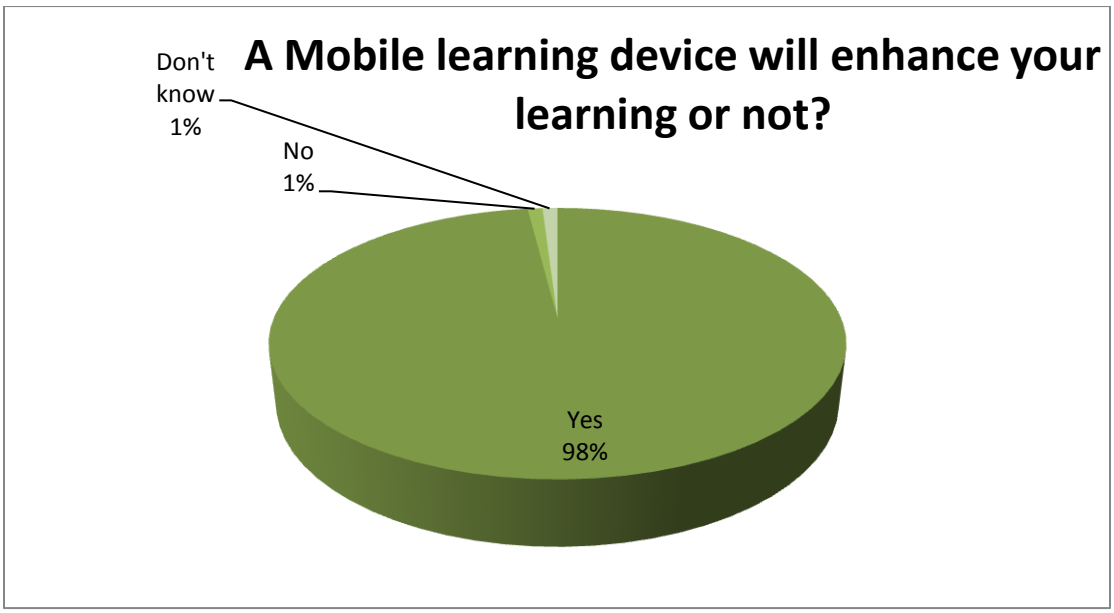

Figure 2.1 Mobile learning system will enhance learning [1]

Figure 2.1 shows that the majority of the respondents said a mobile learning device will go a long way to enhance their learning.

One of the findings of the survey relates to collaboration on a shared task. Figure 2.2 indicates how most of the respondents collaborate on a shared task. Most of them said they usually collaborate on a shared task through group meetings. Thus the proposed MCLS provides collaboration services that enable users to create and join groups, send group messages as well as receive group messages [1].

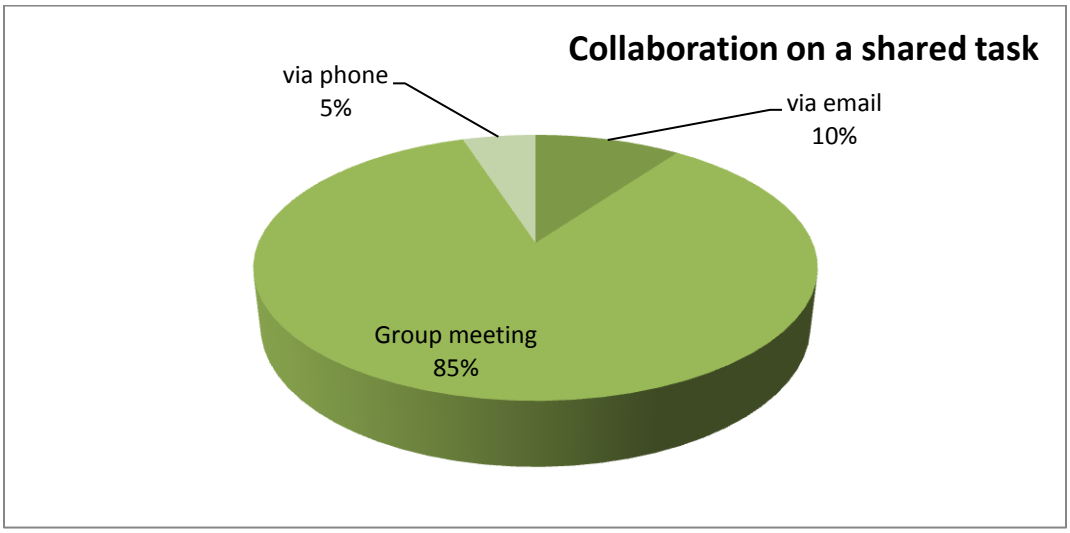

Figure 2.2 Collaboration on a shared task [1]

In reviewing the survey, 85% of the respondents mentioned that it would be nice and helpful to have a device that can help you locate a friend (Figure 2.3).

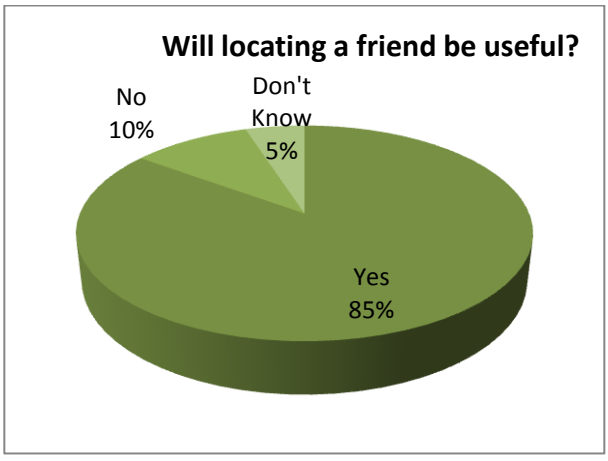

Figure 2.3 Locating a Friend [1]

The proposed MCLS provides a location service that enables users to search for other users.

Description of the proposed MCLS

The proposed MCLS is based on three tier architecture. Tier 1 is the presentation layer which provides a graphical user interface that enables the user to interact with the application. Tier 2 provides the business process logic and data access, it contains a number of web services that provides mobile services to the user. Tier 3 is the data storage layer which consists of the database server [1].

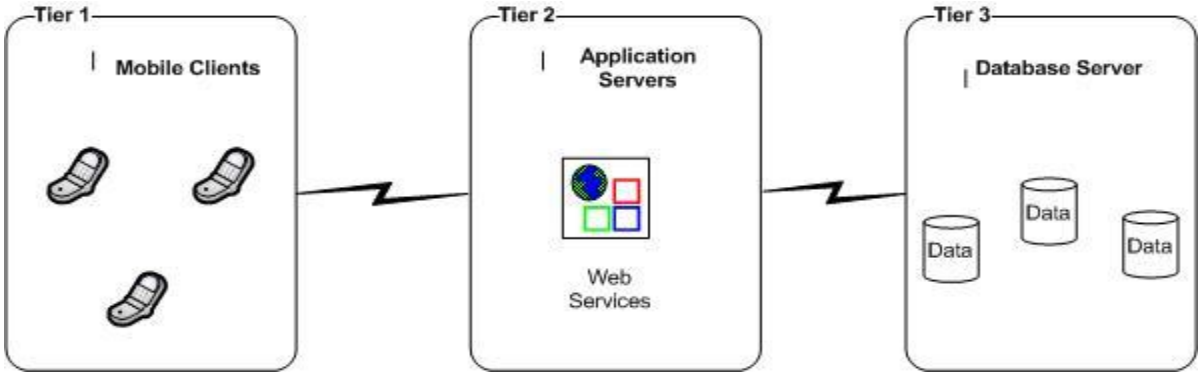

Figure 2.4 Proposed MCLS System Architecture [1]

The proposed MCLS application consists of three main services:

Collaboration Services: This service enable a user to send and receive message, create group and join group, post a message to the group and retrieve group messages as well.

Location Service: This service enables a user to search for other users

Notification Service: This service enables users to receive notification about lecture notes, assignments, solution guidelines and general information on a registered course that is uploaded on Its learning.

2.3 Similar Existing Solutions

Similar mobile learning systems have been developed and there are other ongoing projects being carried out. As part of last autumn specialization project we reviewed similar solutions embarked upon by others; namely FABULA, MOBILEARN, Mobile Learning System for Scaffolding Bird Watching Learning and Mobile Computer Supported Collaborative Learning.

FABULA is a project that is being carried out by Software Engineering group and the Intelligent Systems group of the department of Information and Computer Science of the Norwegian University of Science and Technology (NTNU) as discussed in section 4.5.

This project aims at developing a mobile system for learning enabled by seamless roaming in mobile networks with its focus on services that foster the city learning geographies and ecologies [1][2].

MOBILEARN is a worldwide European-lead research and development project that explores context sensitive approaches to informal, problem-based and work place. It is a project that aims at improving access to knowledge for selected target users such as mobile workers and learning citizens using new ways of mobile environments to meet the needs of the learners [1][3].

Mobile Learning System for Scaffolding Bird Watching Learning is a mobile system designed in Taiwan. It provides structured-assistance learning to users based on user's level of learning [1] [4].

Mobile Computer Supported Collaborative Learning (MCSCL) uses mobile ad-hoc network, it aids students to collaborate in groups, monitoring real time progress regarding learning objectives and controlling the interaction, negotiation, coordination and communication [1][5].

A similar existing solution that was not reviewed last autumn but formed the basis of this project is Mobile Student Information System (MSIS). The MSIS system architecture is based on three tier architecture [6].

The MSIS application consist of three major services namely Location Search, Lecture Schedule Planner and Announcement.

Location Search basically allows users to search for places such as lecture rooms, computer labs, canteens, etc.

Lecture Schedule Planner enables users to view information about course lectures and exercise guidance hours.

Announcement provide news, notifications and other relevant information to the user.

The location service implemented in the prototype of MCLS is an extension of the Location Search service provided in the MSIS application by Moe [6]

Chapter 3
Research Method

This chapter presents the research method used in this project. The research method used in this project is Design-Science paradigm. In the following sections, the research method used will be described in more detail.

3.1 Design Science-Paradigm

Design science paradigm is one of the two paradigms that characterize much of the research in the information systems discipline [7].

Design science is basically a problem solving paradigm that explore ways of creating innovations that define the ideas, practices, technical capabilities and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished [7][8].

Planning and conducting design research involves the use of iterative process which involves five steps [9]. These five steps are briefly described below:

Awareness: Identifying and stating the problem; this can come from reviewing literatures that authors have identified areas for further research.

Suggestion: This involves providing ideas of how the problem identified and stated might be solved.

Development: Implementing the design ideas.

Evaluation: This involves assessing the developed artifact and demonstrating the effectiveness and the efficiency of the developed artifact in solving the identified problem.

Conclusion: It is where results from the design process are consolidated and written up and ideas that could not be implemented are stated for further research purposes.

Hevner et al [7] stated that design science addresses research through the building and evaluation of artifacts designed to meet the identified problem. Hevner et al [7] suggested a set of guidelines for conducting and evaluating good design science research with the focus primarily on technology based design. The set of guidelines are summarized in Table 3.1

Guideline	Description
Guideline 1: Design as an Artifact	Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 3.1: Guidelines for Design Science in Information Systems Research [7]

Guideline 1: Design as an artifact

Design science is a problem solving paradigm. The end result of design science research in information systems is a viable artifact that addresses a problem identified.

For the purpose of this project, the viable artifact constitutes the prototype of Mobile Collaborative Learning System (MCLS).

Guideline 2: Problem Relevance

The objective of design science research is to construct innovative artifacts that can solve important and relevant business problems.

A survey was carried out in autumn 2009, the main findings of the survey indicated that students are interested in a mobile learning device and they agreed that such a device will enhance their

learning. Thus in this project the prototype of MCLS which is the viable artifact aims at solving problems relating to how students can learn and collaborate at anywhere and at anytime.

Guideline 3: Design Evaluation

Evaluation is a crucial component of research process and it is used to demonstrate the effectiveness and usefulness of the developed artifact. Evaluation involves comparing the goals and objectives of the designed artifact to actual observed results from the use of the designed artifact.

The developed artifact which is the prototype of MCLS in this project context will be evaluated using usability testing and user acceptance survey.

Guideline 4: Research Contributions

This guideline states that effective design science research must provide clear contributions in the areas of the design artifact, design construction knowledge and design evaluation knowledge.

Design science research offers three potential types of research contributions namely design artifact, design construction knowledge and design evaluation knowledge. One or more of these contributions must be found in a given research project;

In this project the major research contributions are the design artifact which is the prototype of MCLS and design evaluation knowledge. Design evaluation knowledge consists of creative development and use of evaluation methods. The evaluation methods that will be used in this project are usability testing and user acceptance survey.

Guideline 5: Research Rigor

Design science research requires the application of rigorous methods in both the construction and evaluation of the designed artifact.

With regards to the construction activity of the designed artifact; rigor must be assessed with respect to the applicability and generalizability of the artifact which is underpinned by theoretical foundations and research methodologies.

In the construction of the prototype of MCLS, survey which is one of the research methodologies was used in last autumn report to ascertain the applicability of the proposed prototype.

In the evaluation activity of the prototype of MCLS, usability and user acceptance testing will be carried out to determine how well the prototype of MCLS is usable and accepted by users.

Guideline 6: Design as a Search Process

Guideline 6 states that there should be continuous search for the best possible solution to the problem. Design is essentially a search process to discover an effective solution to a problem

By making an informed design decisions to solving the problem specified in this project, similar existing solutions were reviewed and pre-study carried out.

Guideline 7: Communication of Research

Design science research must be presented to both technology-oriented as well as management-oriented people.

In this project, the designed artifact which forms part of the master thesis will be presented to the project supervisor and other stakeholders.

3.2 Usability and User Acceptance Testing

Design science research guideline 3 [7] stated that the utility, quality and efficacy of design artifact must be rigorously demonstrated via well-executed evaluation methods.

Observing and measuring how well a designed artifact supports a solution to a specified problem is an essential aspect of design science research. At the end of the evaluation, researchers can iterate back to try and improve the effectiveness of the artifact or to leave further improvements to subsequent projects [10]. Usability and user acceptance testing are the evaluation methods used in evaluating the prototype of MCLS.

3.3 Usability

The International Organization for Standardization (ISO) defines usability of a product as the extent to which the product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [11].

Dumas et al also define usability as the ability for people to use a particular product quickly and easily to accomplish their own task [12]. Five attributes are traditionally associated with usability [13]. These five attributes are learnability, efficiency, memorability, errors and satisfaction.

Learnability

The system should be easy to learn so that the user can rapidly start getting some work done with the system.

Efficiency

The system should be efficient to use so that once the user has learned how to use the system, a high level of productivity should be possible.

Memorability

The system should be easy to remember, so that the user is able to return to the system after some period of not using it without having to learn everything all over again.

Errors

The system should have a low error rate so that users make few errors during the use of the system, so that even if they do make errors they can easily recover from them, further, catastrophic errors must not occur.

Satisfaction

The system should be pleasant to use so that users are subjectively satisfied when using the system; they should like the system.

3.4 USABILITY EVALUATION METHODS

There are various methods available that can be used to evaluate the usability of a product. Usability evaluation methods can be divided into the following categories: usability inspection method, usability testing method, and usability inquiry method.

3.4.1 USABILITY INSPECTION METHOD

This is a set of methods for identifying usability problems and improving the usability of a product by checking it against the established standards [14]. Some of the usability inspection methods are heuristic evaluation and cognitive walkthroughs.

Heuristic Evaluation

It is a type of usability inspection method where usability specialists judge whether each dialogue or each element of a product follows an established usability principles [14].

Cognitive Walkthroughs

It is a task oriented usability inspection method in which users are observed whiles they perform step by step task scenarios. Cognitive walkthroughs emphasizes cognitive issues such as learnability which is one of the five attributes associated to usability.

3.4.2 USABILITY TESTING METHOD

Usability testing method focuses on how end users use the functionality of the system. The most common type of usability testing method is thinking aloud protocol.

Thinking Aloud Protocol

This type of usability testing method enables the end user to verbalize their thoughts, feelings and opinions whilst testing the functionality of the system. This method enables the developer to understand how the end users view the system.

Usability testing is to test whether the product being developed is usable by the intended user population to achieve the tasks for which it was designed [12]. Usability testing is meant to improve the process by which products are designed and developed.

According to Dumas et al [12], every usability test shares five major characteristics. These characteristics are

- The primary goal is to improve the usability of a product
- The participants represent real users
- The participants do real tasks
- You observe and record what participants do and say
- You analyze the data, diagnose the real problems and recommend changes to fix those problems

The Goal is to Improve the Usability of a Product

The primary goal of a usability test is to improve the products usability that is being tested. It is also to identify areas where users struggle with the products so as one can make recommendations for improvement.

In this project the focus during the usability testing of the product will be on how users are able to use the functionality of the prototype.

The Participants Represent Real Users

The people who come to test the product must be members of the group of people who will be using the product.

Since the product is meant to be used by students, the participants who will be involved in the testing of the prototype are basically students of NTNU from different departments and different levels of study.

The Participants Do Real Tasks

The tasks that users will perform during the testing of the product must be the ones they will do with the product on their jobs or their homes.

The tasks the students will be performing during the testing of the prototype are the tasks students will encounter when they are using the prototype.

Observe and Record What the Participants Do and Say

In a usability test, several people usually come one at a time to work with the product, the participants are then observed as they work recording both their performance and comments.

In this project, due to limited time and unfavorable date of conducting the usability test, several participants will test the product simultaneously as such observations and recordings of participants will be very minimal.

Analyze the Data, Diagnose the Real Problems and Recommend Changes to Fix those Problems

Data collected during usability testing is analyzed after the testing. Real problems that occurred during the testing are diagnosed and recommendations needed to fix those problems are then made.

3.4.3 Usability Inquiry Method

This method involves collecting qualitative data from end users; this method provides the developer information regarding what end-users want. Some of the usability inquiry methods are focus groups, interviews and questionnaires.

Focus Groups

Focus groups consist of a number of participants who are led by a moderator. The moderator leads the group of participants through discussion on set of questions regarding the system.

Interview

An interview is an approach that enables you to query end-users about their experience and preferences with your system.

Questionnaire

It is a pre-defined set of questions arranged in a pre-determined order whereby respondents answer questions pertaining to the functionality of the system [9].

In this project a seven level Likert scale format questionnaire will be used to measure test users response to questions pertaining to the functionality of the system.

3.5 User Acceptance of Information Technology

What might necessitate end-users acceptance or rejection of a system? Previous research suggests that there are two important determinants which may influence system use [15]. These two determinants are perceived usefulness and perceived ease of use.

3.5.1 Perceived Usefulness

According to Davis [15], perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance. If a user's rating for perceived usefulness of a particular system is high, it implies the user believes in the existence of a positive use-performance relationship.

3.5.2 Perceived Ease of Use

Fred Davis [15] defines perceived ease of use as the degree to which a person believes that using a particular system would be free of effort. This implies a user's perception about the ease of use of a system means he or she should not encounter difficulty in using the system. Thus an application which is perceived to be easier to use than another application is more likely to be accepted by users.

3.6 Mobile Services Acceptance Model

Earlier researches concerning models and theories for determining end-users acceptance of information technology applications did not focus on mobile applications. Since computing technology is becoming more mobile and ubiquitous, it is therefore important to study the factors that influence the user adoption of mobile applications.

Gao et al [16], propose an extended technology acceptance model which is called Mobile Services Acceptance Model (MSAM). The Mobile Services Acceptance Model is based on Technology Acceptance Model (TAM), Theory of Planning Behavior (TPB), Innovation Diffusion Theory (IDT) and Unified Theory of Acceptance and Use of Technology (UTAUT) with a consideration of trust, context, personal initiatives and characteristics factors in addition to perceived usefulness and perceived ease of use.

Mobile Services Acceptance Model as proposed by Gao et al consist of six major components as depicted in Figure 3.1

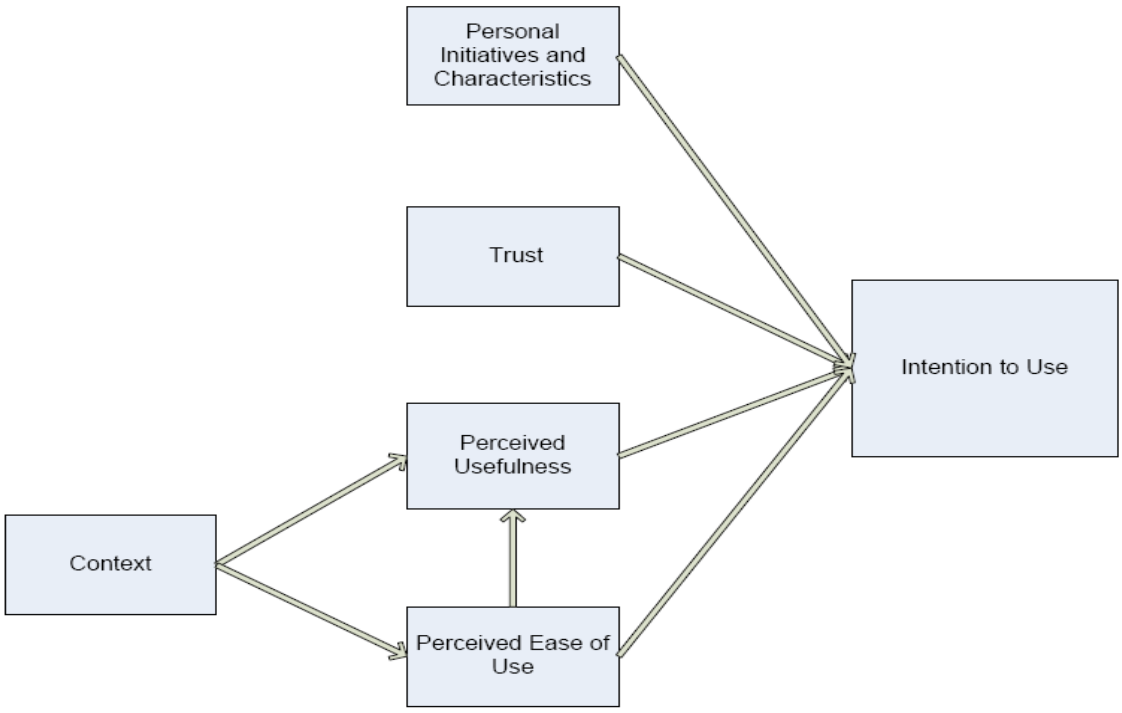

Figure 3.1 Mobile Services Acceptance Model [16]

Context

Context refers to location, identity and the state of people, groups and computational and physical objects [16]. A user's decision on whether a mobile application is useful or easy to use depends on his/her contextual information

Personal Initiatives and Characteristics

Personal initiatives can be defined as the user's willingness to try out new applications [16]. A user's personal characteristics include gender, age, educational background, knowledge and skills, culture and preference. A user's personal initiatives and characteristics determine his/her intentions of using mobile application.

Trust

Trust can be defined as user's belief or faith in the degree to which a specific mobile application can be regarded to have no security and privacy threats [16].

Many factors may influence a user's trust on mobile applications. A user's understanding of how security and privacy issues are controlled and the integrity of the mobile application are important elements of his/her trust on mobile applications.

Perceived Usefulness

It is defined as the degree to which a person believes that using a particular system would enhance his/her task. A user will accept a mobile application if he/she thinks it is useful.

Perceived Ease of Use

It is defined as the extent to which a person believes that using a particular system would be free from effort. A user who experiences difficulty in using a mobile application will be resistant in using that mobile application.

Intention to Use

Intention to use is the user's intent to use the mobile application.

In this project, the Mobile Services Acceptance Model will be used to evaluate the prototype of MCLS system.

Chapter 4
Requirement Specification

This chapter describes the functional and the non functional requirements with scenarios and use cases. All requirements consist of an ID, a brief description, priority and its complexity (High (H), Medium (M), and Low (L)). This chapter also describes a brief evaluation of the functional requirements with similar existing solutions.

4.1 SCENARIOS

Scenario 1: Group Task

Joseph Angbormi, Emmanuel Sintim, Nana Adjoa and Jean Paul are all in the same group TDT4290 Group 5. They decided to meet at Nana Adjoa's residence to discuss an assignment they were supposed to submit. Prior to the group meeting, Joseph felt he was not feeling too well and so decided to send a message to the group members to inform them of his inability to attend the group meeting. He logs onto the application and send his message to the group.

Scenario 2: Accessing Learning Resources

Princess Ofori is taking four courses this semester. On the bus to school, she wants to find out whether there are learning resources available to her. She logs on to the application and selects the resource service. She realized that there are a couple of learning resources available to her. She noticed that one of the learning resources available to her is a Portable Document Format (PDF) file. So she decided to download and read that particular file whiles on the bus since her mobile device has an acrobat reader.

Scenario 3: Seeking Help

Arden is an international student studying at Norwegian University of Science and Technology (NTNU). He has an upcoming test to write on a particular research paper he is seriously struggling to grasp. Whiles studying at gløshaugen campus, he logs onto the application in a bid to locate a course mate who can explain the paper to him. He searched for Izaz on his application and he realized from the search results that Izaz is not far away from him. He walks to where Izaz is and asks him to explain the main concepts in the paper to him. Izaz gladly explained the concepts to him. After the explanation, Arden was so happy he could get help from Izaz, he walked home a happy person who feels more prepared for the upcoming test [1].

4.2 Use Cases

Use cases are a technique for capturing the functional requirements of a system [17]. The textual use case used in this project follow the notation specified by Fowler [17].

UC-1 Retrieve Group Message relates to functional requirement FR-MA10

Title: Retrieve Group Message **Goal Level:** Sea Level
Main Actors: User, System
Pre-Conditions: • The MCLS application is started • The user is successfully logged in • The system displays the main menu
Post-Conditions: The user is able to retrieve group message(s)
Main Success Scenario: 1. User selects the Collaboration item in the main menu 2. User selects the Message item 3. User selects the Get Message item 4. User chooses a group 5. The system displays the group message(s)
Extension: 3a. The system displays a message ”you have no group”

Figure 4.1: Textual Use Case: Retrieve Group Message

UC-2 Create Group relates to functional requirement FR MA7

Title: Create Group
Goal Level: Sea Level

Main Actors: User, System

Pre-Conditions:

- The MCLS application is started
- The user is successfully logged in
- The system displays the main menu

Post-Conditions: The user creates a group successfully

Main Success Scenario:

1. User selects the Collaboration item in the main menu
2. User selects the Create Group item
3. User fills in the group details
4. The system sends a message to the user

Extension:

3a. User chooses the Save option
.1: The system stores the newly created group details

3b. User Chooses the Reset option
.1: The system clears all fields

Figure 4.2 Textual Use Case: Create Group

UC-3 Update Resource relates to functional requirement FR-MA5

Title: Update Resource **Goal Level:** Sea Level
Main Actors: User, System
Pre-Conditions: • The MCLS application is started • The user is successfully logged in • The system displays the main menu
Post-Conditions: The user updates a resource successfully
Main Success Scenario: 1. User selects the Resource item in the main menu 2. User selects the Update Resource item 3. User fills in the resource details and submit 4. The system sends a message to the user
Extension: 3a. System failed to update resource .1: The system displays error message

Figure 4.3 Textual Use Case: Update Resource

UC-4 Locate the position of another user relates to functional requirement FR-MA12

Title: Locate the position of another user **Goal Level:** Sea Level
Main Actors: User, System
Pre-Conditions: • The MCLS application is started • The user is successfully logged in • The system displays the main menu
Post-Conditions: The system displays the location of another user
Main Success Scenario: 1. User selects the Location Search item in the main menu 2. User selects Search User item 3. User enters the name of another user whose position he/she wants to search 4. The system displays the location of another user
Extension: 4a. User Chooses the Reset option .1: The system clears all fields

Figure 4.4 Textual Use Case: Locate the position of another user

UC-5 Send personal message relates to functional requirement FR-MA6

Title: Locate the position of another user **Goal Level:** Sea Level
Main Actors: User, System
Pre-Conditions: • The MCLS application is started • The user is successfully logged in • The system displays the main menu
Post-Conditions: The user sends the message
Main Success Scenario: 1. User selects the Collaboration item in the main menu 2. User selects the Message item 3. User selects the Send Message item 4. User selects the Send Personal Message item from the menu 5. User enters the recipient name and compose message
Extension: 5a. System fails to send the message .1: The system displays error message

Figure 4.5 Textual Use Case: Send personal message

4.3 FUNCTIONAL REQUIREMENTS

The functional requirements specify the functions the system is capable of performing

Functional Requirements for the Mobile Application

ID	DESCRIPTION	PRIORITY	COMPLEXITY
FR-MA1	The system should access the server using a mobile network	H	L
FR-MA2	Each user should have an account profile	H	L
FR-MA3	It should be possible to update user account	M	M
FR-MA4	It should be possible to access course materials from Its learning	H	H
FR-MA5	It should be possible to create and update learning resources to Its learning	H	H
FR-MA6	It should be possible to send and receive messages	H	H
FR-MA7	It should be possible to create and join a group	H	H
FR-MA8	It should be possible to start a discussion thread	H	M
FR-MA9	It should be possible to comment on a discussion thread	H	M
FR-MA10	It should be possible to retrieve a discussion thread	H	M
FR-MA11	It should be possible to find your own location on a map	M	H
FR-MA12	It should be possible for a user to find the position of another user	H	H
FR-MA13	It should be possible to add a location	H	H
FR-MA14	It should be possible to zoom in and out on a map	L	M
FR-MA15	It should be possible to receive notification on learning resources that are uploaded on Its learning	H	H

4.4 NON FUNCTIONAL REQUIREMENTS

These requirements are concerned with how the system will operate rather than the system's behavior.

ID	DESCRIPTION
NFR1	The mobile application should run on windows mobile compatible devices
NFR2	Response time for operations should not be more than 10s
NFR3	The user interface should be in English
NFR4	The user interface should be adaptable to different mobile devices
NFR5	The system should provide feedback to users on errors
NFR6	If the connection to the server is lost, the application on the mobile device should still be running
NFR 7	The user must be authenticated before gaining access to services

4.5 EVALUATION OF THE FUNCTIONAL REQUIREMENTS WITH THE FABULA AND MSIS ENVIRONMENTS.

FABULA is built on service based approach and the system is divided into layers of services. The FABULA service architecture consists of six main layers. These layers are Application specific learning services layer, Basic learning services layer, Resource Management layer, Learning Resource layer and FABULA Multi-Agent System (F-MAS) layer. Below is the FABULA Service Architecture used for the evaluation of the functional requirements [18].

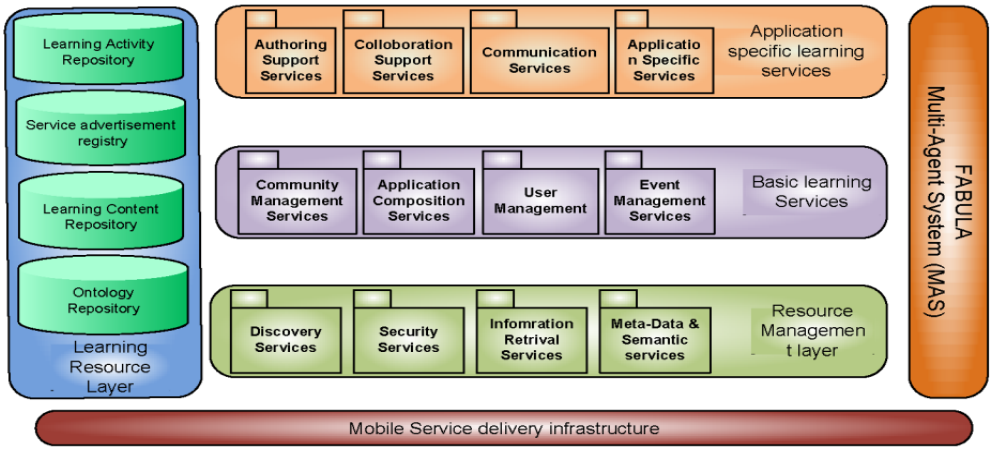

Fig 4.6: FABULA Service Architecture [18]

MSIS is a system which offers a number of mobile services. It consists of three major parts namely; the lightweight client application for deployment on mobile devices, a web based portal

and backend server which provides database storage business logic and number of public web services. Below is the MSIS Architecture used for the evaluation [2].

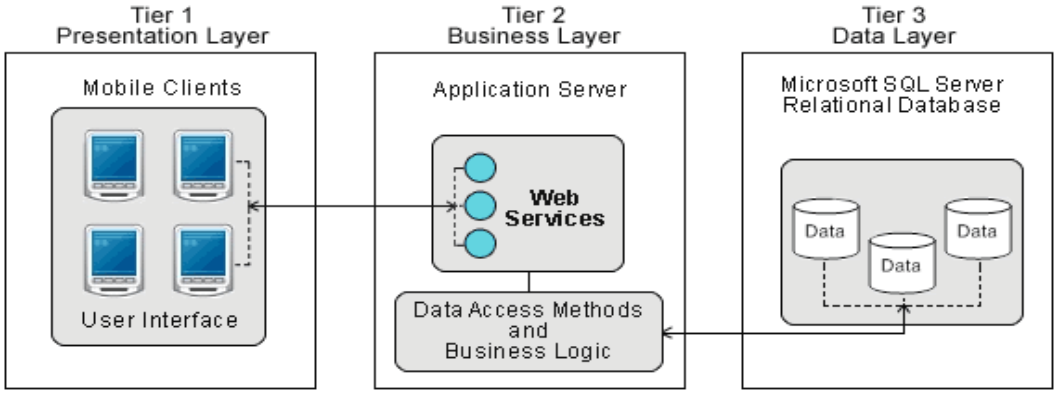

Fig 4.7: MSIS Architecture [6]

Requirements	FABULA	MSIS
FR-MA1	Y	Y
FR-MA2	Y	Y
FR-MA3	Y	Y
FR-MA4	N	N
FR-MA5	N	N
FR-MA6	Y	Y
FR-MA7	Y	N
FR-MA8	Y	N
FR-MA9	Y	N
FR-MA10	Y	N
FR-MA11	Y	Y
FR-MA12	Y	N
FR-MA13	Y	Y
FR-MA14	Y	Y
FR-MA15	N	N

Legends: Y = Yes, N = No

With regards to the FABULA environment, the FABULA Service Architecture supports most of the functional requirements listed above.

For **FR-MA2,** the User Management Services is responsible for managing the storage, retrieval and search of user profile which in this case is the account profile of the user. For **FR-MA3** it should be possible to use the **User Management Services** for updating user profile (account profile of user).

Regarding functional requirement **FR-MA4 and FR-MA5**, even though the system architecture does not have any form of integration with Its learning, with **FR-MA4,** the **Information Retrieval Services** made it possible to store, retrieve, organize and search for learning content in the Learning Content Repository. With **FR-MA5**, the **Authoring Support Services** allow users to edit documents (create, update, delete) and other learning artifacts.

Collaboration Support Services and Communication Services support the following functional requirements; **FR-MA6, FR-MA7, FR-MA8, FR-MA9 and FR-MA10.**

Space AGORA which is under FABULA Multi-Agent System supports both **FR-MA12 and FR-MA13,** regarding **FR-MA14** the user's location information is continuously and automatically updated in the system the moment the user is connected to the FABULA system hence there is no need for the user to manually add his/her location.

With regards to **FR-MA15,** the **User Agent**, which is under FABULA Multi-Agent System, provides the means of prompting its learners which is a form of notification but not a notification from Its learning.

The FABULA infrastructure supports almost all the functional requirements but since the FABULA infrastructure is not available the MCLS prototype is based on the MSIS infrastructure. Even though the MSIS infrastructure does not support some of the functional requirements listed above, there is the possibility of extending the current infrastructure to cater for those requirements that are not currently supported.

Chapter 5
Design and Implementation of the System

This chapter presents the design and description of the MCLS architecture. This chapter also presents the web services provided by the MCLS and their functionality and the implementation of the system.

5.1 SYSTEM ARCHITECTURE

The system architecture of the MCLS is based on an existing MSIS architecture [6]. The system architecture is a three tier architecture based on Service Oriented Architecture (SOA) infrastructure. The three tier architecture was chosen for the MCLS due to a number of advantages such as the separation of the client application and the database functionality which enhances better load balancing [1]. It is also easier to modify or replace the client application (for example the graphical user interface) without affecting the business logic and the data representation. The system architecture has three major layers; the major layers are client layer, application service layer and data storage layer. Figure 5.1 shows the graphical representation of the three tier architecture of the MCLS.

- **Client layer:** This layer presents the end-user with the client application which will be on a mobile device. The client application will provide the end-user an interface which allows the end-user to communicate and access the services.
- **Application Service layer:** This layer contains the services that the client application will be accessing. This layer contains four major service modules:
    - Collaboration Service Module: This service module contains authentication services, Instant Messaging services and Group services
    - Location Service Module: This service module allows users to find different points of interest throughout campus for example lecture rooms, computer laboratories as well as finding your own location and the location of other users [6].
    - Notification Service Module: This service module contains services that provide users with notification on learning resources as well as other relevant information to the user.
    - Learning Service Module: Contains services which allow users to access learning resources create and update learning resources.
    - Schedule Service Module: This service enables users to view information about course lectures and exercise guidance hours [6]
- **Data Storage Layer:** This layer contains the data that is stored and accessed by the services in the application layer.

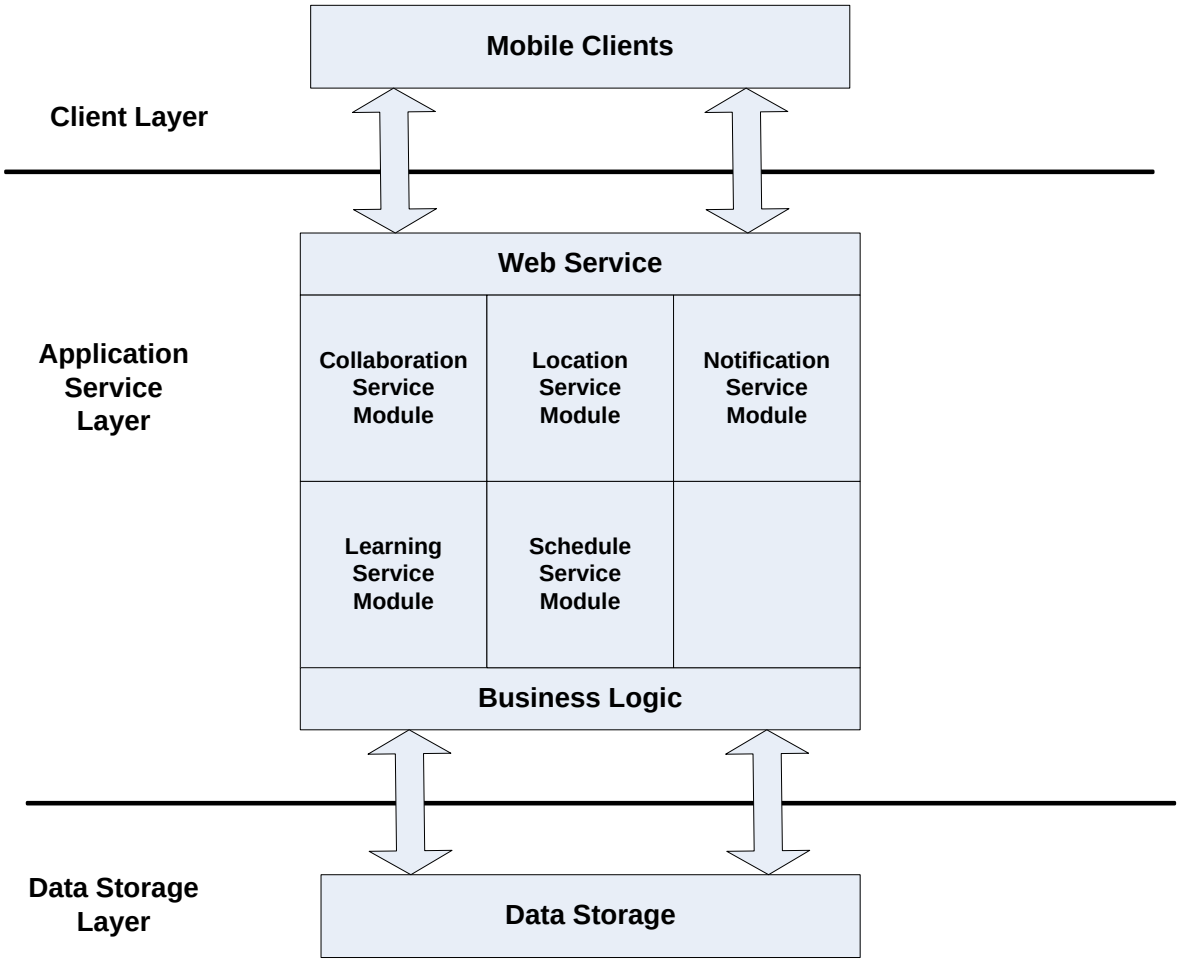

Figure 5.1: System Architecture

The main components of the MCLS architecture are:

- MCLS Client Application
- MCLS Web Services
- MCLS Database

5.1.1 MCLS CLIENT APPLICATION

The MCLS client application is an application developed for windows based mobile devices. The client application provides the end-user with a graphical user interface which access services provided by MCLS.

The client application consists of fewer resources with non-critical data and functions processed on the client whilst all critical functions and processor intensive calculations are made on the external application server.

5.1.2 MCLS WEB SERVICES

The MCLS web services are application logic responsible for the processing and calculations of the functionalities provided by the system. The web services are implemented using ASP.NET and C# language. The web services use xml to code and decode data and SOAP to transport the data. SOAP has become a de-factor standard for web service communication, it is compatible with many different platforms and operating systems and enables machine to machine communication in very heterogeneous environments [19].

There are two new web services in addition to two existing web services developed by Moe [6]. The two new web services are CollaborationService.asmx and LearningWebServices.asmx. The other two existing web services used are UserService.asmx and LocationService.asmx.

CollaborationService

This web service provides the functionality for sending and receiving messages, creating and joining groups. The CollaborationService web service has the following methods:

SendGroupMessage(GroupMessage mg, int Gid, string sendername): This method has GroupMessage object, Gid and sendername as its parameter. Gid specifies the group id and the sendername speficies the name of the user who sent the message.

The method returns true if the group message is sent successfully and return false if it fails to send the group message.

GetGroupMessage(int GroupId): This method has GroupId as its parameter. The GroupId specifies the id of the group, the method queries the database for group messages matching the group id specified and returns all messages belonging to that group.

GetUserGroups(int UserId): This method has UserId as its parameter. The UserId specifies the id of the user. This method returns all groups a user belongs to.

SendPersonalMessage(string msg, string uname, string sender): This method has msg, uname and sender as its parameters. The msg is the message composed by the user, uname specifies the name of the recipient of the message and sender specifies the name of the user who composed the message. This method returns true when the personal message is sent and returns false if it fails to send the personal message.

GetPersonalMessage(int UserId): This method has UserId as its parameter. It queries the database for messages matching id of a user and returns all messages sent to that user.

AddGroup(string groupname, string groupdescription): This method can be used to create new groups. It has groupname and groupdescription as its parameters. The method returns true when a new group is successfully added to the database and returns false if it fails to add a new group to the database.

JoinGroup(string usname, string gpname): This method has usname and gpname as its parameters. The usname specifies the username and the gpname specifies the name of the group. The method returns true if a user joins a group successfully and returns false if it fails.

LearningWebService

The LearningWebService is the web service responsible for the management of the learning resources. The LearningWebService consist of the following methods:

GetAvailableResources(string UserId): This method has a UserId as a parameter. It searches the database for the resources matching the id of a user and returns all the resources the user has.

AddResource(Resource res, string url): This method can be used to add learning resources to the database. The method has Resource object and url as its parameters with the url pointing to where the resource is located. The method returns true when a resource is successfully added and false if it fails to add a resource.

UpdateResource(Resource resource, string url): This method can be used to update an existing resource. The method accepts Resource object and url. The method returns true upon successfully updating a resource and false if it fails to update a resource.

LocationService

The LocationService web service provides the core functionality necessary for the location search service [6]. Three new methods were added to the existing methods provided by the web service. These new methods are:

SaveCurrentLocation(string UserId, int LocationId): This method has UserId and LocationId as its parameters. This method saves a user's current location.

GetUserLocation(string Name): This method accepts a user's name and queries the database for the user's location. This method returns a user's location.

GetUsers(String LocationName): This method has LocationName as a parameter. This method searches for users who are located at a particular location and returns the name of all users located at that particular location.

UserService

The UserService web service provides the functionality for account management and user login authentication [6]. The method for the login is:

Login(string username, string password): The method has username and password as its parameters. The method authenticates users against the database of known users. If the user is authenticated successfully, it returns the user's details. If authentication fails, an empty UserProfile object is returned with the property 'isAuthenticated' set to false.

5.1.3 DATABASE DESIGN

The database of MCLS system is the extension of the database of MSIS system which uses one Microsoft SQL Server database (see Figure 5.2). The database of MCLS has a total of 9 new tables. The additional tables added to the existing MSIS database are; Groups, Group_User, Group_Message, User_Location, User_Courses, User_Message, Resource, Available_Resource and Announcement_Resources. The group name and its description are stored in the Group table. Information about user's who belong to a particular group are stored in the Group_User table. The Goup_Message table contains group messages. User_Location stores information of a user's location. The User_Message table stores information about user's message. Information about the type of resources and the person who owns the resource are stored in the Resource table. The Available_Resource table stores information about the resources that are available. The Announcement_Resources alerts users of the type of resources and the owner of those resources. The revised database with all the tables are shown in the ER diagram in Figure 5.3

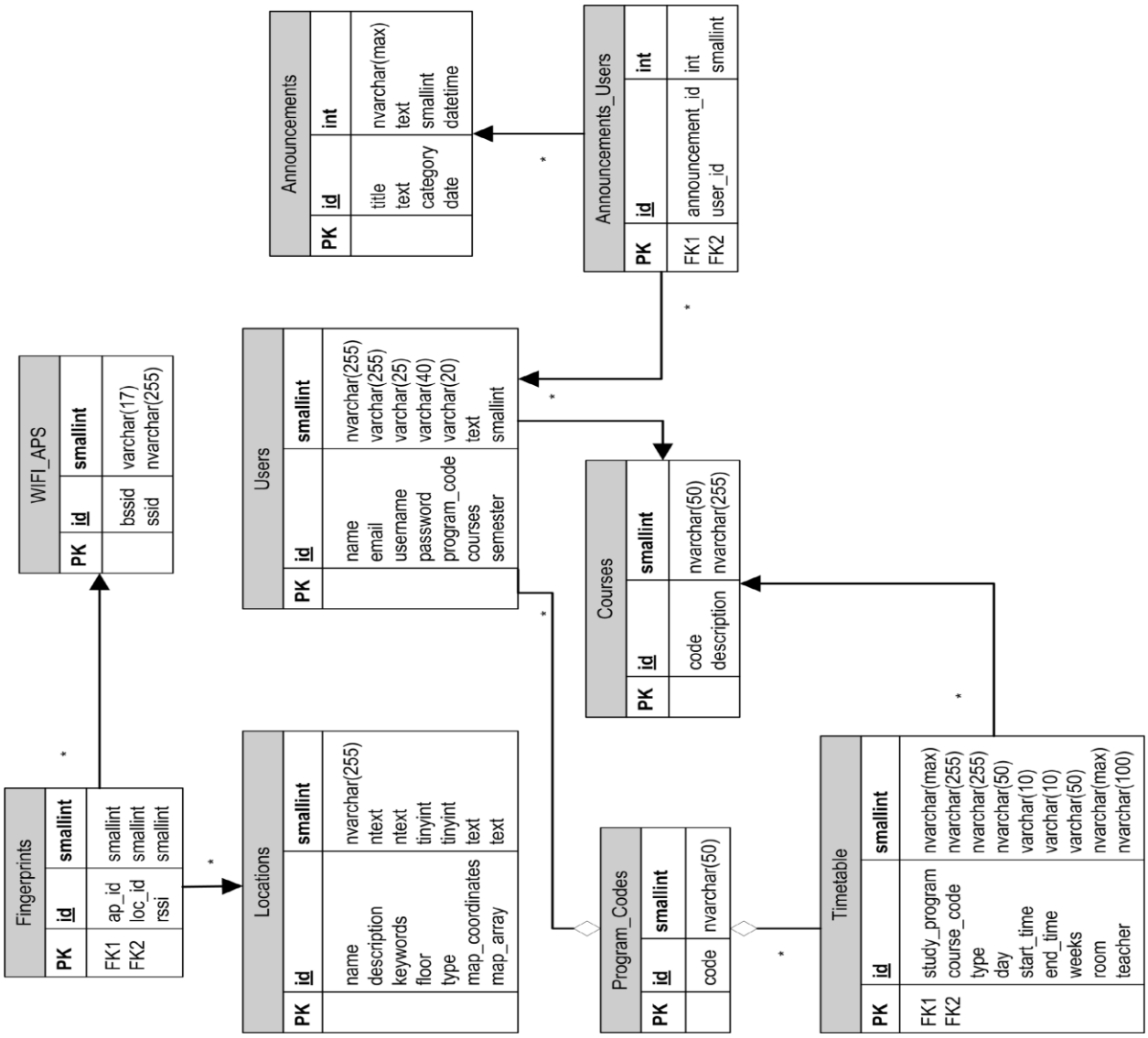

Figure 5.2: Database of MSIS [6]

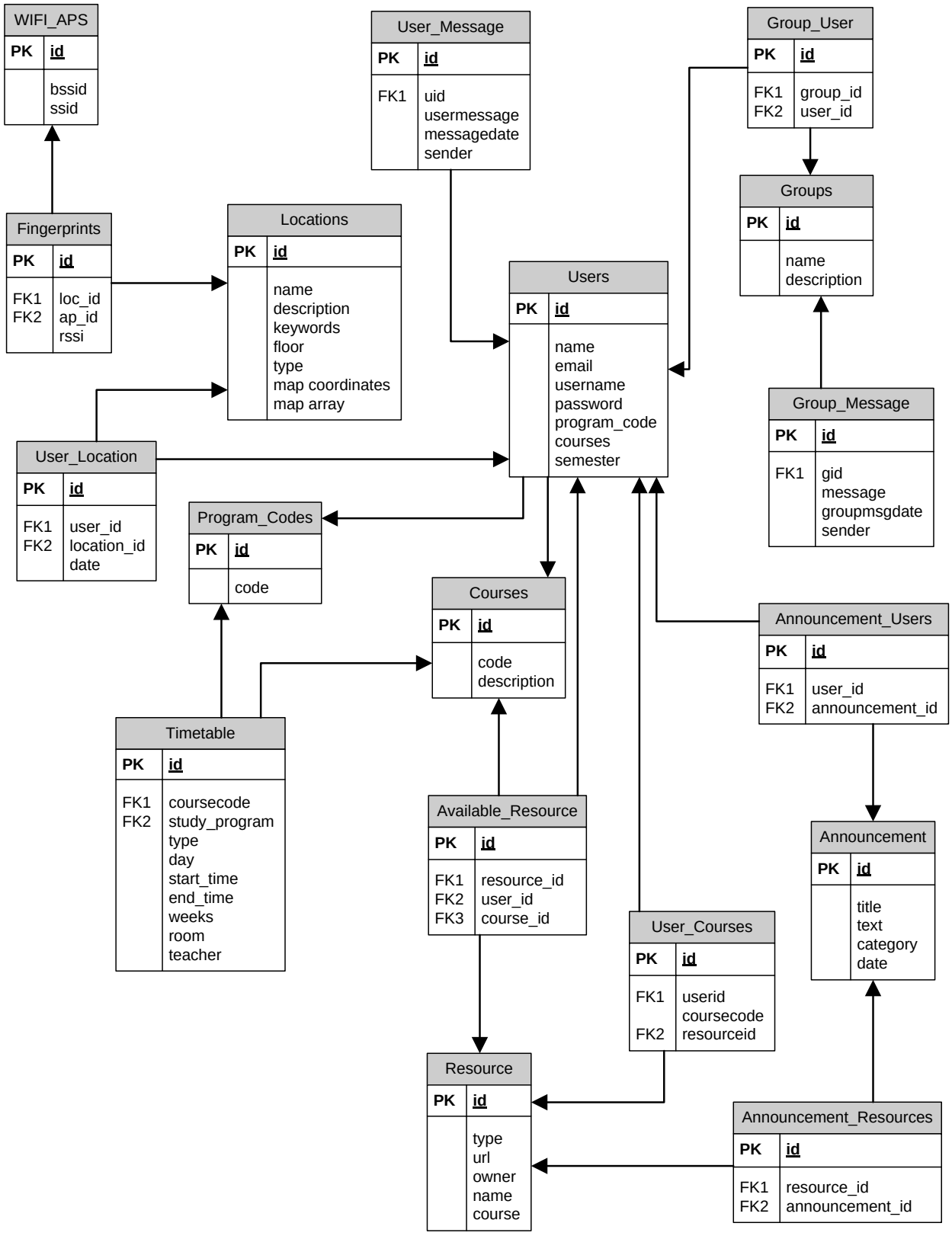

Figure 5.3: MCLS Database ER Diagram

5.2 IMPLEMENTATION

This section presents some aspects from the implementation of the system.

5.2.1 USERS OF THE SYSTEM

All users of the system are supposed to have an account before logging into the system. A new user first creates an account profile, saves it and then uses the account details to log into the system. An existing user only needs to log into the system with his/her account details. Figure 5.4 shows the log in window as it appears on a windows mobile 6 professional emulator and Figure 5.5 shows the window that enables a new user to create an account. Figure 5.6 shows the MCLS main menu that appears when a user successfully logs into the system.

Figure 5.4: Log in window

Figure 5.5: New User window

Figure 5.6: Main Menu

5.2.2 Resources

A user can check for available learning resources, add resources and update resources. Figure 5.7 shows the window that enables a user to add a resource and listing 5.1 shows the web services method that implements adding of resources.

Figure 5.7 Window for Adding Resource

Web service method that implements adding of resource

```
[WebMethod]
   public bool AddResource(Resource res, string url)
   {



      SqlConnection sqlConn = new SqlConnection(SQLConn.connectionString);
      // Terminate if unable to open SQL Connection
      if (!SQLConn.Open())
      {
         return false;
      }

      // Create SQLCommand object and prepare statement
```

```
        SqlCommand cmd;
        cmd = SQLConn.ExecuteCommand("INSERT INTO Resource (type, url, owner, name, course) VALUES (@type, @url, @owner, @name, @course)");
        cmd.Parameters.AddWithValue("type", res.Type);
        cmd.Parameters.AddWithValue("url", res.Url);
        cmd.Parameters.AddWithValue("owner", res.Owner);
        cmd.Parameters.AddWithValue("name", res.Name);
        cmd.Parameters.AddWithValue("course", res.Course);


        // Execute command
        using (cmd)
        {
            if (cmd.ExecuteNonQuery() > 0)
            {
                //
                SQLConn.Close();
                // Execution completed successfully, resulting in a new row in DB. Returns 'true' to indicate this success.
                return true;
            }
        }

        // Terminate and return false (indicates failure) at this stage (successfull path above)
        SQLConn.Close();
        return false;



    }
```

Listing 5.1: Adding Resource

5.2.3 MESSAGES

A user can send and receive group messages as well as personal messages. Figure 5.8 shows the window that enables a user send a group message and listing 5.2 shows the web service method that implements sending of group message.

Figure 5.8 Window for sending group message

Web service method that implements sending of group message

```
[WebMethod]
   public bool SendGroupMessage(GroupMessage mg,  int Gid, string sendername)
   {
      SqlConnection sqlConn = new SqlConnection(SQLConn.connectionString);
      // Terminate if unable to open SQL Connection
      if (!SQLConn.Open())
      {
         return false;
      }
```

```
        string sqlQuery = "insert into Group_Message (gid,message,groupmsgdate,sender) values
(@gid,@message,@groupmsgdate, @sender)";
        SqlCommand cmd = SQLConn.ExecuteCommand(sqlQuery);
        cmd.Parameters.AddWithValue("message", mg.Message);
        cmd.Parameters.AddWithValue("gid",Gid );
        cmd.Parameters.AddWithValue("groupmsgdate",DateTime.Now);
        cmd.Parameters.AddWithValue("sender", sendername);

        // Execute command
        using (cmd)
        {
            if (cmd.ExecuteNonQuery() > 0)
            {
                //
                SQLConn.Close();
                // Execution completed successfully, resulting in a new row in DB. Returns 'true' to
indicate this success.
                return true;
            }
        }

        // Terminate and return false (indicates failure) at this stage (successfull path above)
        SQLConn.Close();
        return false;

    }
```

Listing 5.2 Send Group Message

5.2.4 GROUPS

A user can create and join a group. Figure 5.9 shows the window for joining a group and listing 5.3 shows the web service method that implement joining a group.

Figure 5.9: Window for joining a group

Web service method that implements joining a group

Join Group

```
[WebMethod]
   public bool JoinGroup(string usname, string gpname)
   {
      SqlConnection sqlConn = new SqlConnection(SQLConn.connectionString);
      // Terminate if unable to open SQL Connection
      if (!SQLConn.Open())
```

```
        {
            return false;
        }
        string a = "select id from Users where username like '%" + usname + "%'";
        SqlCommand m;
        m = SQLConn.ExecuteCommand(a);
        int Uid = 0;
        using (SqlDataReader ud = m.ExecuteReader())
        {
            while (ud.Read())
            {

                Uid = (Int16)ud["id"];

            }
        }

        string b = "select id from Groups where name like '%" + gpname + "%' ";
        SqlCommand t;
        t = SQLConn.ExecuteCommand(b);
        int Gid = 0;
        using (SqlDataReader k = t.ExecuteReader())
        {
            while (k.Read())
            {
                Gid = (Int16)k["id"];
            }

        }
        string sqlQuery = "insert into Group_User (group_id, user_id) values (@group_id, @user_id)";
        SqlCommand cd = SQLConn.ExecuteCommand(sqlQuery);
        cd.Parameters.AddWithValue("group_id", Gid);
        cd.Parameters.AddWithValue("user_id", Uid);

        // Execute command
        using (cd)
        {
            if (cd.ExecuteNonQuery() > 0)
            {
                //
                SQLConn.Close();
                // Execution completed successfully, resulting in a new row in DB. Returns 'true' to indicate this success.
                return true;
            }
```

```
    }

    // Terminate and return false (indicates failure) at this stage (successfull path above)
    SQLConn.Close();
    return false;

}
```

Listing 5.3: Joining a Group

Chapter 6
Evaluation and Discussion of Results

This chapter presents the outcome of the evaluation of the prototype. Usability testing and user acceptance survey are the evaluation methods used in evaluating the prototype. All the test users who participated in the evaluation of the prototype are students from Norwegian University of Science and Technology (NTNU) with different academic background.

6.1 Usability Testing

Two scenarios were proposed for testing the functionality of the system. These scenarios involved number of tasks that test users would encounter in real world when using the system.

The first scenario involved a number of tasks that relates to the resource service of the system. For the test user to access the resource service, the test user was asked to log on to the system with a username and password that was provided for the evaluation purpose. The main tasks the test users would perform in this scenario were checking for available resources and downloading one of the resources.

The second scenario involved a number of tasks that relates to the collaboration service of the system. The sub-tasks test users would be performing in this scenario were reading of group message and reading of personal message.

During the test, the test users verbalize their thoughts, feelings and opinions, some of these were written as comments at the end of each scenario whilst others drew my attention and expressed how they felt using the system. For example, one of the test users complained about how irritating it is whenever he wants to type a character and the on-screen keyboard covers the message area; he hardly sees what he is typing.

The usability test scenarios are included in Appendix A.

6.1.1 Results

Scenario 1: Checking for available resources

The test users were asked to check for resources that are available to them. Some of the test users encountered couple of issues such as logging onto the system. Some of these test users using the new HTC Touch 2 windows professional 6.5 mobile device had problem with logging in due to how the on-screen keyboard appears, but after overcoming the initial problem, they were able to check for the resources available to them. All the test users were able to check for available resources. One of the test users felt reducing the steps involved in checking available resources will help usability of the system.

The next task, the test users performed was downloading of resources; once again there was a problem with the new HTC Touch 2 windows professional 6.5 mobile device. It must be noted that two different types of HTC mobile devices were used in evaluating the system. One of the HTC mobile devices is the HTC Touch 2 windows professional 6.5 whilst the other is HTC Pro windows 6.1 mobile dev ices. Downloading a resource on the new HTC Touch 2 windows professional 6.5 mobile devices always gives an error whilst it works very well on the HTC Pro windows 6.1 mobile device.

Scenario 2: Sending group message

The test users were asked to create a message and send the message to a selected group. All the test users were able to send messages successfully but there were some suggestions regarding sending of messages. One of the test users suggested that empty messages should not be delivered to a group. This suggestion has been implemented successfully.

The next task the test users performed was reading personal message. Most of the test users were able to read personal messages sent to them, a couple of them received index out of range error message. There were a few suggestions, one of the test users suggested that he should be notified when he received a message rather than having to check for messages that he has received. One of the test users also said he was a bit confused that you have to click on the menu to read a personal message.

Discussion

Both the resource service and the collaboration service worked well except the download task which did not worked on the new HTC Touch 2 windows professional 6.5 mobile device. This problem can be attributed to compatibility issues and not the application. Most of the test users are of the view that the system would be beneficial to them. One of the test users stated: “I think this would be very helpful and would make life easy especially accessing relevant materials”. Some of the test users who have never used touch screen mobile devices such as HTC phones, initially have difficulty in using the mobile device, one of such test users suggested there should be enough training for people with less knowledge on mobile application systems. A couple of test users suggested that instead of selecting a message and then clicking on the read message button to view the full message, a user should just click on the message to read the full message.

6.2 User Acceptance Survey

The test users after testing the functionality of the system were asked to evaluate the system based on mobile services acceptance model described earlier in section 3.6. The test users were asked to answer a number of questions pertaining to the utility, perceived usefulness, usability and general impression of the system. A seven scale Likert scale format was used to measure test users responses to statements in the questionnaire. The user acceptance survey is included in Appendix B.

6.2.1 Results

Perceived Usefulness (PU)

Table 6.1 shows the results concerning the perceived usefulness of the system. From the results with an average score of 5.5, about 87% of the test users agreed that the system would allow them to retrieve relevant information at NTNU (see item PU2). The majority of the test users with an average score of 5.8 agreed that the system would make it easier for them to keep track of their study related resources and tasks (see item PU3), with only very few of them disagreeing. In all about 79% of the test users with an average score of 5.6 perceived the system to be useful, only about 4% disagreed that the system would be useful to them with about 17% not sure of the system been useful to them or not (see item PU5). Figure 6.1 shows the response of perceived usefulness of the system. Findings from the user acceptance survey relating to perceived usefulness indicated that the test users believed in the existence of a positive user-performance relationship as discussed in section 3.5.1

Response: Strongly Disagree (1) – Strongly Agree (7)								
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Average Score
PU1	0.0%	8.7%	8.7%	21.7%	21.7%	26.1%	13%	4.9
PU2	0.0%	8.7%	0.0%	8.7%	21.7%	47.8%	17.4%	5.5
PU3	0.0%	4.3%	4.3%	4.3%	17.4%	34.8%	34.8%	5.8
PU4	0.0%	4.3%	13%	4.3%	34.8%	30.4%	13%	5.1
PU5	0.0%	4.3%	0.0%	17.4%	13%	39.1%	26.1%	5.6

Table 6.1: Frequency Results – Perceived Usefulness (PU)

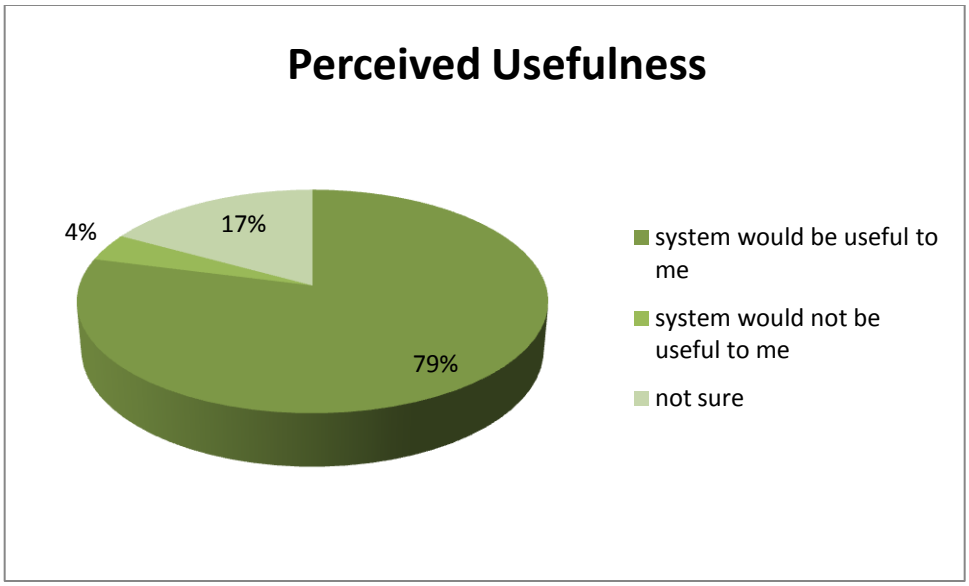

Figure 6.1: Perceived Usefulness

Perceived Ease of Use (EOU)

The results relating to perceived ease of use of the system is shown in Table 6.2. With an average score of 6.0, 87% of the test users agreed learning to operate the system would not be a problem at all with about 52% strongly agreeing to it (see item EOU1). All the test users except 8% of them do agree they would find the information they are looking for using the system (see item EOU2). 78% of the test users perceived the user interface of the system to be clear and intuitive with an average score of 5.5 (see item EOU3). Item EOU 4 got the lowest average score with just 52% of the test users agreeing that the system would be flexible to interact with, about 35% of them are not sure, comparing item EOU1 and EOU4, the test users uncertainty could be attributed to the ambiguity of the term flexible in relation to the system. About 74% of the test users with an average score of 5.1 perceived the system to be easy to use whilst about 17% disagree with about 9% uncertain. Figure 6.2 show the response of perceived ease of use of the system.

Response: Strongly Disagree (1) – Strongly Agree (7)								
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Average Score
EOU1	0.0%	4.3%	8.7%	0.0%	8.7%	26.1%	52.2%	6.0
EOU 2	0.0%	0.0%	8.7%	0.0%	17.4%	39.1%	34.8%	5.9
EOU 3	0.0%	4.3%	4.3%	13%	17.4%	39.1%	21.7%	5.5
EOU 4	0.0%	8.7%	4.3%	34.8%	13%	17.4%	21.7%	4.9
EOU 5	0.0%	8.7%	8.7%	8.7%	26.1%	30.4%	17.4%	5.1

Table 6.2: Frequency Results – Perceived Ease of Use (EOU)

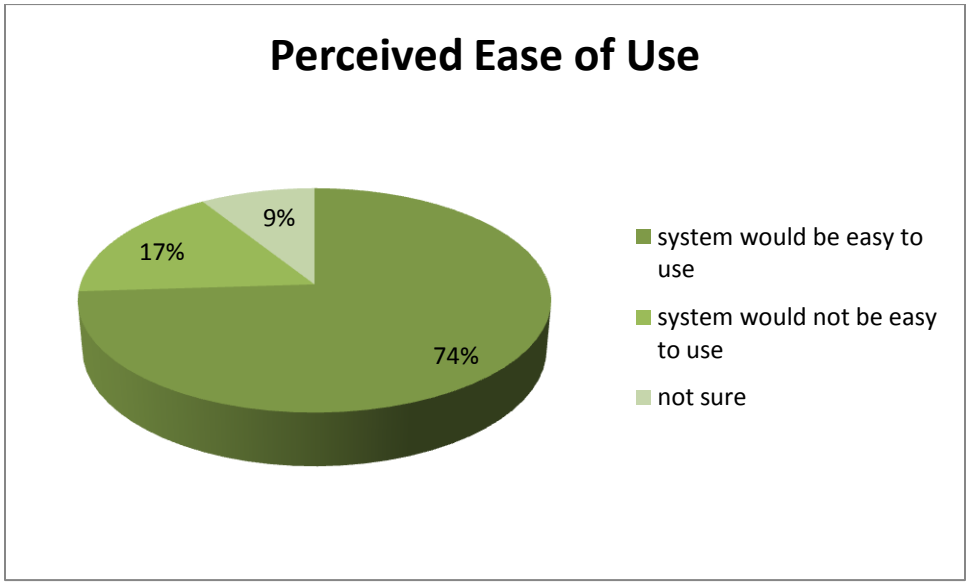

Figure 6.2: Perceived Ease of Use

Trust (TU)

Table 6.3 shows the results pertaining to Trust. A user who feels his/her privacy is threatened by a system would feel reluctant to use that particular system, thus trust can be considered as a factor for acceptance of mobile services. This is confirmed by the overwhelming majority of the test users with an average score of 6.1 that they could use the system if only they are convinced the system protects their privacy as users (see item TU3). Furthermore about 91% of the test users also consider the reliability of the data returned by the system important with about 48% of them considering it as a very important factor (see item TU5). Based on these results, it shows that a user's trust of a system affects his/her intention of using that particular system.

Response: Not Important (1) – Very Important (7)								
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Average Score
TU1	0.0%	0.0%	4.3%	13%	26.1%	30.4%	26.1%	5.6
TU 2	4.3%	8.7%	4.3%	8.7%	17.4%	39.1%	17.4%	5.1
TU3	0.0%	0.0%	0.0%	8.7%	21.7%	21.7%	47.8%	6.1
TU 4	0.0%	4.3%	4.3%	0.0%	43.5%	17.4%	30.4%	5.6
TU5	4.3%	0.0%	0.0%	4.3%	13%	30.4%	47.8%	6.0
TU6	0.0%	0.0%	4.3%	17.4%	4.3%	30.4%	43.5%	5.9

Table 6.3: Frequency Results – Trust (TU)

Personal Initiatives and Characteristics (PIC)

The findings' relating to personal initiatives and characteristics is shown in Table 6.4. About 74% of the test users agreed that it would be interesting using the system with only 13% disagreeing (see item PIC1). With an average score of 4.1, about 43% of the test users disagreed to the statement that they would be the first to use the systems with about 22% not certain (see item PIC3). From the results most of the test users agreed they would only use the system if it was provided for free (see item PIC5), this indicates that, even though most of the test users perceived the system to be useful to them they do not consider the system so important that they would be willing to pay for. With an average score of 5.4, about 79% of the test users felt it was rewarding using the system and only about 4% disagreed (see item PIC6). Even though about 79% of the test users felt it was rewarding using the system, only about 39% of them do agree they would prefer to be the first to use the system (see item PIC3).

Response: Strongly Disagree (1) – Strongly Agree (7)								
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Average Score
PIC1	0.0%	4.3%	8.7%	13%	13%	43.5%	17.4%	5.4
PIC 2	0.0%	13%	8.7%	17.4%	17.4%	26.1%	17.4%	4.9
PIC3	8.7%	21.7%	13%	21.7%	8.7%	13%	17.4%	4.1
PIC 4	0.0%	8.7%	13%	21.7%	26.1%	4.3%	26.1%	4.8
PIC5	0.0%	0.0%	4.3%	8.7%	17.4%	39.1%	30.4%	5.8
PIC6	0.0%	4.3%	4.3%	13%	26.1%	34.8%	17.4%	5.4
PIC7	13%	8.7%	13%	8.7%	30.4%	17.4%	8.7%	4.2

Table 6.4: Frequency Results – Personal Initiatives and Characteristics (PIC)

Context

A user's decision to use mobile applications can be determined by his/her contextual information. Table 6.5 shows the results pertaining to context. Most of the test users agreed they could use the system if they are out of their home or their office (see item CT1) relating this response to that of item CT6 in which overwhelming majority of test users agreed they could use the system if they did not have access to a desktop computer or laptop, this implies that a lot of people are more likely to use the system in situations where they could not have access to laptops or desktop computers. It is also worth noting that most of the test users do agree that they could use the system if most people around them are equally using the system (see item CT2). Finally with an average score of 5.9, about 91% of the test users agreed they could use the system, if the system offers services that is contextually relevant to them (see item CT7). As expected the findings underpinned the fact that a user's decision to use a mobile application can be influenced by his/her context.

Response: Strongly Disagree (1) – Strongly Agree (7)								
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Average Score
CT1	0.0%	0.0%	0.0%	13%	21.7%	39.1%	26.1%	5.8
CT 2	0.0%	0.0%	0.0%	17.4%	30.4%	30.4%	21.7%	5.6
CT3	4.3%	4.3%	4.3%	8.7%	43.5%	21.7%	13%	5.0
CT 4	0.0%	0.0%	8.7%	8.7%	17.4%	39.1%	26.1%	5.7
CT5	0.0%	0.0%	0.0%	4.3%	17.4%	47.8%	26.1%	6.0
CT 6	0.0%	0.0%	0.0%	8.7%	8.7%	43.5%	39.1%	6.1
CT7	0.0%	0.0%	4.3%	4.3%	17.4%	47.8%	26.1%	5.9

Table 6.5: Frequency Results – Context (CT)

Intention to Use

Table 6.6 presents the results relating to intention to use. About 83% of the test users agreed they intend to use the system, if they have access to the system with only 13% disagreeing and about 4% not certain (see item IU1 and Figure 6.3). Furthermore about 83% of the test users predicted that they would use the system provided they already have access to the system and only 13% of the test users perceived others with about 4% of the test users not sure of their decision (see item IU2 and Figure 6.4). Comparing the two items IU1 and IU2 there is every indication that majority of the test users intend to use the system.

Response: Strongly Disagree (1) – Strongly Agree (7)								
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Average Score
IU 1	0.0%	0.0%	13%	4.3%	21.7%	26.1%	34.8%	5.6
IU 2	0.0%	0.0%	13%	4.3%	17.4%	43.5%	21.7%	5.6

Table 6.6: Frequency Results – Intention to Use (IU)

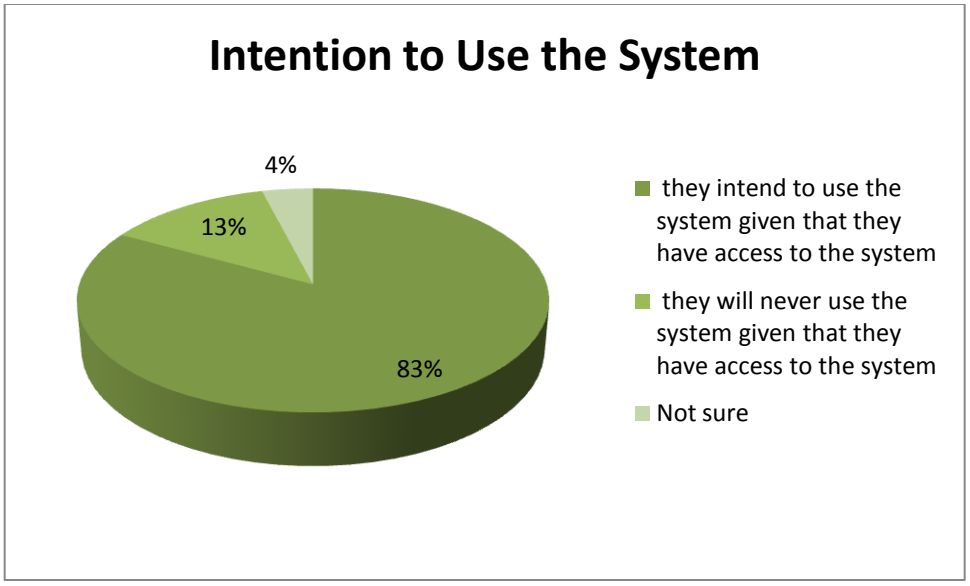

Figure 6.3: Intention to Use the System

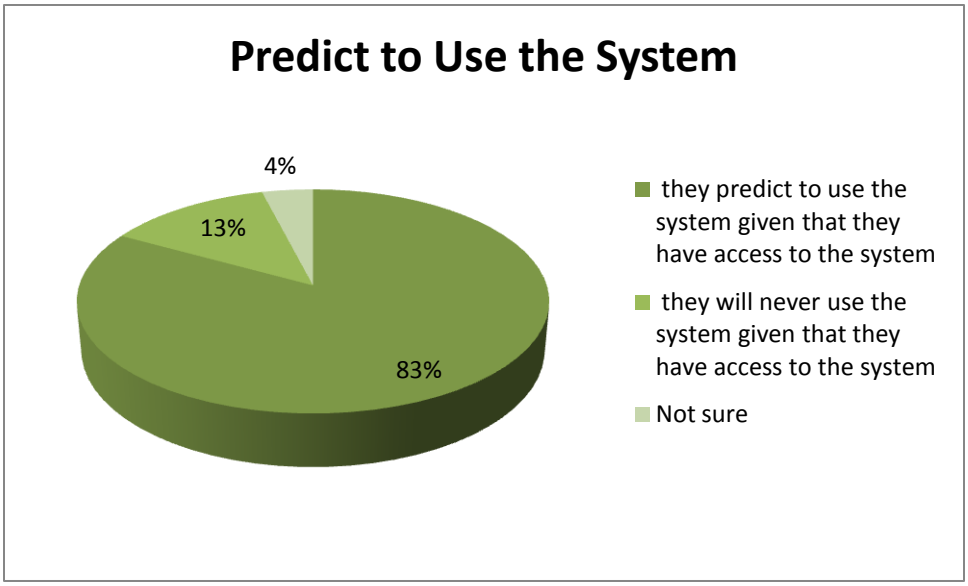

Figure 6.4: Predict to Use the system

Figure 6.5 shows the relationship between perceived usefulness and intention to use the system. From the graph, the test users who rated perceived usefulness high also equally rated the intention to use the system high. In cases that the test users rated the perceived usefulness low,

they also rated the intention to use the system low. This clearly shows that the perceived usefulness of the system affects the intention to use the system.

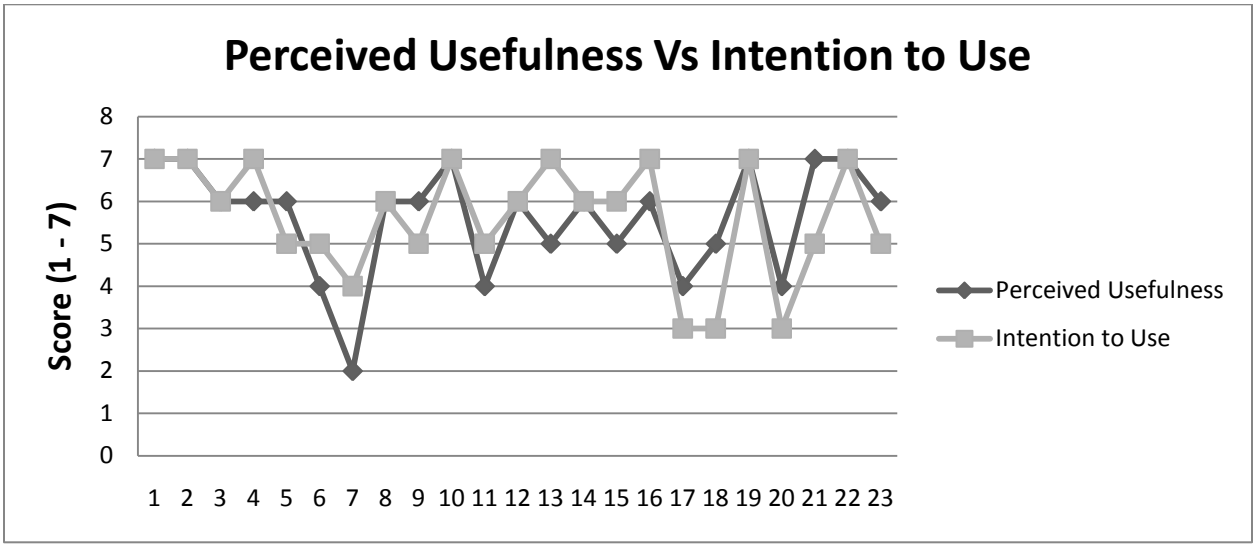

Figure 6.5 Perceived Usefulness Vs Intention to Use

Figure 6.6 shows how the perceived ease of use of the system relates to intention to use the system. From the graph, the test users who rate the perceived ease of use of the system low also do so for the intention to use. There is clear indication from the graph that perceived ease of use of the system affects the intention to use the system.

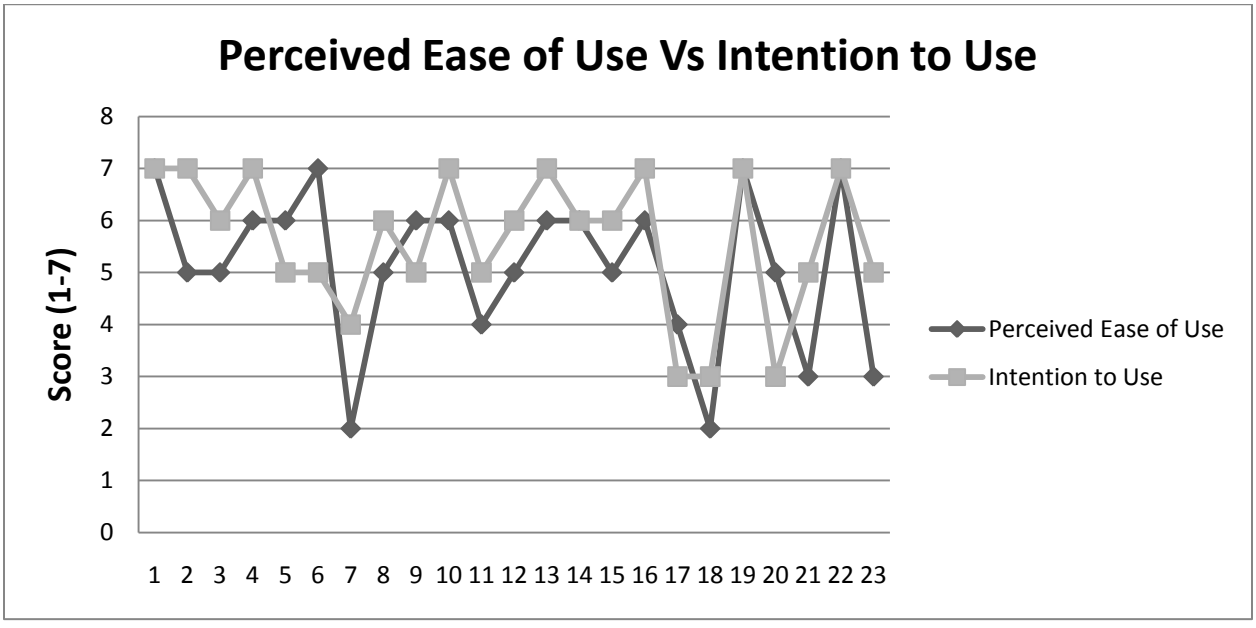

Figure 6.6 Perceived Ease of Use Vs Intention to Use

Chapter 7
Conclusions and Further Work

This chapter ends the report with a brief overview of the contributions made, discussion of limitations and suggestions for further work.

7.1 Contributions

This work is based on a specialization project carried out in autumn 2009, which proposed the implementation of a Mobile Collaborative Learning System (MCLS) that will help students in learning and collaborating.

The main contribution towards this project work is the design and implementation of MCLS prototype. Evaluation of the prototype was conducted using two evaluation methods namely usability testing and user acceptance survey. A group of test users assessed the usability of the prototype by testing the functionalities of the system, after which they answered a couple of questions pertaining to perceived usefulness of the system, perceived ease of use of the system, intention to use and other constructs as described in section 3.6. This project applied design science research methodology.

7.2 Conclusion

A preliminary study conducted among students in autumn 2009 indicated that students are interested in a mobile learning device and they agreed such a device will enhance their learning. The evaluation of the prototype confirmed the survey findings in autumn 2009. The results from the user acceptance survey indicated that the majority of the test users perceived the prototype to be useful to them and most of them agreed they intend to use the prototype provided they have access to it and even if given that they have access to the prototype, the majority once again predicted they intend to use the prototype.

These findings provide a firm basis for the future research and further development of the Mobile Collaborative Learning System.

7.3 LIMITATIONS

The initial idea was to integrate some aspects of the prototype especially the resource service to Its learning, but this could not be implemented. Its learning is a commercial product; the developers of Its learning could not provide any Application Programming Interface (API) that could possibly enable their system to interact with the MCLS prototype. This limitation affected the implementation of the following functional requirements; FR-MA4, FR-MA5 and FR-MA15 (see section 4.3).

7.4 FURTHER WORK

There is always room for improvement. There is the need for further development for the prototype to become a complete functional system that would be wholeheartedly accepted by majority of the students. The possible suggested extensions for further development of the prototype are:

- The prototype should be able to interoperate on multiple platforms; the current prototype only supports windows platform.
- The prototype should be able to support synchronous chat
- The prototype should be able to provide notification of messages received
- The prototype should be able to support dynamic location management
- The prototype should be improved by implementing the click event for reading messages.

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APPENDIX A – USABILTY SCENARIOS

SCENARIO 1: RESOURCE SERVICE

Princess Ofori is taking four courses this semester. On the bus to school, she wanted to find out whether the courses she has registered this semester has resources available to her.

Checking for Available Resources

The following procedures will enable you perform the task of checking for Available Resources

- Log on to the main application with username(tilly) and password(korkoi)
- Click on the Resource to start the resource service.
- Click on the Available Resource button to view the resources that are available.

After Checking for Available Resources, Princess wanted to download one of the resources onto her mobile device.

- Select the resource you wish to download.
- Click on the download button. The download dialog box pops up, you can choose to click on yes to download the resource to the default path specified or you can choose the save as option and edit the following parameters: Name of resource, Folder and Location.
- Click on the Yes button to save the resource to the mobile device's "My document folder"
- Return to the main menu.

Comments (What worked, what did not work? Response? Something illogical / difficult?)

USER GUIDE FOR RESOURCE SERVICE

CHECKING FOR AVAILABLE RESOURCES

LOG IN AND MAIN APPLICATION

Figure 1 **Figure 2**

Figure 1 is the main application login form where a user can enter the main application by using **user name** and **password**

Figure 2 is the main application form, click on the Resources menu icon to begin the resource services.

Figure 3

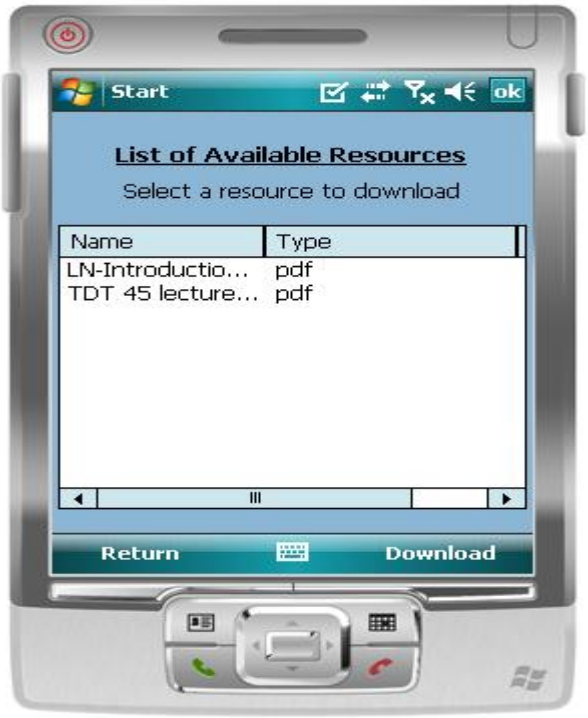

Figure 4

Figure 3 is Resources window which appears when the user clicks on the Resource icon in the main application in Figure 2. Click on the Available Resource icon in Figure 3 to display the available resources window in Figure 4.

DOWNLOADING A RESOURCE

Select a resource from the available list of resources in Figure 4 and click on the download in Figure 4 to display the download window in Figure 5

Click on Yes button to download the resource to the default path specified.

Figure 5

Comments (What worked, what did not work? Response? Something illogical / difficult?)

SCENARIO 2: COLLABORATION SERVICE

Joseph Angbormi, Emmanuel Sintim, Jean Paul and John Doe are all in the same group TDT4290 Group 5 and have all decided to meet at Jean Paul's residence to discuss the assignment they are suppose to submit. During the course of the day, Joseph Angbormi was not feeling too well and so decided to send a message to the group that "he is sick and will not be able to come for the discussion".

Sending a group message

The following procedures will enable Joseph Angbormi send a message to the group members of TDT4290 Group 5

- Log on to the main application with username(tilly) and password(korkoi)
- Click on the collaboration icon to start the collaboration service
- Click on the message icon
- Click on the send message icon
- Select TDT4290 Group 5 from the group drop down box
- Type your message and click on the send message button to send the message
- Return to the main application

Reading personal message

John Doe wanted to read the personal messages he has received.

- Log on to the main application with username(tilly) and password(korkoi)
- Click on the collaboration icon to start the collaboration service
- Click on the message icon
- Click on the get message icon
- Select from the menu personal message
- Select a message and click on the read message to view the full message
- Return to the main application

USER GUIDE FOR COLLABORATION SERVICE

SENDING GROUP MESSAGE

Figure 2

Click on the collaboration icon in the main application form to begin the collaboration services.

Figure 6

Figure 7

Figure 6 is collaboration window which appears when the user clicks on the collaboration icon in Figure 2 icon in the main application in Figure 2

Click on the Message icon in Figure 6 to display the Message window in figure 7. Click on the Send Message icon in Figure 7 to display the send message window in Figure 8.

Figure 8

Select a group from the group drop down box, type your message and click on the send message button to send the message to the group members of the group you have selected.

Return to the message window in Figure 7 by clicking on the return button.

READING PERSONAL MESSAGE

Figure 7

Figure 9

Click on the Get Message icon in the Message window in Figure 7 to display the get message window in Figure 9.

Click on the menu in Figure 9, sub menu item appears with the name Personal Message as shown in Figure 10.

Figure 10

Figure 11

Click on the Personal Message in Figure 10 to display the Personal Message window in Figure 11. Select a message and Click on the Read Message to view the full message.

Comments (What worked, what did not work? Response? Something illogical / difficult?)

APPENDIX B – USER ACCEPTANCE SURVEY

MSIS Experiment Questionnaire

Part 1. Personal information

1. Gender:
❑ Female ❑ Male

2. Age:
❑ Less than 20 years old ❑ 20–30 years old
❑ Larger than 30 years old

3. Department
❑ Science or Engineering Department ❑ Other Departments

4. Education Level
❑ Bachelor Student ❑ Master Student ❑ Doctoral Student or above

5. Experience in Mobile Services:
❑ 0-1 year ❑ 2-5 years ❑ more than 5 years

6. Nationality:

Part 2. Post-Experiment Questionnaire

Please use a few minutes to answer the following questions pertaining to the utility, perceived usefulness, usability and general impression of the MSIS service. All respondents remain anonymous.

Perceived Usefulness (PU)	**Strongly disagree**						**Strongly agree**
PU 1. Using the system would increase the efficiency of my daily work.	❑	❑	❑	❑	❑	❑	❑
PU 2. The system would allow me to retrieve relevant events and news at NTNU.	❑	❑	❑	❑	❑	❑	❑
PU 3. The system would make it easier to keep track of my study related resources and tasks.	❑	❑	❑	❑	❑	❑	❑
PU 4. The system would allow me to better plan and organize my activities at NTNU.	❑	❑	❑	❑	❑	❑	❑
PU 5. The system would be useful for me as a student.	❑	❑	❑	❑	❑	❑	❑

Perceived Ease of Use (EOU)	**Strongly disagree**						**Strongly agree**
EOU 1. Learning to operate the system would easy for me.	❑	❑	❑	❑	❑	❑	❑
EOU 2. I would easily find the information I am looking for using the system.	❑	❑	❑	❑	❑	❑	❑
EOU 3. I would find the user interface of the system clear and intuitive.	❑	❑	❑	❑	❑	❑	❑
EOU 4. I would find the system to be flexible to interact with.	❑	❑	❑	❑	❑	❑	❑
EOU 5. I would find the system to easy to use (user-friendly).	❑	❑	❑	❑	❑	❑	❑

Trust (TU) *I could use the system…*	**Not important**						**Very important**
TU 1. if I have a clear conception of the functionality of the system.	❑	❑	❑	❑	❑	❑	❑
TU 2. if the system provider(e.g. NTNU) and the software developers is widely acknowledged.	❑	❑	❑	❑	❑	❑	❑
TU 3. if the system protects the privacy of its users .	❑	❑	❑	❑	❑	❑	❑
TU 4. if I feel confident that I can keep the system under control.	❑	❑	❑	❑	❑	❑	❑
TU 5. if I feel confident that the data returned by the system is reliable.	❑	❑	❑	❑	❑	❑	❑
TU 6. If I believe it is risk-free to use the system.	❑	❑	❑	❑	❑	❑	❑

Personal Initiatives and Characteristics (PIC)	**Strongly disagree**						**Strongly agree**
PIC 1. Using the system would be interesting.	❑	❑	❑	❑	❑	❑	❑
PIC 2. I have fun using the system.	❑	❑	❑	❑	❑	❑	❑
PIC 3. I prefer to be the first one using the system.	❑	❑	❑	❑	❑	❑	❑
PIC 4. Using the system gives me an advantage over those who don't.	❑	❑	❑	❑	❑	❑	❑
PIC 5. I would only use the system if it was available for free.	❑	❑	❑	❑	❑	❑	❑
PIC 6. I find it rewarding to use the system.	❑	❑	❑	❑	❑	❑	❑
PIC 7. Using this mobile system can be considered as a social status symbol among my friends	❑	❑	❑	❑	❑	❑	❑

Context **(CT)** *I could use the system…*	**Strongly disagree**						**Strongly agree**
CT 1. if I am being out of home or the office.	❑	❑	❑	❑	❑	❑	❑
CT 2. if most people around me are using the system.	❑	❑	❑	❑	❑	❑	❑
CT 3. if I had nice experience in using mobile services before.	❑	❑	❑	❑	❑	❑	❑
CT 4. if the University encourage students to use the system.	❑	❑	❑	❑	❑	❑	❑
CT 5. if it is meaningful/relevant to my daily tasks.	❑	❑	❑	❑	❑	❑	❑
CT 6. if I did not have access to a desktop computer or laptop.	❑	❑	❑	❑	❑	❑	❑
CT 7. if the system is offering services that is contextual relevant to me, based upon where I am and what I am interested in	❑	❑	❑	❑	❑	❑	❑

Intention to Use (IU)	**Strongly disagree**						**Strongly agree**
IU 1. Assuming I have access to the system, I intend to use it.	❑	❑	❑	❑	❑	❑	❑
IU 2. Given that I have access to the system, I predict that I would use it.	❑	❑	❑	❑	❑	❑	❑

Please comment on the scales above: