Specialization Project Autumn 2009

Mobile Collaborative Learning System
Abstract

The project work is about mobile learning, how a system that is supposed to be developed based on mobile technology will aid people to learn and collaborate on a shared task at anywhere and at anytime.

The project work is performed as a design science project with a survey conducted to gather information from students concerning their general approach to learning and what functionalities they expect the proposed system to have. In this project we proposed a solution to how the proposed system titled Mobile Collaborative Learning System is to be developed.
Preface

This report is a documentation of the project work performed in the course TDT 4520, Program and Information Systems, Specialization Project. The project counts for 15 points and is undertaken in the first semester of the second year of a 2-year Master of Science program in Information Systems at the Norwegian University of Science and Technology, NTNU.

The project was defined by the Department of Computer and Information Science, and our supervisor for the project was Professor John Krogstie. In the project work, we suggested a solution to how a Mobile Collaborative Learning System can be implemented.

We wish to thank our supervisor, Professor John Krogstie for his immense contribution, valuable feedback and advice throughout the entire period of the project work. We wish to thank all those who participated in the survey we conducted. We also wish to thank Siddiqui for his support.

Trondheim, 15th December, 2009

..........................................

Noble Kuadey

..........................................

Izaz Ul - Haq
# TABLE OF CONTENTS

**CHAPTER 1– Introduction** ................................................................. 1
  1.1– Project Motivation ................................................................. 1
  1.2– Project Description and Context ................................................ 1
  1.3– Problem Definition ............................................................... 2
  1.4– Report Outline ................................................................. 2

**CHAPTER 2– Pre Study** ............................................................... 3
  2.1– Mobile Learning ............................................................... 3
  2.2– Pedagogical theories ............................................................ 4
  2.3– CSCW and its relevance to our Project ..................................... 8
  2.4– Computer Supported Collaborative Learning ......................... 8
  2.5– Context-aware computing and Context .................................. 9
  2.6– Positioning services or Location based services .................... 10
  2.7– Service discovery protocol .................................................. 11
  2.8– Challenges in Mobile collaborative learning system ............... 12
  2.9– Privacy issues in Mobile collaborative learning system .......... 13
  2.10– Existing similar service ...................................................... 13

**CHAPTER 3– Research Method** .................................................. 15
  3.1– Research questions .............................................................. 15
  3.2– Design Science ................................................................. 15
  3.3– Survey ............................................................................ 18

**CHAPTER 4– Student Survey** ...................................................... 21

**CHAPTER 5– Suggested Solution** ............................................... 28
  5.1– Scenarios ........................................................................ 28
  5.2– Requirements Specification .................................................. 29
  5.3– System architecture ........................................................... 30

**CHAPTER 6– Evaluation** ............................................................. 36

**CHAPTER 7– Further Work** ......................................................... 39

References ................................................................................ 41
Appendices ................................................................................ 44
List of Figures

2.1 Basic Structure of an Activity Model

4.1 Using Mobile devices for learning
4.2 Own Mobile or Additional device
4.3 Source of learning and information
4.4 Mobile device or conventional email system
4.5 Existing services like its learning
4.6 Mobile learning system will enhance learning
4.7 Collaboration on a Shared task
4.8 Locating a friend
4.9 Useful or not
4.10 Notification about social activities

5.1 System Architecture
5.2 Modules of the Mobile Collaborative Learning System

6.1 Authentication
6.2 Main Window of MCLS
6.3 Entering friends name/selecting from the list
6.4 Friends location

List of Tables

3.1 Guidelines for Design Science in Information Systems research
Chapter 1

INTRODUCTION

In this chapter we will present a brief Introduction of the Project and its scope. We will also discuss our motivation for selecting this project. An overview of the rest of the project report is also provided in this chapter.

1.1 Project Motivation:

Mobile collaborative learning is a new and modern technology and a lot of research is carried out in this field and is still going on. This modern technology has changed the way we live and the way we interact with each other. But unfortunately when it comes to education, we haven’t used this modern technology up to the level which is required. We are still stuck to the old learning ways.

As we mentioned the Mobile collaborative learning technology is relatively a new one, so it’s always a dream for a student to deal with new technologies and learn something new. Which motivated us in the first place but when we studied one of a similar kind of big Project FABULA, which is a project of NTNU in which three Departments are involve, it enhanced our motivation. Basically FABULA is also aiming for the same objectives as our project but on a much higher level. Making a city or a campus a learning arena for its inhabitants is such an attractive idea that no one can stop him/herself from getting involved.

The fact that our proposal could free students of the bounds for learning is out biggest motivation. It would be a dream situation that one can learn anywhere and anytime and he/she can work on a project and collaborate with other students without being present at the same time and place.

1.2 Project Description and Context:

The purpose of the project is to identify and explore new ways for learning. Till date the method of learning is the same, for example sitting in a classroom or working in a common space with other students for a project. This project is an attempt to find ways for learning other than these conventional ways. In ideal case, after the implementation of this project, a student would be able to learn even if he/she is not inside the classroom and there would be no restriction for him/her to be in the same place if working on a project with other students.

One of the important aspects of this project other than mobile learning is the collaboration of students while learning. That means, the students will not only learn with the help of mobile devices but they will also make use of these devices for collaboration with each other.
To achieve these goals we will suggest the use of latest mobile technology, while using the environment of Wireless Trondheim. This can be look upon as the context of the project.

1.3 Problem Definition:

This project report is mainly a proposal about a Mobile Collaborative Learning System which is mainly for the students of NTNU. The goal of the project is to propose a system which will help students in learning, making use of the Wireless Trondheim facilities. This would be an attempt to allow students to take a participative role in collaboration. Our proposed Collaborative mobile learning system would be based on user-centered approach which will accomplish the following.

- The system will adopt dynamically as student changes their location.
- Student would be able to collaborate with other fellow students on a shared task.

1.4 Report Outline:

This section explains the overall outline of the project.

Chapter 1: Introduction

Chapter 1 contains a brief introduction to the project, Motivation and outline of the project.

Chapter 2: Pre Study

Chapter 2 explains the literature review of the project.

Chapter 3: Research Method

This chapter describes the research method that will be used in this project.

Chapter 4: Student Survey

This chapter presents the elaboration of the results of the survey that we conducted among students for requirements gathering. it has an.

Chapter 5: Own Contribution, Requirement specification and Scenarios

Chapter 5 presents an outlook of the different scenarios and the requirement specification of the project. It also includes discussion on the system architecture.

Chapter 6: Evaluation

This chapter presents the evaluation of the proposed system based on the scenarios and screen shots.

Chapter 7: Conclusions and Further Work

Chapter 7 concludes the report and summarizes what have done, as well as suggestions for future work.
Chapter 2

PRESTUDY

2.1 Mobile Learning

Mobile Computing is a field of computing which more or less describes a person’s ability to use technology via computers that are smaller and portable which allows transmission of data without having to be connected to a fixed physical link.

Since the emergence of mobile computing there have been several technologies to support it. There are various kinds of mobile technologies but in this project the focus will be more on mobile phones and Personal Digital Assistants (PDAs). Out of these mobile technologies, a new term called mobile learning has come into focus. Mobile learning can generally be described as the use of wireless mobile technologies such as mobile phones and Personal Digital Assistants (PDAs) to enhance learning. Mobile learning basically comprises of two major aspects namely mobile computing and e-learning. E-learning can be described as the use of technology to enable people to learn anytime and anywhere. According to [1], the advances in learning and technology have converged, since the early 1970s, setting the stage for a successful mobile learning environment. As learning has become more individualized, learner-centered, situated, collaborative, ubiquitous, and continuing, so has the technology; ICT has similarly become more personalized, user-centered, mobile, networked, ubiquitous, and durable.

Mobile technologies are becoming more embedded, ubiquitous and networked, with enhanced capabilities for rich social interactions, context awareness and internet connectivity [2]. Mobile technologies provide the opportunity for people to learn thereby giving them experiences which can effectively engage and educate contemporary learners and which are often markedly different from those offered by conventional desktop computers. These devices are used dynamically, in many different environmental settings, giving access to a broad range of uses and situated learning activities. The personal nature of these technologies means that they are well suited to engaging learners in personal learning experiences, and to giving them increased ownership over their own work [2].
2.2 PEDAGOGICAL THEORIES

When looking at the use of mobile technologies for learning it is essential to determine a pedagogical paradigm that suits the characteristics and capabilities of the technology and the content [3]. Mobile collaborative learning system will enable a mobile user to build his/her knowledge either through self studying or by collaborating with peers. Looking at how people learn, it is necessary to look at some pedagogical theories relating to learning.

**Behaviorist Learning**

In the behaviorist paradigm learning is thought to be best facilitated through the reinforcement of an association between a particular stimulus and a response. Relating this to educational technology, learning which happens to be aided by computer represents the presentation of a problem thus the stimulus and the learners solution to the problem probably is the response [4]. Thus learning is indicated when a correct response follows the presentation of an instructional environment stimulus. An example based on behaviorist paradigm is the Skills Arena.

Skills Arena is mathematical drill software which is a video game implemented using Nintendo Game Boy Advance system. It was designed to supplement traditional curricula and teaching methods [5]. Skills Arena presents drills in addition and subtraction with advanced scoring and record keeping, constant feedback, character creation and variable difficulty levels. A user creates a character which they use to compete in problem solving against computer generated opponents. Difficulty levels increase with increasing speed at which problems pass by on the screen. Comparing Skills Arena to traditional worksheets, it was designed to provide faster means of feedback, user’s ability to choose the difficulty level that suits him/her and also to motivate the user.

An early pilot study conducted indicated that students were able to do three times more math problems in 19days than would have been expected with traditional worksheets. [5]
Constructivist Learning

Constructivist learning focuses on how people construct new knowledge and understanding based on what they already know. Learners are encouraged to be active constructors of knowledge [4]. This approach gives the learner some level of motivation and sense of ownership. A typical example of pedagogical application based on constructivism happens to be the virus game where learners in this case students played major role in the simulation of a dynamic system.

The virus game happens to be a participatory simulation project. Participatory simulation project [6] investigates how direct, personal participation in a simulation leads to rich learning experience that enables participants to explore the underlying structure of the simulation. In this virus game, it gave the students involved a real experience that was mediated by a set of underlying formal rules. The students were tasked to meet as many people as possible without getting affected by the virus. Each student happen to wear thinking tag and one of these thinking tags happen to contain the virus and could simple spread to the other person the moment they meet and their tags communicates. It created a learning environment for the students to be able to define problems relating to the spread of the virus and to construct testable hypotheses. At the end, the students indeed collaborated with each other to find out what actually was happening in the simulation and provided the relevant answers to the nagging problems defined. The technology used enabled normal interaction among students.

Situated Learning

Situated learning has been defined as a learner executing tasks and solving problems in an environment which reveals the various intended uses of the knowledge [7] cited in [8]. Thus in situated learning, knowledge is created in a context. Since context-aware applications happen to be a mobile computing paradigm it implies mobile users can make use of different context to enhance their learning activity beyond the classroom. An example of a mobile system that was developed to situate learning within a context is Ambient Wood.

Ambient Wood [9] happen to be a multi-site project within the learning and playing theme that builds upon the experiences and lessons gained from the hunting of the snark project. The project happen to be based upon the benefits of incorporating physicality and tangibility into learning. The Ambient Wood provided a range of interconnected learning activities aimed at engaging children with their immediate physical surrounding and providing some form of surprises through unexpected and novel digital events caused by their own actions. This was
to motivate the children so as to reflect and think beyond the present of their physical experiences to higher levels of abstraction.

**Collaborative Learning**

Collaborative learning happens to take its root from earlier works on Computer Supported Collaborative Work/Learning which focuses on how group of people can work together on a task with the aid of technology. Thus one can say that Collaborative learning is more or less a situation whereby a group of people interact with each other by sharing their knowledge about a task or activity they are suppose to do. A typical example of a mobile system to support this pedagogical theory happens to be the Mobile Computer Supported Collaborative Learning (MCSCIL) developed and used in Chile to encourage face-to-face collaborative learning in some primary and secondary schools [10].

**Activity Theory**

Activity theory has its threefold historical origins in a classical German philosophy (from Kant to Hegel), in the writings of Marx and Engel, and in the Soviet Russian cultural-historical psychology of Vygotsky, Leont’ev and Luria [11]. Activities always take place in a certain situation with a specific context [12]. Engeström (1987) formulated activity context as a network of different parameters or elements that influence each other. The figure below shows Engeström’s model (1987) of an activity system.

![Figure 2.1: Basic Structure of an Activity Model](image)

An activity consists of basically a subject and an object coupled with a mediated tool. A subject can be a learner or a student; an object can be a course of study whilst the mediated tool can be a computer. In the context of mobile learning system, a subject can be related to the mobile user, the object probably a mobile learning material and the mediated tool can be
the mobile device such as mobile phone or Personal Digital Assistants (PDAs). The activity model also includes rules, community and division of labour. Rules control actions and interactions with an activity and mediate between subject and community, community happens to be a group of people sharing the same object whilst division of labour describes how tasks are shared among community members and mediate between objects and community. Activity theory can be used for the design and understanding of mobile learning environments.

**Informal and Lifelong Learning**

With the emergence of mobile computing, which has permeated the world; mobile technologies are enabling mobile users to enhance their learning outside of formal education. Informal Learning according to [13] is any kind of activity involving the pursuit of the curricula of educational institutions providing courses, programs, workshops or seminars. Thus informal learning may occur in any context outside curricula’s drafted by educational institutions.

A country-wide survey of informal learning activities of Canadian adults was conducted in 1998 [13]. According to self reports, Canadians are now averaging about 15 hours a week in informal learning activities regardless of prior schooling or current further education involvement. A comparison was made with regards to earlier studies and it was realized that there seems to be an increase in the incidence of informal learning and points to the fact that people from all walks of life seem to exhibit similar patterns of incidence of informal learning.

M - Learning is a 3 year pan European research and development program aimed at enhancing informal learning among a group of young adults aged between 16 and 24. These groups of people were deemed to be at risk of social exclusion in Europe [14]. The group comprises mainly of people who couldn’t succeed in any education system, were not involved at all in any kind of education or training, and were unemployed or underemployed. Majority of these people have one thing in common; a mobile phone. Thus the m-learning project was launched so as the lifelong learning objectives of these groups of young adults can be achieved.

The underlying infrastructure of the m-learning includes a Learning Management System whose learning content included information and activities tailored to develop their literacy and numeracy skills and a custom designed microportal interface that will facilitate access to
m-learning materials and services from variety of mobile devices in addition to web and TV access.

2.3 Computer Supported Collaborative Work (CSCW) and Its Relevance to Our Project

The early introduction of Computers changed our societies up to a great extent but still the way we interact with each other remained more or less the same. As the Computers and modern communication technologies emerged with the passage of time, people tried to find out new ways of interaction and cooperation. The intentions behind CSCW or Computer supported collaborative works were the same, to find out new technologies so that people can communicate and cooperate in an easy and convenience way.

The idea of CSCW was first introduced by Irene Greif along with Paul Cashman when they defined a new field of cooperative work that is supported by computer technology. Computer supported cooperative work or CSCW is the way people work in groups and take help of the technology. According to Greenberg, “the study and theory of how people work together, and how the computer and related technologies affect group behavior is called Computer Supported Cooperative Work” [15].

So in simple words, CSCW is the term defining the way people work in groups and using technologies.

Our Project which is based on the idea of developing a Mobile collaborative learning system is closely related to CSCW, where people can collaborate on a shared task. Our proposed Mobile collaborative learning system will enable individuals such as students to work individually or in groups by utilizing the modern technologies. This directly comes under the definition of CSCW.

2.4 Computer Supported Collaborative learning (CSCL)

In this modern and rapidly changing world, one of the basic requirements is to find new ways for people to interact with each other and more specifically to learn from each other. The focus is on learning in a networked society. Researchers are hoping that computer will be playing key role in reorganizing the teaching and learning process in order to cope with the future challenges.

In this context Computer supported collaborative learning or CSCL is considered as one of the most promising field [30]. Computer supported collaborative learning; the form of learning in which computers are used to facilitate knowledge building in groups or in other words a field concerned with collaborative learning and how it might be supported by computers.

CSCL is very popular because of the positive effects on different aspects of learning. In CSCL the learners and teachers are not required to be in the same place and same time. Computer supported collaborative learning requires teachers and students to adopt an educational philosophy that focuses on “knowledge building” rather than “knowledge reproduction” as the main learning activity [30]. This requires both teachers and students to
believe in and trust a learning style that involves active, constructive and self-regulated learning by groups of students, more or less independently.

As in our proposed Mobile collaborative learning system we are focusing on learning outside of the classroom, it will also be considered as an application with the field of computer supported collaborative learning.

### 2.5 Context-Aware Computing and Context

Context-aware computing is a mobile computing paradigm in which applications can discover and take advantage of contextual information (such as user location, time of day, nearby people and devices, and user activity) [16]

As people become more mobile, it is imperative to provide them with means of accessing information anytime, anywhere with the mobile devices they carry all the time and this can be achieved within a context. Schmidt et al. define context as “knowledge about the user’s and IT device’s state, including surroundings, situation, and to a less extent, location” [reference: a survey of context [17] whiles Dey et al defines context as “any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves” [18].

Three important aspects of context happen to be: where you are, who you are with, and what resources are nearby. Context includes more than just the user’s location, because other things of interest are also mobile and changing. Context also includes lighting, noise level, network connectivity, communication costs, communication bandwidth, and even the social situation.

**Relevance of Context and Context-Aware Computing to our Project**

For a development of a mobile collaborative learning system whereby people are generally mobile and make use of the applications on the wireless mobile technologies such as mobile phones and PDAs to enhance their learning, the context and context-awareness is an important aspect and a major requirement that cannot be over look. The definition stated by Dey et al suits very well for a mobile collaborative learning system. To collaborate with one another, the service needs to take into account one’s location, the time of the day, people who are nearby and also the resources available in order to know what kind of information to
display. The context of an environment can inform a user on whether it will be possible to collaborate on a task or not.

2.6 Positioning Services or Location Based Services

In this section we will present some of the location based services which aid people to be either located or to locate places, things etc. This will be useful in the development of our proposed Mobile collaborative learning system.

**Geographical Positioning System (GPS)**

GPS is a system of satellites and receiving devices which can determine the location of its user anywhere in the world at any time. It was developed by the Department of Defense, United States. Till today GPS provides reliable positioning and navigation services to its users all over the world in all any weather condition or time. The use of GPS is now becoming quite popular in many aspects of our society, for example it is used in transport systems for directional and tracking purposes.

**Wireless Local Area Network (WLAN)**

WLAN help connects group of computers. WLAN, also known as Wi-Fi uses high frequency radio signals to transmit and receive data over a limited area, like a distance of a few hundred feet. As GPS only works in the open area, in other words in order to connect a group of people inside a building you need to use something else other than GPS.

For our Project scope we will be examining Wireless Trondheim. Wireless Trondheim is a wireless service which is using a Wi-Fi network and provides a wide range of wireless network to its users in Trondheim. It can be access from within the city with any device having a wireless connection facility. Wireless Trondheim has coverage both outdoor and indoor such as inside shopping malls and cafes. This enables the users to get connected to the network all the times regardless of their mobility.

**Geographical Position Service (GeoPos)**

GeoPos is a location based service provided by Wireless Trondheim and by using this service anyone can get their own location inside the City. This Project [Geo Pos 2008] is initiated by NTNU and the goal of this project is to provide a user their current location while connected to Wireless Trondheim. This could be done by a simple web request. This project is considered as an alternative to global positioning system when inside the coverage area of Wireless Trondheim and since our proposed Mobile collaborative learning system is based on wireless Trondheim facility.
2.7 Service Discovery Protocols (SDP)

According to [19], service discovery is defined as a process enabling networked entities to advertise their services, query about services provided by other entities, select the most appropriately matched services and invoke the services.

Service discovery issues have mainly be solved with regards to wired networks. With the emergence of mobile computing and wireless communication which is penetrating the world at large, researches have been conducted with regards to solving service discovery issues in mobile networks. Most of these researches happen to focus on Mobile Ad-hoc Networks (MANETs). MANETs are networks which comprised of mobile nodes such as Personal Digital Assistants, Portable Computers and Handheld Pocket PCs equipped with wireless interfaces and communicating with each other without relying on any infrastructure [19].

SDP goes a long way to help a mobile user discover and make use of nearby services smoothly. Some examples of well known SDPs are Universal Plug and Play (UPnP) by Microsoft, Jini by Sun Microsystems, Service Location Protocol (SLP) by Internet Engineering Task Force (IETF), Bluetooth SDP and Bonjour by Apple.

UPnP technology happens to be architecture for pervasive peer to peer network connectivity of wireless devices, intelligent appliances and PCs of all form factors [20]. UPnP is based on Simple Service Discovery Protocol and leverages TCP/IP and the web technologies to enable seamless proximity networking in addition to control and data transfer among networked devices in the office, home, school, and everywhere in between. Consider a scenario whereby Alex who is supposes to present his report on the shared task they have been working on us a group. In his attempt to catch up with the bus, he hurriedly left his room, leaving behind his printed report. It was during the course of the meeting with his fellow group members that he realized he has forgotten to pick up his printed report. Fortunately for him, on his Window CE handheld PC he has a copy of the report. Since his Window CE handheld PC has a wireless network and supports UPnP (SDP by Microsoft), it automatically discovers and uses an Ethernet connected printer which happens to be nearby without any network configuration and set up. He quickly printed the report out and presented his report to his fellow group members. That is how essential Service Discovery Protocol can aid a mobile user.

Jini Technology is created by Sun Microsystems and it is a service oriented architecture that enables the construction of secure, distributed systems, consisting of federations of well behaved network services and clients [21]. The service discovery component of Jini specifies how service discovery and service invocation are to be performed among java-enabled devices [19]. One of the main aspects of the Jini technology happens to be the look-up service. Look – up occurs when a client needs to locate and invoke a service that is described by its interface type.

SLP is developed by IETF which provides a scalable framework for the discovery and selection of network services. SLP comprises of three agents namely User Agent (UA), Service Agent (SA) and Directory Agent (DA). UA are processes that acquire services on behalf of a user application. The SA is a process that advertises services on behalf of one or
more services and they advertise by registering with the DA. DA caches advertisements from SAs.

When a client joins a network and requires a service, its UA sends a query to the DA, then the DA query its database to find out if there is any matching service against the needs of the UA, a respond with service reply message from the DA is then sent to the client. With regards to security, SLP implements a Public Key Infrastructure (PKI) security mechanism for signing service advertisements. [19].

Bluetooth SDP is a service discovery protocol for devices that have Bluetooth facility. Bluetooth SDP addresses only service discovery and does not address service advertising, service caching in registries or service access [19]. Bluetooth SDP enables applications to discover services that are available.

Bonjour developed by Apple is also called zero configuration networking. It enables automatic discovery of services, devices and computers on Internet Protocol (IP) networks [22]. With the help of bonjour, devices that are found on the networks are able to discover each other automatically without the need for configuration of Domain Name System (DNS) or entering IP addresses.

2.8 Challenges in Mobile Collaborative Learning Systems

As mobile learning is becoming popular and researches are been conducted in that respect, it faces some challenges as well. Some of the challenges are discussed below:

Mobile elements are resource poor relative to static elements with regards to computational resources such as processor speed which is very limited, memory size which is quite small and disk capacity not big enough to store more applications [23]. With limited processing power and memory for mobile devices that are used for mobile learning, It can only run few applications and due to small disk capacity, only limited amount of data can be stored on the device, this implies that with security issues, these mobile devices can only store small amount of security related data such as large public key certificates of other networks for authorization purposes.

Mobile connectivity is highly variable in performance and reliability [23]. Mobile computing based on wireless technology faces connectivity problems with frequent disconnections as communication links become unavailable. This may be a challenge in the mobile collaboration learning system whereby users collaborating on a shared task can face disconnection problems.

Bandwidth is another issue relating to wireless technology and since mobile collaborative learning system is based on wireless technology, bandwidth issue is worth mentioning. Some areas where the user might be at a point in time may offer a reliable high bandwidth as the user moves to another location he/she encounters poor unreliable low bandwidth connection. A scenario to depict this issue: Kofi happens to be streaming a video on campus on how to
conduct interview, and on campus he happens to be enjoying quality video, as he moves towards his hostel which happens to be quite far from campus, he realizes that the quality of the video reduces as he drifts away from campus and becomes poorer, all due to the fact that where is now accessing the video has a low bandwidth.

2.9 Privacy Issues in Mobile Collaborative Learning Systems

Information that takes place between a user’s device and the infrastructure providing the learning context over a wireless means of communication can be intercepted by active attacker or passive attacker thus posing a threat to privacy and confidentiality [24]. According to [25] cited in [26] considering unrestricted access to a person’s location data can be an unacceptable invasion of privacy. Since Mobile Collaborative Learning Systems is user centered, much details about a user is stored and make use of when the need arises. There should be a way whereby a user can be informed of what kind of information about him/her is being viewed by others. Probably the use of digital certificates, encryption techniques, authentication and access control can go a long way to countermeasure those threats.

2.10 Existing Similar Services

There have been some mobile learning systems developed to meet various needs of learning. Some of the existing mobile learning systems are cited below briefly and also those that are been carried out.

FABULA

FABULA is an ongoing project carried out by Software Engineering group and the Division of Intelligent Systems group of the Department of Information and Computer Science of the Norwegian University of Science and Technology (NTNU). The principal objective of this ongoing project is to develop novel principles and technical solutions for learning enabled by seamless roaming in mobile networks, with its focus on services that foster the city learning geographies and ecologies and enable new relationships among learners and communities [27]. This ongoing project is similar to our proposed Mobile Collaborative Learning System. The focus here is on learning as an individual and as well as collaborative learning.
MOBILEARN

MOBILEARN is a worldwide European-led research and development project exploring context-sensitive approaches to informal, problem-based and workplace learning by using key advances in mobile technologies [28]. It is a project which explores new ways to use mobile environments to meet the needs of learners, working by themselves and with others, and it aims at improving access to knowledge for selected target users (such as mobile workers and learning citizens) giving them ubiquitous access to appropriate learning objects by linking to the internet via mobile connections and devices.

Some of the areas of innovation in MOBIlearn are to use ambient intelligence for educational purposes, context awareness to exploit context and capture learning experience, development of methodologies and tools for collaborative learning, application of organisational learning in mobile environment, active user interface for personal mobile navigation using XML and XHTML and adoption, review and adaptation of relevant standards for mobile learning (ISO/IEC JTC1/SC36, ADL SCORM, CEN/ISSS WSLT, IEEE LTSC, XML, 3GPP, DVB-MHP) [28].

Mobile Learning System for Scaffolding Bird watching learning

The Bird Watching Learning systems is a mobile learning system designed in Taiwan using wireless mobile ad-hoc networks and it is suppose to aid students learning through scaffolding. [29]. The system provides structured-assistance learning to users based on user’s level of learning.

Mobile Computer Supported Collaborative Learning (MCSCL)

This mobile learning system is used to encourage face-to-face collaborative learning in some primary and secondary schools in Chile. The MCSCL activities manage and encourage tasks that include organization of information, aiding students to collaborate in groups, monitoring real-time progress with respect to learning objectives and controlling the interaction, negotiation, coordination and communication [10]. The MCSCL uses mobile ad hoc network that works over a wireless 802.11b network.
Chapter 3

Research Method

In this chapter we have presented the research method; Design Science and Survey of the project.

3.1 Research Questions

We seek to find answers to these research questions during the course of the project.

1. What can be the challenges a user may encounter in collaborating with other users in the system?
2. What are the challenges the system may face in adapting dynamically as users change their locations?

3.2 Design Science

We can define design science as a process of recognizing, defining and solving problems and formulating a goal and the systematic path of reaching that goal. It could also be defined as a problem solving paradigm which involves the creation, analysis and evaluation of design artifacts to obtain knowledge about a problem domain and propose a solution. Design science research is increasingly recognized as an equal companion to behavioral science research in the information systems field.

Design research is concerned with construction as a human activity, how designers work, how they think, and how they carry out design activity. It is also concerned with what is achieved at the end of a purposeful design activity, how an artificial thing appears, and what it means. According to Salvatore T. March and Veda C. Storey [31],

“A design science research contribution requires, Identification and clear description of a relevant organizational IT problem, demonstration that no adequate solutions exist in the extant IT knowledge-base, development and presentation of a novel IT artifact (constructs, models, methods or instantiations) that addresses the problem, rigorous evaluation of the IT artifact enabling the assessment of its utility, articulation of the value added to the IT knowledge-base and to practice, and explanation of the implications for IT management and practice.”

Alan R. Hevner, Salvatore T. March and Jinsoo Park [32] derived seven guidelines from the fundamental principle of design science research, that is knowledge and understanding of a design problem and its solution are acquired in the building and application of an artifact. The seven guidelines are presented in the table 3.1 below.
Table 3.1: Guidelines for Design Science in Information systems research [2].

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

**Guideline 1: Design as an artifact**

By definition the design science research in Information systems should result in a purposeful IT artifact created to deal with an important organizational problem. According to Hevner, March, Park, and Ram [32],

"Artifacts constructed in design science research are rarely full-grown information systems that are used in practice. Instead, artifacts are innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, and use of information systems can be effectively and efficiently accomplished."

According to guideline 1, the result of the research should be a feasible artifact. Because of the time constraint for the proposed project we would not be able to implement it but we will provide a suitable architecture based on the requirements that the system must have. We will also present a survey and some scenarios showing what the system would do and based on all this an initial prototype will be developed, hopefully during our master thesis.

**Guideline 2: Problem Relevance**

This guideline mentions that the objective of design research in Information systems is to provide and implement solution based on new technology to solve an important business problem. This could be done by acquiring knowledge and understanding about the problem. According to Hevner, Problem could be defined as the differences between the goal state and the current system’s state.
Guideline 2 is related to the use of new technology for solving a business problem. In our project Mobile computing and location based services will be used to solve basic problems related to collaborative learning.

**Guideline 3: Design Evaluation**
According to this guideline all the aspects like quality and efficiency must be evaluated. Evaluation is a very important component of the design science research. Evaluation methods for observation purpose are case studies and field studies; for analytical purpose are static analysis, architecture analysis, optimization and dynamic analysis; for experimental purposes it is either controlled experiment or simulation. While for testing purpose it could be functional testing or structural testing and finally the descriptive evaluation methods are informed arguments and scenarios.

According to guideline 3 the designed artifact’s quality, efficiency and other aspects must be evaluated. As because of the time constraint we would not be able to come up with a prototype at the end of the project, therefore right now we would only use a survey among the students to evaluate the functionality of the proposed system.

**Guideline 4: Research Contributions**
Guideline 4 states that effective design science research must provide clear contribution in the area of design artifact, design construction knowledge and design evaluation knowledge. In the assessment of any design science research, the first question is always “what are the contributions which might be interesting and new for others.” In design science the contribution could be in one of the three areas which are the design artifact, foundation and methodologies. In a research project one or more of these contributions must be addressed.

Guideline 4 is about the research carried out in the relevant area in order to better support the development of a prototype. In our project we have carried out some research in pre study chapter and also a student survey is conducted in order to get all possible information necessary for the betterment of the project.

**Guideline 5: Research Rigor**
Rigor addresses the way in which research is conducted. For both the construction and evaluation of the designed artifact, design science requires the application of rigorous methods. In design science rigor is derived from the effective use of the knowledge base; theoretical foundations and research methodologies.

According to guideline 5, a thorough research should be carried out for both construction and evaluation. In other words, the research should be carried out using well-founded and logical methods. In our project we are following the methods which are well sustained and known.

**Guideline 6: Design as a Search Process**
Guideline 6 states that there should be a continuous search for the best possible solution to the problem.

This guideline is focusing on a continuous research which will result in a best possible solution. We didn’t start our project with a single focus on a solution rather we conduct research and carried out study for a best solution. We are still not finished e.g. If after the survey we came to know that something is missing or we need some improvement, we will definitely work for that.
Guideline 7: Communication of Research
This guideline focuses on the fact that the resulted solution of a research must be presented to both the technology and management oriented people. The technology oriented people concern with the implementation phase of the solution and they need sufficient detail so that they could implement the solution. This enables practitioners to take advantage of the benefits offered by the artifact while it helps the researchers to build a knowledge base for the further extension and evaluation.

The management oriented people need sufficient detail so that they could decide if the organizational resources should be utilized to use and purchase this artifact and whether it would be helpful for them to use within their organization or not?

The final guideline is focusing on the presentation of the solution to both technical and managerial people. Again, as we wouldn’t be able to come up with a prototype this semester, so we will focus on this guideline during the implementation of the proposed project during our master thesis. Of course the proposed solution will be presented and discussed with our Project supervisor and other advisors.

3.3 Survey

According to [33]; the idea of a survey is that you will obtain the same kinds of data from a large group of people (or events), in a standardized and systematic way. Survey method is an example of a quantitative research method which was originally developed in the natural sciences to study natural phenomena. Survey is an accepted form of research methodology used in the field of Information Systems and Computing. In computing an example of the use of survey is in the user evaluation of a software system. There are six different activities involved in planning and conducting of survey [33]. These six different activities are classified under the following headings: data requirements, data generation method, sampling frame, sampling technique, response rate and non-responses and sample size.

Data Requirement

In planning and conducting a survey, you need to take a decision on what kind of data you wish to generate. The data could be on topics directly or indirectly relating to your research questions [33].

Data Generation Method

There are various approaches in which one can use to collect data during a survey. Most notably is the use of written questionnaires; other approaches are interviews, documents and observations. You therefore need to decide on which approach you will use in collecting data [33].
**Sampling Frame**

A sampling frame is more or less some sort of list or collection of documents or events or the whole population of people that could be embodied in your survey; out of which you will choose a sample [33].

**Sampling Technique**

Base on your sampling frame, you then need to decide on a sampling technique. There are two types of sampling technique [33]; probability and non-probability.

Probability sampling technique is a technique that utilizes some form of random selection in which the sample of respondents chosen are representative of the overall population being studied.

Non – probability sampling technique is a technique that does not involve random selection. It is a technique used when a researcher believes it is not feasible or necessary to have a representative sample [33].

**Response Rate and Non-Responses**

Response rate is essential in giving credence to your survey, thus strategies needed to be put in place to increase the number of responses. For example response rate of 10 % is not desirable if out of 30 people you gave a written questionnaire only 3 people responded to the questionnaire. With regards to non-responses, one needs to device means of finding out at least some characteristics of the people who have not responded to the survey, so that you can analyze whether their non-response is meaningful or whether their inability to respond has resulted in a bias in your final sample [33].

**Sample Size**

Decision must be made with regards to how large your final sample will be, taking into consideration your best estimate of the likely non-response rate of participants. The higher the accuracy required in your claim that your sample represents fully the total population involved; the higher must your sample size.

Surveys plays major role in drawing general conclusion based on the fact that it involves wide range of people or events. Survey is also have its drawbacks, one of such is they do not establish cause and effect rather they show associations [33], for example analysis of a survey results might indicate that people are addicted to facebook but might not necessarily indicate what causes that addiction.
Relevancy of Survey to the Project

Survey is one of the research approaches chosen for this project. The six activities enumerated above will be used in planning and conducting student survey for this project. In this project a written questionnaire will be used as a method of generating data. The target group is students from NTNU. The main goal of this student survey will be to get valuable response regarding what kind of services and functionality that students will expect the propose Mobile Collaborative Learning System will provide and whether there is the need at all for such a system.
Chapter 4

Student Survey

This chapter presents the evaluation of the survey that we conducted among students for requirements gathering. It was a paper based survey and students were asked to fill it out and return it.

Initially we conducted a pilot survey among five International students to make sure that there is no confusion for students in understanding the survey questions. The success of pilot survey was a green signal for us to proceed with the full survey. The survey was conducted among the Master’s and PhD students of NTNU. Some 50 students from different Department and different levels were selected for conducting the survey. These students were all International students, majority of these students were International Master’s students and they were selected because we had a short time and we didn’t want to distribute the survey among 100 or 200 people, while getting only 20 responses. Great care was taken, not to distribute the survey among particular Departments students. International Master Student from almost every Department was contacted and requested to provide his/her feedback in a specific time. We were lucky enough to have a good response from the students and all the 50 students responded in the given time.

Based on response and feedback of these students, we finalized our requirements.

Evaluation of Survey

In this section we have evaluated the student’s response. Keeping this evaluation in view, we have also prioritized our requirements. Important questions and the student’s response are presented with the help of charts.

Q. 3: In your opinion, being able to learn at any point in time with your mobile device is a good idea?

This question was asked to know the general approach of students towards mobile devices. While few of the students were of the views that they should stick to their conventional learning system, like having a meeting, attending classes etc. The response of the students is mentioned in figure 4.1 below.
Q. 4: Would you like to get this Mobile collaborative learning system on your mobile phone or will you prefer to have it on another additional device, specifically used for this purpose?

The purpose of this question was to get an idea of the student’s mentality that whether they wanted an additional device, which could only be used for learning purpose just like people using MP3 players for music or they wanted to have this system on the existing mobile phones they carry.

The response was as expected, majority of the students are interested to have this Mobile collaborative learning system on their mobile phones, just to minimize the burden of hardware. The response is presented in figure 4.2 below.

Figure 4.2: Own mobile or Additional device
Q. 5: How do you get information relating to course materials (Lecture notes, assignments)?

The idea behind this question was to get an insight of the student’s interaction with the services provided by NTNU. As we are planning to provide this information on our Mobile collaborative learning system, we should have an idea of which services are frequently accessed by students and it must be provided on our system. According to the survey, it’s learning in addition to the course web pages is the major source of learning while some of the students take other services like mailing list etc. The response is presented in figure 4.3.

![Figure 4.3: Source of learning and Information](image)

Q. 6: How best do you wish to receive information concerning lecture notes, assignments and assessments?

Basically this question was asked to justify the development of a Mobile collaborative learning system. According to the expectations the response was in favor of the development of a Mobile learning system. Although some of the students, very few in numbers though, replied that they want keep using the conventional email system. The overall response is presented below in figure 4.4.

![Figure 4.4: Source of learning and Information](image)
**Q. 7: Does the main form of communication such as insida/it’s learning, student web, webmail and other related NTNU websites effectively aid your learning?**

The purpose behind this question was to get an idea of whether the current learning channels are fulfilling the learning desires of the students or some improvement is needed? This question is important because these services will provide the basis for our Mobile collaborative learning system. Majority of the students believed that this service especially it’s learning is the prime source of learning for them. Some of the students have mentioned that there is some room for improvement in these services. Only a few students mentioned that these services are not up the expectations. The summary of the feedback is presented in figure 4.5 below.

![Figure 4.4: Mobile device or conventional email system.](image)

![Figure 4.5: Existing services like it’s learning etc.](image)
Q. 9: Do you think that a mobile learning system which offers you access to the course materials will enhance your learning anywhere at any time?

Response to this question was overwhelmingly positive. Huge majority of students mentioned that they always face problems when they are on the move and a mobile collaborative learning system will really enhance their learning. Response is shown in figure 4.6.

![Pie chart](image)

Figure 4.6: Mobile learning system will enhance learning.

Q. 11: How do you collaborate on a shared task?

By this question, we wanted to know that how students collaborate on a shared task? We should know how students approach towards a collaborative task because our proposed Mobile collaborative learning system will enable students to work on a collaborative task without being in the same place. Most of the students are relying on meeting at a specific place at the school. This means that Mobile collaborative systems would be the ultimate solution of freeing students from being at the same place. The response is shown in figure 4.7.
Q. 13: Do you find it difficult to locate a friend or colleague to work on a shared task or for help?

Q. 14: Do you think a Mobile learning system with the functionality of locating people will be useful?

Question 13 and 14 were asked to justify the location based services of the proposed Mobile collaborative learning system. We received a mix response to these questions. Majority of students mentioned that locating a friend is not a problem because of the mobile phone communication but at the same time the stated that it would be nice and would be helpful to have a device for locating a friend. The feedback is presented in figures 4.8 and 4.9 respectively.
Q. 15: Would you like to receive information on different activities from different student organizations?

Different student organizations used to arrange different activities for students. The only source of information for these activities is the relevant organization mailing list. We want our Mobile collaborative learning system to provide this information to the students as well. Majority of the students responded that they would appreciate such service but in their comments, they mentioned that they must have some option of specifying their choices. In other words students want to have restriction on such sort of notifications. The response of the students is presented in the figure 4.10.

![Figure 4.10: Notification about social activities.](image)

**Conclusion**

The overall response of the survey was according to our expectations but it also reveals some aspects that we might have missed without conducting the survey.

Majority of the students mentioned it in their comments that developing devices which will help in mobility is the demand of the era. They really believe that such a system will enhance their learning capabilities but at the same time they also mentioned that such device should not make their lives difficult by issuing unwanted notifications and messages. Most of the students belongs to fields related to Computers are aware of the interruptions caused by these digital devices so they suggested to focus on the interruption management.

In other comments students also mentioned that the proposed device must have a user friendly interface.
Chapter 5

OWN CONTRIBUTION

This chapter will explain the project in details with scenarios depicting the use of the system. The scenarios will depict the usefulness of the system and also provide better understanding of the intended functionality of the system. Requirement Specifications for the project are also discussed in this chapter.

5.1 SCENARIOS

Scenario 5.1.1: Treasure Hunt

A group of computer science students have been asked by their teacher to identify a treasure in the city. The treasures are hidden at different places around the city. Each member of the group logs on to the system using their Personal Digital Assistants (PDAs). Each member then received clues associated to the treasure. These clues contain the information about location of the treasure in the city. The group members noticed where each was currently located as well as their individual location. Consequently the members decided to collaborate using the group chat to brainstorm on the clues each have received and to figure out where exactly the treasure is located. After having discussion on the various clues, they were able to locate where the treasure was. After the location of the treasure, they were now faced with questions. Once again they collaboratively answer the questions through the group chat. After correctly answering the questions, they were given another clue to the next treasure. They continued with their discussion until they were able to correctly locate all the hidden treasures in the city, answering all the questions correctly as well. At the end of the task, each member of the group learnt a lot during the question and answer session through participation and collaborative problem solving. They also realized how they were dependent on each other which caused them to be motivated enough to immersed themselves fully in the task [34].

Scenario 5.1.2: Group Task

Elorm, Kofi, Anne and Debby are assigned to the same group and have been tasked by their lecturer to find out the effect and causes of global warming and present a report on their findings. They decided to split the tasks with Elorm and Kofi working on effects of global warming whilst Anne and Debby concentrate on the causes of global warming. Elorm updates his profile on the mobile by setting “global warming” among his interests. He received a notification from the system couple of minutes later about one of his friends who have similar interest. He quickly checks the availability of his friend and sends a message to him that he will want to have a discussion with him relating to global warming. The friend responded and
they had a fruitful discussion on global warming through their mobile device. After the discussion, Elorm then sends the information he has gathered on causes of global warming to Kofi and other information he had relating to effects he send it to Anne and Debby. The group then set a date where they met and discuss their findings and presented a report to their lecturer.

Scenario 5.1.3: Seeking Help

Joseph is an international student studying at NTNU. Joseph has an upcoming test to write and yet still there is a paper in the syllabus that he is seriously struggling to grasp. Joseph logs onto the system on his Personal Digital Assistant (PDA) in a bid to locate a course mate who can be of help to him. Fortunately for him, he realized that Emmanuel, his course mate is not far away from him. Joseph walks to where Emmanuel is and ask him if he can explain the main concepts in the paper to him. Emmanuel gladly explains the main concepts in the paper to him. After the explanation, Joseph was so happy he could get help. He walked home a happy person and feels more prepared for the upcoming test.

5.2 REQUIREMENT SPECIFICATION

This section describes the specific requirement for the system. All requirements follow a common template which consists of an ID, a brief description, and a priority (High (H), Medium (M), and Low (L)).

5.2.1 FUNCTIONAL REQUIREMENTS

The functional requirement specifies the functionality of a system that is describing the functions the system is capable of performing.

General Functionality for the Mobile Application

<table>
<thead>
<tr>
<th>ID</th>
<th>DESCRIPTION</th>
<th>PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-MA1</td>
<td>The system shall access the server using a mobile network</td>
<td>H</td>
</tr>
<tr>
<td>FR-MA2</td>
<td>Each user shall have an account profile</td>
<td>H</td>
</tr>
<tr>
<td>FR-MA3</td>
<td>The user interface shall be in English</td>
<td>H</td>
</tr>
<tr>
<td>FR-MA4</td>
<td>The user interface shall be well structured and easy to use</td>
<td>M</td>
</tr>
<tr>
<td>FR-MA5</td>
<td>The system shall provide access to learning resources such as course materials</td>
<td>H</td>
</tr>
<tr>
<td>FR-MA6</td>
<td>The system shall support collaborative services by providing location services to users</td>
<td>H</td>
</tr>
<tr>
<td>FR-MA7</td>
<td>The system shall provide Instant Messaging and group forum as a collaborative technology for supporting collaboration</td>
<td>H</td>
</tr>
<tr>
<td>FR-MA8</td>
<td>The user interface shall be adaptable to different mobile device screens</td>
<td>M</td>
</tr>
</tbody>
</table>
Location Functionality

<table>
<thead>
<tr>
<th>ID</th>
<th>DESCRIPTION</th>
<th>PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-LF1</td>
<td>It shall be possible to find your own location on a map</td>
<td>H</td>
</tr>
<tr>
<td>FR-LF2</td>
<td>The user shall be able to navigate around the map</td>
<td>M</td>
</tr>
<tr>
<td>FR-LF3</td>
<td>It shall be possible for a user to find the position of another user</td>
<td>H</td>
</tr>
<tr>
<td>FR-LF4</td>
<td>It shall be possible to zoom in and out on the map</td>
<td>L</td>
</tr>
</tbody>
</table>

Notification Functionality

<table>
<thead>
<tr>
<th>ID</th>
<th>DESCRIPTION</th>
<th>PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-NF1</td>
<td>The user shall receive notification about lecture notes, assignments, solution guidelines and general information on a registered course that is uploaded on Its learning</td>
<td>H</td>
</tr>
<tr>
<td>FR-NF2</td>
<td>The user shall receive notification on assessments</td>
<td>H</td>
</tr>
<tr>
<td>FR-NF3</td>
<td>It shall be possible to add a sound alert to each notification</td>
<td>M</td>
</tr>
<tr>
<td>FR-NF4</td>
<td>Notifications with time limits shall be highlighted in red color</td>
<td>M</td>
</tr>
</tbody>
</table>

5.2.2 NON FUNCTIONAL REQUIREMENTS

Non functional requirements are constraints that have to be satisfied by the systems. These requirements are more or less concern with how the system will operate rather than the system’s behavior.

<table>
<thead>
<tr>
<th>ID</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFR1</td>
<td>The mobile application shall run on different platforms</td>
</tr>
<tr>
<td>NFR2</td>
<td>Response time for operations shall not be more than 4 seconds</td>
</tr>
<tr>
<td>NFR3</td>
<td>The system shall be able to interact with other systems</td>
</tr>
<tr>
<td>NFR4</td>
<td>The system shall provide feedback to users on errors</td>
</tr>
<tr>
<td>NFR5</td>
<td>If the connection to application server is lost, the application running on the mobile shall still be running and will not be broken down</td>
</tr>
<tr>
<td>NFR6</td>
<td>A user shall log onto the system by providing a username and a password</td>
</tr>
</tbody>
</table>

5.3 SYSTEM ARCHITECTURE

This section gives an overview description of the proposed architecture for Mobile Collaborative Learning System.

Overall Architecture

The propose Mobile Collaborative Learning System is based on a three-tier architecture which consist of three layers. The first layer which is Tier 1 is the Graphical User Interface
Presentation layer; this layer basically provides the end-user interface that allows interaction between the end-user and the application. The second layer which is the Tier 2 is the application logic layer which provides the business process logic and the data access. The third layer which is Tier 3 is the Data Storage layer which consists of the database server in this instance Microsoft SQL Server Relational Database Management System which provides the business data.

The three tier architecture was chosen for the proposed Mobile Collaborative Learning System due to the benefits one can get from using this architecture. Some of the benefits are; the separation of the application and the database functionality which enhances better load balancing. It is easier to modify or replace the graphical user interface presentation layer without necessarily affecting the application logic layer. Fewer resources needed for the presentation layer which is very essential since the presentation layer will be on mobile devices.

The system architecture uses Model-View-Controller (MVC) application pattern. The model represents the underlying object or data structure in the application. The view deals basically with everything graphical; requesting data from their model and displaying the requested data. The controller on the other hand defines application behavior.

Figure 1 presents the three tier system architecture for the proposed Mobile Collaborative Learning System. The internet and HTTP protocol provides a common communication backbone for the proposed system.

Communication between the mobile client and the application server is performed through SOAP protocol whereby a web proxy on the mobile client invokes a web services through SOAP invocation and the web service responds to the web proxy through SOAP response. Web services are implemented using ASP.NET. Communication between Mobile Clients and Application Servers is basically based on Wi-Fi Connection. Communication between the Application Servers and the Database Server is through TCP/IP protocol.
MODULES OF THE MOBILE COLLABORATIVE LEARNING SYSTEM

The Mobile Collaborative Learning System consists of three major modules; Collaboration module, Location module and the Notification module. Each main module has a corresponding web service on the application service.

Figure 5.2: Modules of the Mobile Collaborative Learning System

Collaboration Module

The collaboration module includes functionality for creating a forum and sending instant messages. The following web services describe the Collaboration module.

Search_user ():

Input: username

Output: list of usernames

Description: functionality for searching for users
Send_IM ():

Input: sender_username, receiver_username, message

Output: acknowledgement message

Description: functionality for sending and receiving an instant messages

Create_forum ():

Input: subject, description

Output: acknowledgement message

Description: Functionality for creating a forum

Post_reply ():

Input: username, message, thread_id

Output: acknowledgement message

Description: functionality for commenting on a thread

Get_post ():

Input: thread_id

Output: list of thread

Description: functionality for retrieving thread.

Location Module

This module provides the services for locating one’s own location as well as other users’ location. The following web services describe the Location module.

Get_location ():

Input: username

Output: location of user

Description: functionality for locating a user
Add_location():
Input: name of location, GPS coordinates
Output: acknowledgement message
Description: functionality for adding new location

Add_resources():
Input: resource_id, name of location
Output: acknowledgement message
Description: functionality for adding resources

Get_resources():
Input: name of location
Output: list of resources
Description: functionality for viewing available resources within a particular location

Notification Module
Notification feature provided by the system allows users to receive notification about lecture notes, assignments, solution guidelines and general information on a registered course. The following web services describe the Notification module.

Get_notification():
Input: username
Output: list of notification
Description: This functionality provides a user with list of notifications

Subscribeto_notification():
Input: notification_id
Output: acknowledgement message
Description: Functionality for subscribing to specific notifications
Remove_notification ():

**Input:** notification_id

**Output:** acknowledgement message

**Description:** Functionality for removing notification

GetAll_notification ():

**Input:** empty

**Output:** list of all notifications

**Description:** Functionality for providing the user with all notifications available
Chapter 6

EVALUATION

In this chapter, we are presenting the scenario-based evaluation of our proposed system. Because of the limited time, we were not able to fully implement the system but our proposed system is backed by the system architecture that we have proposed.

Example Scenario

In this section, we have taken one of the scenarios presented in the report and will explain how the proposed system will respond to that scenario, of course in ideal case. We will be using scenario 3 as an example here. Scenario 3 shows the basic functionality of the system.

Scenario 3

Noble is an international student studying at NTNU. Noble has an upcoming test to write and yet still there is a paper in the syllabus that he is seriously struggling to grasp. Noble logs onto the system using his Personal Digital Assistant (PDA) in a bid to locate a course mate who can be of help to him. Fortunately for him, he realized that Izaz, his course mate is not far away from him. Noble walked to where Izaz was and asked him if he can explain the main concepts in the paper to him. Izaz gladly explains the main concepts in the paper to him. After the explanation, Noble was so happy he could get help. He walked home a happy person and feels more prepared for the upcoming test.

Noble logs onto our proposed system, using his PDA. As the basic security requirement of the proposed system, Noble has to enter his user name and password.

Figure 6.1: Authentication
After logging into the proposed mobile collaborative learning system, Noble has the options of checking updates in case any Professor has uploaded the lecture notes or not. He can check his assignments available now and deadline etc. Another option that is available to him is to find any location by just entering the location name. By using the social activities option, Noble can get latest information about the social activities of different student organizations. According to the scenario, Noble used the ‘‘find a friend’’ function of system to locate his friend.

After using the function ‘‘find a friend’’, now Noble has the options of either entering the friend name or selecting it from the available friend’s list. He will only be able to locate his friend, if he his friend has already agreed to be located by Noble. In this case Noble has the rights to locate his friend.
Once Noble enters his friend’s name (Izaz) either by selecting it from the list or by entering it manually, his friend’s location is now revealed to him. The system shows him the location of Izaz as well the distance between both of them. By clicking the red sign showing his friend’s location, Noble can see the location detail. He has the option to zoom in and out by using two different keys on his PDA.

Figure 6.4: Friend’s location
Chapter 7

CONCLUSION AND FURTHER WORK

This chapter includes the conclusion of the report. An overview of the contribution made is also presented. At the end of the chapter, suggestions for further work are provided.

Contribution

There are two main contributions towards this report.

1. A survey was conducted among NTNU students, which not only provides an insight for the requirements of the proposed system but also shows the overall response of students towards the current communication and learning channels of NTNU.
2. Architecture for the Mobile collaborative learning system has been proposed. By implementing the proposed system, students will be able to learn in new ways other than the traditional group meetings etc.

Conclusion

As a result of the advancement in technologies, there is an increasing demand of new tools and methods for learning as well for collaboration. It is also noticed that NTNU students are not fully satisfied with the communication and learning channels provided by NTNU and there is room for improvement in these systems. A mobile collaborative learning system will provide some degree of relief to the students. The proposed system has the ability to integrate with the existing communication channels as well to provide additional functionalities to the students, like location based service. The results of the survey conducted among the students clearly shows that students will welcome such a system.

The requirements specification, scenarios and the proposed architecture provides a firm basis for the future research and implementation of the system.

Further work

Because of the time constraint, we were unable to implement the proposed system, so there is still some work to be done. Hopefully, we are looking forward to implement this system during our Master thesis period. Although the proposed architecture fulfills the basic requirements for a collaborative learning system and once implemented it will work accordingly but still we believe that some additional extensions could be added to the system.
Suggested Extensions

As mentioned before, the time constraint only allowed us to focus on the basic functionality of the collaborative learning system but we are hoping to extend the functionality of the proposed system with the following extensions.

- The system can be improved by providing students with the facility of booking a room on campus using his/her Mobile collaborative learning system.
- The system should be able to support persistent notification of an event until a student reads what the notification is about
- The system can be improved to provide general information, like weather report, bus routes and bus schedules within Trondheim etc.
References


[2] Laura Naismith, Peter Lonsdale, Giasemi Vavoula, Mike Sharples: Literature Review in Mobile Technologies and Learning REPORT 11: FUTURELAB SERIES


[14] [http://www.m-learning.org/archive/background.shtml](http://www.m-learning.org/archive/background.shtml) accessed on 14.10.09


[31] Hevner, March, and Jinsoo; Design Science in Information Systems Research, MIS Quarterly Vol. 28 2004, pp. 75-105,


[34] Surya Bahadur Kathayat & Rolv Bræk: Platform Support for Situated Collaborative Learning, 2009 International Conference on Mobile, Hybrid and On-line Learning
APPENDIX A – SURVEY QUESTIONS

Mobile Collaborative Learning System - NTNU

Description:

We are currently working on a project entitled Mobile Collaborative Learning System and we are eliciting information from students through this survey. This system will help students to learn even when they are not inside their classroom. It will also help them to collaborate with their project mates and other students on a shared task.

The whole survey will take less than 10 minutes but your response is extremely helpful for us and it will be really appreciated. All information you provide will be treated as confidential and anonymous in our analysis.

Questions for survey

1. What program are you studying? (i.e. Information systems, Project Management etc)

2. What is the level of your studies? (i.e. Master Student, Exchange student etc)

3. In your opinion, been able to learn at any point in time with your mobile device is it a good idea?
   a. Yes
   b. No

4. Would you like to get this Mobile learning system on your mobile phone or will you prefer to have it on another additional device, specifically used for this purpose?
   a. Own Mobile
   b. On other device
5. How do you get information relating to course materials (lecture notes, assignments)?
   a. it’s learning
   b. Course web pages
   c. other

6. How best do you wish to receive information concerning lecture notes, assignments and assessments?
   a. Conventional email system
   b. Mobile device

7. Do the current main form of communication such as innsida/its learning, student web, webmail and other official websites effectively aid your learning?
   a. Yes
   b. No

Comments

8. How are you able to learn spontaneously in response to a situation which occurs at any moment when you are not in a classroom?

9. Do you think a mobile system which offers you access to course materials will enhance your learning anywhere at any time?
   a. Yes
   b. No

Comments
10. Do you think a mobile system which provides you with notification concerning lecture notes, assignments, and assessments will improve your learning?  
   a. Yes  
   b. No  
   Comments  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………

11. How do you collaborate on a shared task?  
   a. Conventional email system  
   b. Group meetings at a place  
   c. Phone conversation  
   d. Other ways (Please mention)..............................

12. Do you think a mobile system which enables you to create group forum where you can discuss issues will enhance how you collaborate and learn?  
   a. Yes  
   b. No  
   Comments  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………

13. Do you find it difficult finding a colleague or a friend to work on a shared task or for help?  
   a. Yes  
   b. No  
   Comments  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………………………………………………………………………………  
   ……………………

14. Do you think a mobile system with the functionality of locating people will be useful?  
   a. Yes  
   b. No
15. Will you like to receive information on different activities from different student organizations?
   a. Yes
   b. No

16. What other things would you like to be in a Mobile learning device?