HONOURS PROJECT

SHAWCO K2 Center Mobile Learning System

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Abstract

The usage of mobile phones and web learning environment are important in teaching and learning. This improves the learning process of the students in and out of their classrooms. In addition, technology plays an important role in our communities, business and education because of the high demand of research, training and teaching. Therefore, with time and needs, universities and businesses need to exploit the current technologies to solve and improve the current problems without the development affecting any entity.
This report details the features that the application provides and the key success factors to measure the features. The application should provide tutors with a facility to notify students of upcoming events. In addition, the application should provide students with a facility to ask tutors questions after hours. The report continues presenting the analysis, design, experiments, user testing and conclusion of the system. The analysis and design critically analysis the current Learning Management System and technologies to be used to build the system. Furthermore, the report explains the software engineering principles used to design the system. The aim of the report is to present the analysis, design, experiments, user testing results and conclusions of the Mobile Learning and Learning Managements systems. The research question for the Mobile Leaning System tries to find out whether the system improves communication between tutors and students:

Keywords
MXIT, SHAWCO, mobile phones, teaching, learning

Acknowledgments

Thanks to Jonathan for allowing us to develop the mobile learning application for SHAWCO K2 Center; and to Gary Stewart and Jakkaphan Tangkuampien for supervising us though out the development of the application and to all the SHAWCO K2 Center participants and volunteers for taking the system evaluating experiments.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Project Introduction

Khayelitsha meaning "New Home" that is known to be an informal township in Cape Town grown to be one of the largest townships in South Africa hosting between 500,000 and 1 million people [14] . Khayelitsha was established in 1985 after a group of blacks were not allowed to live in the cities. In 1987, after the cancellation of pass laws, people started moving to Khayelitsha in search for jobs.

In 1984, ANC declared that Khayelitsha's living conditions improved and new project of building schools grew.

1.2 Problem Definition

The SHAWCO K2 Centre is a non profit student run organisation situated at Khayelitsha, teaching grade 10 – grade 12 learners from the surrounding area basic computer skills. The organisation gets help from the student body at the University of Cape Town (UCT) by acquiring volunteers at the beginning of each year. The problems currently faced by students and the organisation are as follows:

- Currently, there is no functioning network;
- No Medium to communicate and notify students of upcoming events;
- there is no facility for students to ask questions after hours;
- and there is no central online system to share resource

1.3 Project Aims

Based on the current problems, it was decided that a Learning Management System (MLS) such as Moodle is going to be customized and simplified to meets users 'need and requirements.

The following lists of requirements were drawn from discussions with clients at the center and from the understanding and analysis the possibilities:

- Customize and simplify the LMS user interface to facilitate the students and tutors with an online learning;
- Database backend and repository to store all course material;
- View or download any course materials;
- Chat facilities for students and tutors via LMS;
- Customize MLS with mobile phone communication to allows students and tutors to communicate via forums ;
- And provide tutors with a facility not notify students of new events via mobile phones.

It was decided earlier that the SHAWCO K2 Center Project will be a combination of User Centred Interaction Design and User Evaluation Experimental design type of a system.

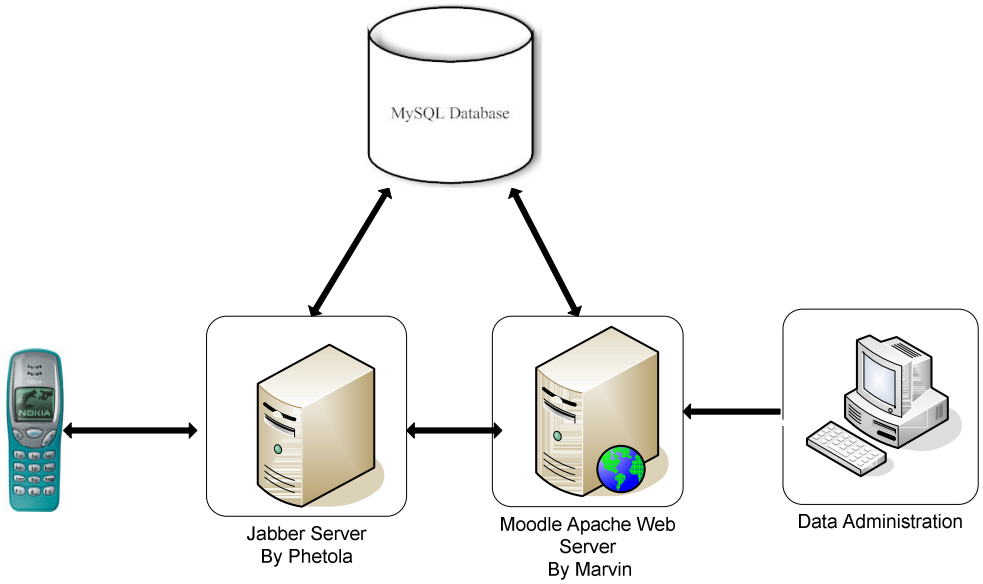

Figure 1: Separate Components of the SHAWCO Project

The project 's main aim is to develop an Online Learning Environment (OLE) that will provide tutors with a facility to notify students of upcoming events by sending text messages to student's mobile phones. This will provide students with a forum to ask tutors questions by sending text messages using mobile phones to a central web server and provide a backend to store frequently asked questions.

The SHAWCO Project was divided into two different components as shown on the diagram such as the Mobile Learning System (MLS) and Learning Management System (LMS).

The MLS Component provide students with a facility to exchange messages using mobile phones while the LMS provide students with a facility to share and access information.

The aim of the report is to present the analysis, design, experiments, user testing results and conclusions of the MLS and LMS. The research question for the Mobile Leaning System find out whether:

- The ML functionality of Sending Messages is user friendly, efficient and easy to manage;
- and find whether the system's communication facility improves the communication between tutors and students.

The User Centred Interaction Design, Evaluation and the functionality of the system are going to be measured against the following key success factors:

- **Usability**

The user should intuitively navigate through the interface without any problems and have an enjoyable experience while doing so, this applies to both expect and none expect users. In addition, it aims at providing the users with an easy to use user interface that will give the users an enjoyable experience

- **Cell phone Communication**

Students should be able to post questions on the forums using their mobile phones and tutors should be able to notify students of upcoming events via their mobile phones.

- **Reduced Learning Curve**

Tutors can easily update information in the database and upload new teaching material without any problems.

- **Easy Maintenance Of The System**

The system should require less effort to maintain.

1.4 Project Outcomes

The system serves as an example of how the learning and teaching challenges (especially in developing countries) can be solved using cell phones communication applications. It can also be used to investigate whether cell phone application can improve the teaching and learning in rural areas.

The success of the system will allow students to access, share information and knowledge, receive and post questions at any point in time with lower cost, time and effort.

Lastly, tutors will use student's questions as feedback to trace student's knowledge, find common questions or concepts that need to be addressed .This allow tutors to derive solutions to facilitate or revisit the common problems.

1.5 Report Outline

The report is divided into the following sections:

- Chapter 2: Related Technology and Research
- Chapter 3: Analysis and Design
- Chapter 4: Integration and Implementation
- Chapter 3:Experiments and Testing
- Chapter 3:Results and Conclusions
- Chapter 3:Recommendations and The Way Forward

2 Related Technology and Research

2.1 Technology

2.1.1 MXIT and Jabber Technologies

MXIT is mobile phone chat application that allows one to exchange messages between a computer and a mobile phone and between MXIT mobile phones [8]. It works together with Jabber which is an open source instant messaging protocol for exchanging information [7]. Jabber is the internet standard protocol for Instant Messaging and Presence communication. Its base technologies are Extensible Messaging and Presence Protocol (XMPP) which is set of streaming XML protocols and technologies that enable any two communicating parties on the internet to exchange messages, presence and structured information in real time [9]. Why are cell phone based technologies going to be used in project?

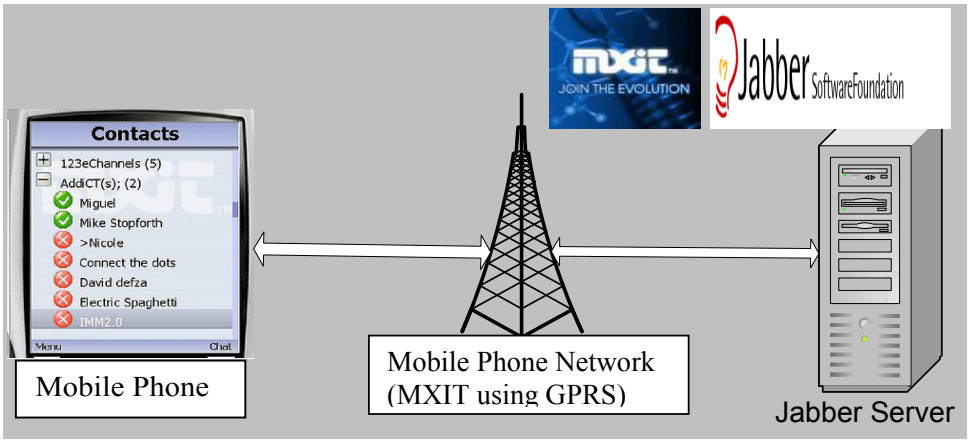

Figure 2: How MXIT and Jabber work together

2.2 Related Projects

A number of projects have been developed which use mobile phones and web based learning environments to solve the learning and teaching problems. In particular the applications exchange text messages in order to communicate, share information and ask questions from their tutors, friends and classmates. This section will present evidence of similar applications solving similar problems as follows:

2.2.1 Dynamic Frequently Asked Questions (DFAQ)

The Dynamic Frequently Asked Questions (DFAQ) is an application that solves the learning and teaching challenges using cell phones and web interface which makes it similar to our project. The aim of DFAQ is similar to the aim of the proposed system because DFAQ exploits the competence of SMS texting among University of Cape Town students to address the educational challenges and address the impact that the SMS and Web Interfaces creates to the students [5]. The main educational challenges that were addressed by the DFAQ system are the preparedness of the students, background diversity and large size classes. Large size classes and the preparedness of students mean that some of the students do not have opportunity to ask questions in their classrooms. This implies that students will ask questions using the DFAQ web and mobile phones system after hours. This is the main problem of SHAWCO K2 Centre that the project is going to focus on.

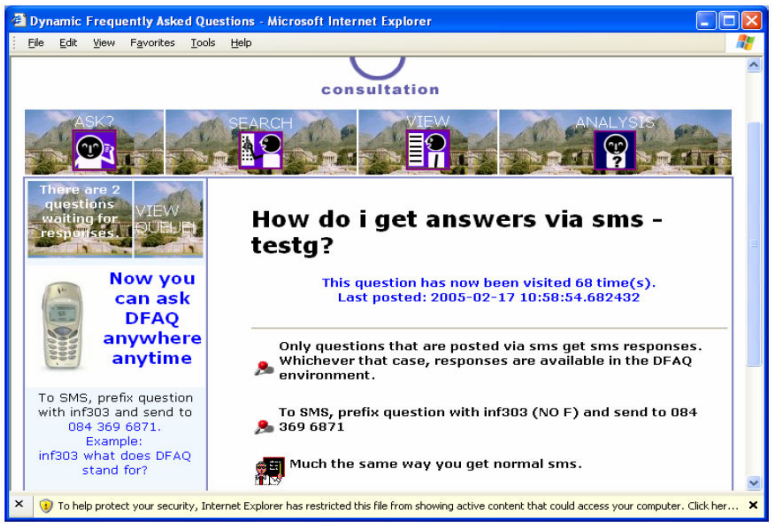

Figure 3: DFAQ Web Interface

The DFAQ system creates two processes when the question is posted. In the first process, the questions are sent to the public queue where anyone can respond. In the second process the email notification is sent to the lecturer about the questions. The SMS is delivered to the lecturer if the questions sent by the students were not delivered within thirty minutes. It also implements the mechanism to trace how the users use the response delivered to them. DFAQ has two versions which are not integrated, the cell phone messaging application and web application. The web application uses emails to send responses to the user.

2.2.2 ALYKKO Tutoring Application

ALYKKO is a tutoring application like Moodle that provides both the web learning interface and the mobile learning interface using SMS messaging and Multimedia messages to notify students with events and allows students to ask questions after classes, which is similar to the main aim of our project [1]. It consists of portfolios and documented tutoring dialogues that are shared between students, tutors and teachers which allows students to communicate and share information. It also uses tutoring agents to answer student's questions automatically to reduce the waiting time for the question to be answered. This differs with our application because our application needs tutors to answer the questions manually. This application extends the leaning and tutoring to take place in and out of the classrooms like DFAQ. The applications can be used with GPRS and Web based environment to transmit messages.

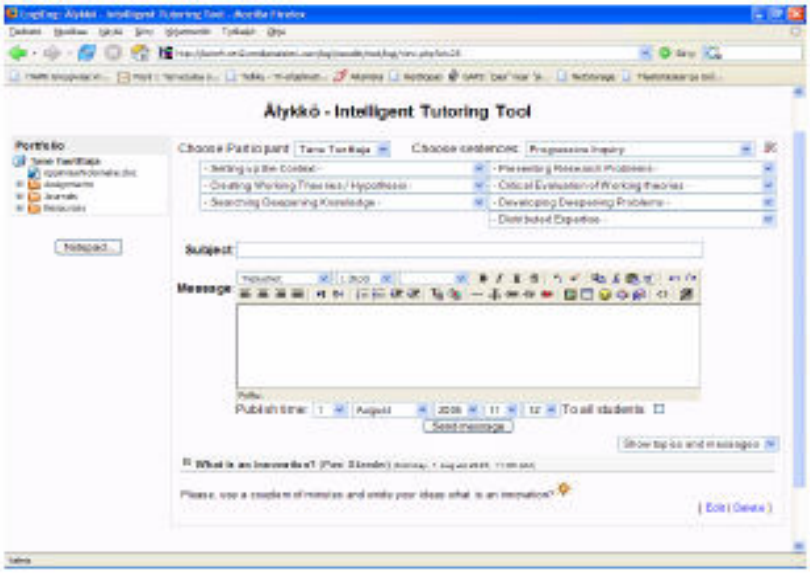

Figure 4: ALYKKO Web Tutoring Interface

2.2.3 MOOP Tutoring and Teaching Application

MOOP is an interactive mobile learning environment where students use mobile phones to collect and record information about their surroundings; manage and analyze information about the surroundings and communicate within groups [3]. It allows students to send queries to other members that can collect information and record the findings on the learning environment. MOOP is also one of the applications similar to DFAQ and ALYKKO to solve the teaching and learning communicational problems using SMS messaging to help students after their classrooms .The aim of MOOP is to create a learning model to support learning and teaching using mobiles phones. This will increase the interaction and collaboration between students and teachers which gives students the opportunity to learn and access information from anywhere at anytime using their mobile phones.

The application is designed for mobiles phone capable of running Symbian (S60) operating system for cell phones. It also uses General Packet Radio Service (GPRS/3G)

to connect the cell phones and transmit digital data to appropriate servers and mobiles phones which is similar to MXIT mobile phone application. The application allows students to access the same information using the web based learning environment called Riihi.

2.2.4 Intelligent Agent for adapting and Delivering Electronic Course Materials to Mobile Learners (IAADE)

A mobile phone communication system for solving learning and teaching education challenges was suggested by Mohamed Ally et.al [14]. The aim is to develop an intelligent agent capable of adapting to the heterogeneous of mobile computing environments, since mobile phones operate differently and have different capabilities. The system uses the user preference sent by the user based on the cell phone hardware and software capabilities to make decisions on which tools to use to format the course materials before delivery.

The user sends the request to the server using mobile phones. This includes the course materials and the mobile phone software and hardware capabilities, thus increase the sever performance in a case where the server cannot automatically match the capabilities of the client‘s mobile phone with the capabilities stored in the database using the mobile name. The web application server receives the information and sends back the reply back to the user’s mobile phone. It use the Resource Description Framework (RFD) represented Composite/Preference Profile (CC/PP) to describe the cell phones capabilities and user format preferences and Resource Description Query language(RDQL) to get device information.

2.3 Analysis of Related Project and Technologies

2.3.1 Critical Comparisons of Current Mobile Phone Applications

The applications mentioned above shows an insight of how the communication problem of providing tutors with a facility to notify students of upcoming events by sending text messages to student's mobile phones is solved. Basically, these applications are solving very similar problems using the same mechanism which is to provide students with SMS text messaging media to communicate and ask questions anywhere at anytime using their mobile phones when they are at home after their classrooms or tutoring sessions. Similarly, the usage of the Web and the Mobile phone is common in these applications. Looking deeply into the current applications, one can realize that theses applications are solving similar problems using different ways and answering different research questions. MOOP uses mobile phones to collect record and manage information while ALYKKO provides a tutoring agent to automatically answer the student's questions and automatically guide the students with their dynamic learning models. It differs with our application because it uses S60 operating system while our application uses mobiles phones capable of running MXIT. The key feature is that no matter what these applications are solving, at the end they exchanging text messages between tutors and students using mobile phones and the web interface which is the aim and focus of the SHAWCO K2 Centre project.

Mobile learning is a growing field that is encouraging in the choices it provides to solve the communication problems in education. There are very encouraging lessons that the current mobile applications showed. They showed that it is advantageous and reasonable to exploit the usage of mobile text message exchanging to communicate. In addition, they showed that mobile phones are becoming the best and efficient technology for communication between students; students love and use mobiles phones because of the portability of using mobile phone in authentic environment and enjoyment of using the mobile phone [3]. Similarly, most of the people own mobile phones than desktop computers in that mobile phones are cheap since the price is subsidized by the network usage payment and people knows how to use mobile phones better compared to desktop computers. This will allow greater penetration to affectively solve the communication problems.

It is clear and understandable what and how the current applications are solving the communication problems; and mobile learning provided us with new knowledge and information, the information can be used to proceed to explain how the SHAWCO K2 Centre is going to be done. The system will integrate both the web and cell phone application that is most similar to DFAQ replacing the email usage mechanism of sending responses to students with the mobile phones texting message exchange using MXIT to minimize the cost of using SMS and integrating both interfaces. The system will provide different features to support the aim of the project and the research questions that need to be answered. Some of the technologies to be used are PHP and MySQL that are similar to the technologies used by ALYKKO. MXIT is also going to be used as media to exchange text messages between tutors and student using Jabber based on the

Smack API. It is important to realize that MXIT also uses GPRS like the current applications.

A study has also been conducted with the SHAWCO K2 Center management and tutors. The results show that SHAWCO uses the Community Bulk SMS application [12] to notify the volunteers of any tutoring event with a cost of approximately R5000, 00 per month (23 cents per message). This is disadvantageous because of the costs of sending SMS; and it provides one way communication between the management and volunteers excluding the participants. This means that SHAWCO will have to pay extra money to send SMS messages to a large number of students. The alternative cheaper solution that we are proposing suggests the usage of MXIT mobile application. MXIT will allow two way communication between the management, volunteers and participants, thus tutors and management will send messages for free while students will pay 2 cents to send a message.

MXIT		**BULK SMS**
MSG Direction	Rand/MSG	Rand/MSG
Tutors-> Students	0	0.23
Students->Tutors	0.2	Not Possible

Table 1: MXIT and BULK SMS costs comparison

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2.3.2 MXIT Mobile Phone Application Proposed Solution

There are number of reasons why this technology is used as media to exchange messages between the student's mobile phone and the web application providing the communication service between tutors and students. It was mentioned earlier on that SHAWCO K2 Centre is a non profit organization that is currently faced with the problems of notifying students and facility to ask questions after the tutoring sessions or after their classrooms. It is reasonable and advantageous to exploit the usage and cost of MXIT. It is widely used by many teenagers, cheaper than SMS (maximum cost of sending a message is 2 cents) and free to download with no monthly cost. There are currently 2 million users where the majority of users are between 12 and 17 [6]. Similarly, one of the UCT PhD students Jakkaphan Tangkuampien, is currently involved in a project with high school students. The project involves the usage of Jabber and MXIT mobile phone application with the majority of students having access to mobile phone. This will contribute is testing our application and answering the research questions after implementation. The maximum length of messages is 2048 while SMS is 160 characters. MXIT provides us with very good benefit. However, only MXIT users with mobile phones capable of running MXIT can communicate and receive messages from their tutors.

The disadvantage of MXIT can be reduced to provide the communication service to a larger population by the usage of the internet for people without Java enable mobile phones. Internet users can use Instant Messaging (IM) applications such as GTalk, MSN, AIM, ICQ and Yahoo with no trace that a mobile phone or the IM application was used because both users can access the same service. Furthermore MXIT handles the problem of converting information to a mobile phone appropriate format which reduces the work of converting data to all different kinds of mobile phones. Unfortunately, IM applications are costly when used with internet enabled mobile phone to exchange messages between the communicating parties with a higher cost than that of MXIT. The number of MXIT users increased from 360 038 users to 2.3 million from January 2006 to 20th November 2007 where Gauteng makes up 28.58% of MXIT users, followed by Western Cape with 26.78% and Kwazulu-Natal at 22.14 % [10]. This shows that MXIT has a great potential in providing the efficient and cheap communication service, thus helping to solve the teaching and learning problems.

2.3.3 2.4.3 Jabber Proposed Solution

Jabber is network architecture and platform independent as it follows the architecture of many Instant Messaging applications and it makes the integration between application and products easier, thus provides IM applications to use it. It provides features such as notification, addressing, data exchange, negotiation, information metadata and support multi-third party data exchange to application that are built on top of it. In addition, It also allows conservation between people, applications and both people and application together [11].

3 Analysis and Design

3.1 Analysis

3.1.1 Finding a Solution

In order to develop good software that meets the user requirements, needs and expectation, it is a good software engineering principle to start designing a pilot system (Prototype) before implementation and present it to the users. This establishes a good relationship and agreements with the client. Furthermore, this will ensure that clients do not later refuse the software. Furthermore, this ensures that the software conform to the user specifications, thus saves lot of money and time. Moreover, this avoids conflicts with the clients. The following iterative process in coordination with the clients was used to develop the prototype:

3.1.1.1 Project Requirements

The meetings to gather the project requirements were set and held at the SHAWCO office with Jonathan (management) and Andiswa(interactive user). In addition, it was shown how BULK SMS (see above) was used to send bulk SMS to students and tutors.

3.1.1.2 Building the Prototype

Microsoft FrontPage was found as one of the quickest ways to design the user interfaces. After the prototype was designed, prototype was evaluated with Jonathan and Donald Cook and Jakkaphan. The feedback was used to change the prototype and specifications.

Some of the feedback gathered from the users was that the search feature should not use the exact date to search for messages since user might not remember the exact date they received or sent a message. The solution was that the search functionality should allow users to specify the date range of the message such as the first or second week of the month. The modified feature will be shown in the next section.

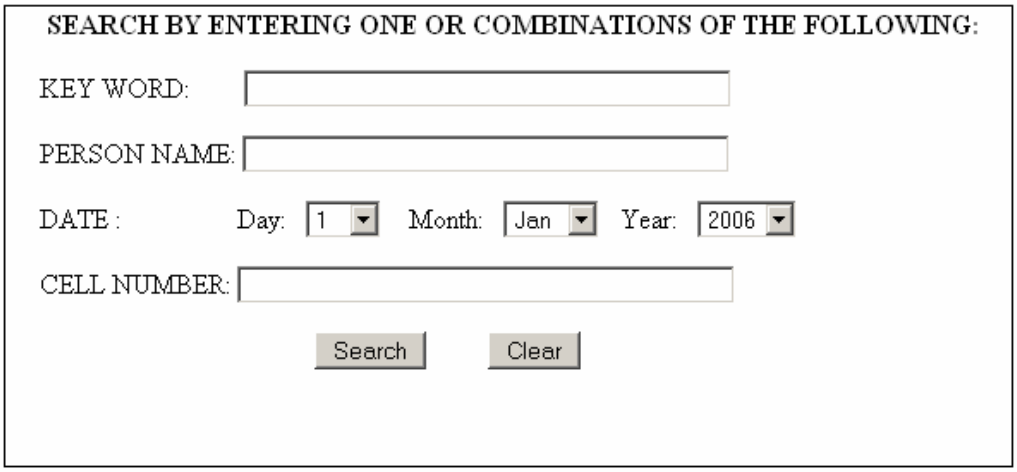

Figure 5: Initial Design of the Search Functionality

3.1.1.3 Evaluation and Modification

The evaluation design process was performed iteratively changing the prototype until the final design was achieved (see Design).

3.1.2 Analysis of the Communication between Tutors and Students

The SHAWCO K2 Center Information Technology project teaches students computer skills at the Center every day or second day for the maximum of two hours. This is the only way that tutors and students can communicate and share information. In order to analyze the communication problem, three environments for students are identified as follows:

3.1.2.1 Student inside their Classrooms with their Teachers

Student spent most of their mornings attending classes. This gives students the opportunity to learn and communicate with their teachers, thus student has the opportunity to learn Mathematics, English, Biology and other subject excluding computer studies. The SHAWCO K2 Center tutoring sessions start around 14:00 pm in the afternoons, it is clear that students spent less than 8 hours in their classrooms since the time to walk to the center should be taken into consideration.

3.1.2.2 SHAWCO K2 Center

After arrival, students will spend less than 3 hours at the SHAWCO Center. This is the only time that student have to communicate and share information with their tutors.

3.1.2.3 Student outside of their Classrooms

This is the time that students spent alone or with their parents. Clearly, this is the longest period that student spent alone or with their parents. This can be a great opportunity to allow student to efficiently learn from their parents or use mobile phone to communicate with their tutors or the central server. The central server can be implemented to automatically communicate or answer any question students might have about a particular course. Based on this information, it may be drawn that that the best opportunity for students to learn is when they are outside their classrooms.

Furthermore, the cost BULK SMS and MXIT were compared above.

3.1.3 Analysis of Previous System

The meetings with the clients were useful to quickly identify common problems and decide which technologies to use. In addition, the experience of having volunteered at center was useful to understand the system from an end user perspective. The following list of problems was identified:

- **Hidden message functionality**

  Moodle has existing messaging hidden functionality. This functionality takes the user time to find and use. The messaging functionality is accessed thougth the user profile or the Online User block. This means that it is only easy to send messages when users are online. Since, one of our key features is to provide user with an easy to use system, the proposed solution suggest making the functionality easy to access and use. The figure below shows how to access the message functionality.

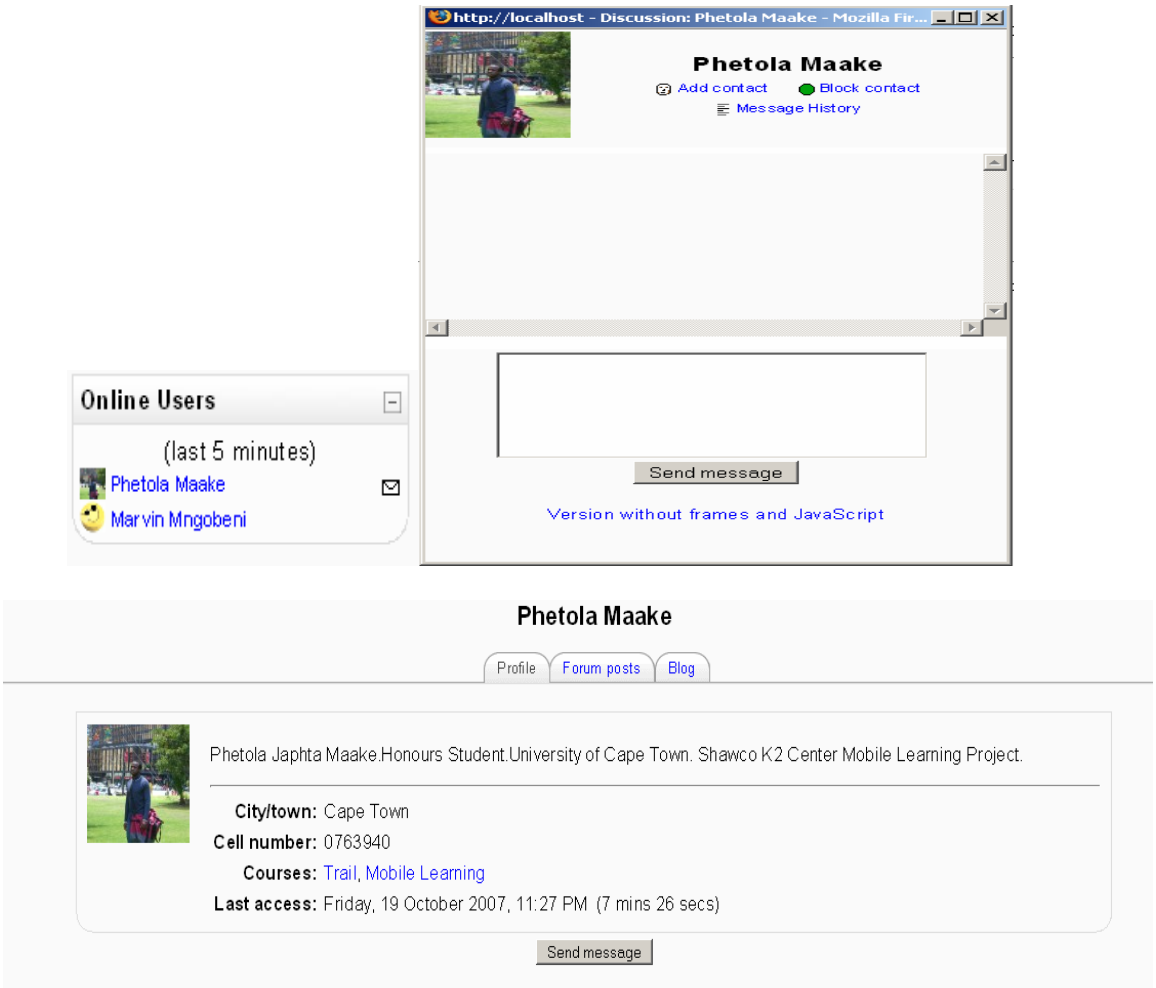

Figure 6: The Online User Block to Access the Messaging Functionality

- **Internal Moodle Forum**

  This forum allows registered Moodle users with access to the internet to exchange internal messages from Moodle to Moodle. The proposed solution customizes this functionality to allow tutors and students to exchange message between the central server and MXIT mobile phone.

3.1.4 Proposed Solution

PHP and MySQL used because the Learning Managements System to be customize was implemented using PHP and uses MySQL database. In addition, Java was used to route MXIT messages since PHP cannot be used to exchange messages with the MXIT network. he user with an interface to send a new message. The user clicks the select button to choose the group to send the message to. In addition, the user can select one or more users to send a message to.

3.2 Design

3.2.1 System Architecture

The ML Project architecture conforms to as three tired architectures such as the Data, Middle and Client tier. The three tiers are responsible for the following:

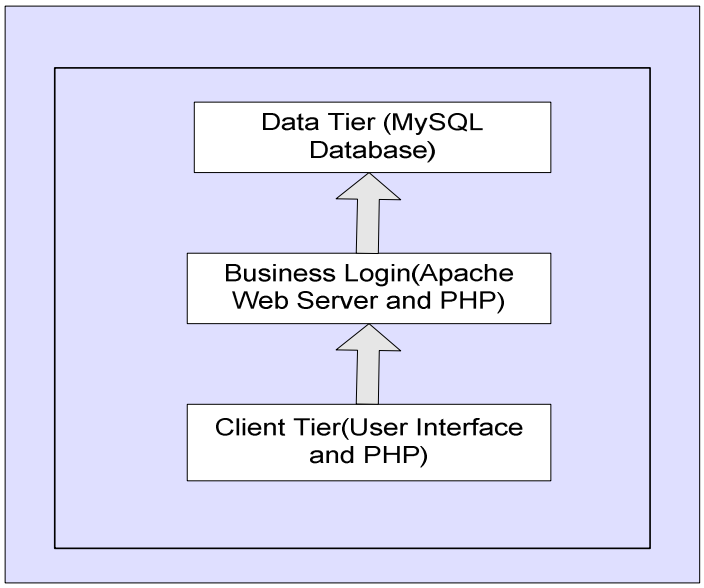

Figure 7: Overview of the System Architecture

- The Client tier provides the user interface to allow easier interaction between the user and the system
- The Data tier is responsible for the storage and retrieval of information from the Database.
- Middle tier is responsible for manipulating data and100
- controlling the flow of information depending on the operation requested by the user

3.2.2 Moodle Architecture and Customization

The ML Project serves as a plug in to Moodle. Moodle is a highly interoperable software package for producing and managing online courses and web sites [15]. It allows the addition and modification of new Modules to bring new functionality. A Module is a course that consists of Blocks and Activities that are integrated together to build one course. These components are as follows:

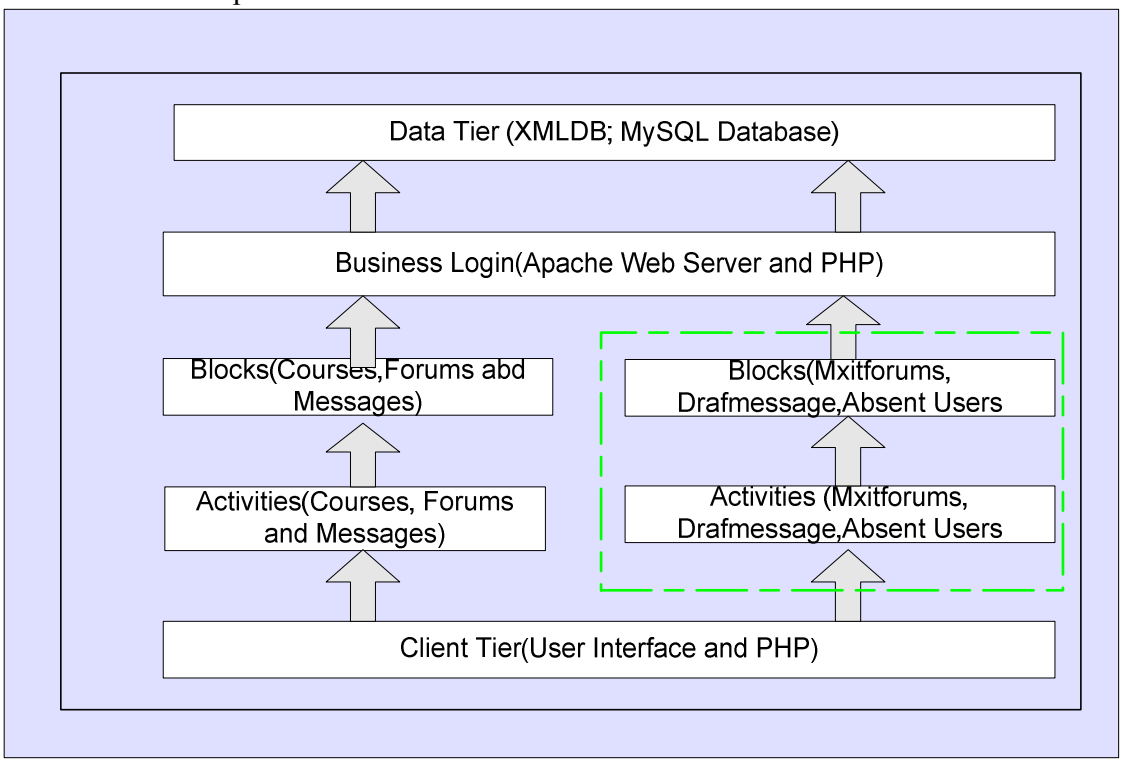

Figure 8: Overview of the Moodle Architecture

- A Block is a child component that consists of a list of hyperlink(s). The hyperlink(s) are entries to activities.
- Activities are responsible for the interaction with the user and the presentation of the user interface.

The capability of Moodle to add new independent Modules and Blocks gives us the opportunity to develop new software without wasting time and money to build existing systems. In addition, Moodle provides a central location for information and internal communication through Moodle forums for Moodle users. However, the communication and information is available for registered Moodle users with access to internet.

3.2.3 Use Case Diagrams

Figure 9: Tutor Use Case Diagrams

The Tutor use case diagrams shows what kinds of operations a tutor can perform on the system.

3.2.4 Use Case Narratives

The use case narratives of the system describe fully all the possible scenarios, conditions and process that are involved when the operation is performed. The scenarios can either be the system scenarios, conditions or user scenarios.

USE CASE #1	**Send Message**
GOAL IN CONTEXT	User compose the message, press the send button and expert the student to receive the message
SCOPE	System
LEVEL	Summary
PRE-CONDITIONS	User has logged in as a tutor, has enough airtime, recipients exits and both sender and recipient uses and invited each other to MXIT
SUCCESS END CONDITION	Message saved in the database and student receives the message from the cell phone.
FAILURE END CONDITION	The student does not receive the message or a database error occurs.
PRIMARY ACTOR	User
TRIGGER	User press the "compose" button from the "sent items" page
MAIN SUCCESS SCENARIO	➢ User press the "compose" button ➢ Select the recipients, press select and choose recipients ➢ User selects message contents ➢ System read the data fro the form , save the data into the database and write the cell number and message contents into the outgoing table ➢ System reads the message contends and recipients cell number from the outgoing table and send it to the recipient
FAILURE SCENARIO	➢ System fail to read and write to the database ➢ System fail to identify the recipients and send the message

Table 2: Sending Message Use Case Scenario

USE CASE #2	Delete Message
GOAL IN CONTEXT	User selects an item and expects the item and its associated attributes to be removed from the database.
SCOPE	System
LEVEL	Summary
PRE-CONDITIONS	User has logged in as a tutor and there are messages in the inbox.
SUCCESS END CONDITION	User selected the message and the message removed from the database or the message type changed (Trash/Drafts).
FAILUTURE END CONDITION	User stopped the process or a database error occurred.
PRIMARY ACTOR	User.
TRIGGER	User select an item from the list of messages
MAIN SUCCESS SCENARIO	➢ User select and item ➢ User presses the delete button and System removed the item and its associated attributed from the database
FAILURE SCENARIO	➢ Database error occur ➢ In case of error, the user is informed

Table 3:Delete Message Use Case Scenario

USE CASE #3	Search Message
GOAL IN CONTEXT	User enters enter the attributes of the message, click the search button and expect a list of messages matching the category to be displayed.
SCOPE	System
LEVEL	Summary
PRE-CONDITIONS	User has logged in as a tutor and there are messages that match the input in the "sent item: folder.
SUCCESS END CONDITION	User press the search button and view the message(s) that match the attributes of the existing database
FAILUTE END CONDITION	User stops the process or a database error occurs; there are no messages that match the input attributes.
PRIMARY ACTOR	User.
TRIGGER	User enter the keyword to search for
MAIN SUCCESS SCENARIO	➢ User enter the keyword ➢ User presses the search button ➢ System reads the input and compares with the messages in the database. ➢ System displays the result(s) to the user
FAILURE SCENARIO	➢ Database error occur ➢ In case of error, the user is informed

Table 4: Search Message Use Case Scenario

USE CASE #4	Un-delete Message
GOAL IN CONTEXT	User selects an item and expects the item to be removed from the list of messages
SCOPE	System
LEVEL	Summary
PRE-CONDITIONS	User has logged in as a tutor and there are messages in the trash folder.
SUCCESS END CONDITION	User selects the message and the message type changes (Trash/Drafts).
FAILUTE END CONDITION	User stopped the process or a database error occurred or there are no messages in the trash folder
PRIMARY ACTOR	User.
TRIGGER	User select an item from the list of messages
MAIN SUCCESS SCENARIO	➢ User select and item ➢ User presses the un-delete button ➢ System change the item type or status, this the item moves from the "Trash" folder back to " Sent items"
FAILURE SCENARIO	➢ Database error occur ➢ In case of error, the user is informed

Table 5: Tutor Use Case Diagrams to Un-delete Message(s)

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3.2.5 Modules Diagrams

The system is divided into three modules namely, the MXIT Forum, Draft Messages and Absent Users. The functionality of the system modules are well explained in the Integration of Modules section. Each and every module has a sub module that is used to access the database. In addition, the database consists of scripts and xml document that are used to install and setup the database tables during installation and to upgrade Moodle . The modules are dependent on the database.

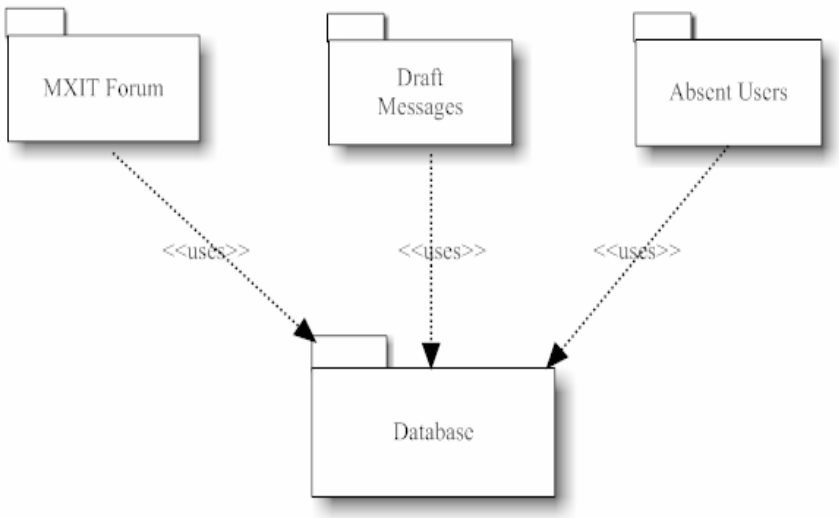

Figure 10: Package Diagrams for Overview of the System

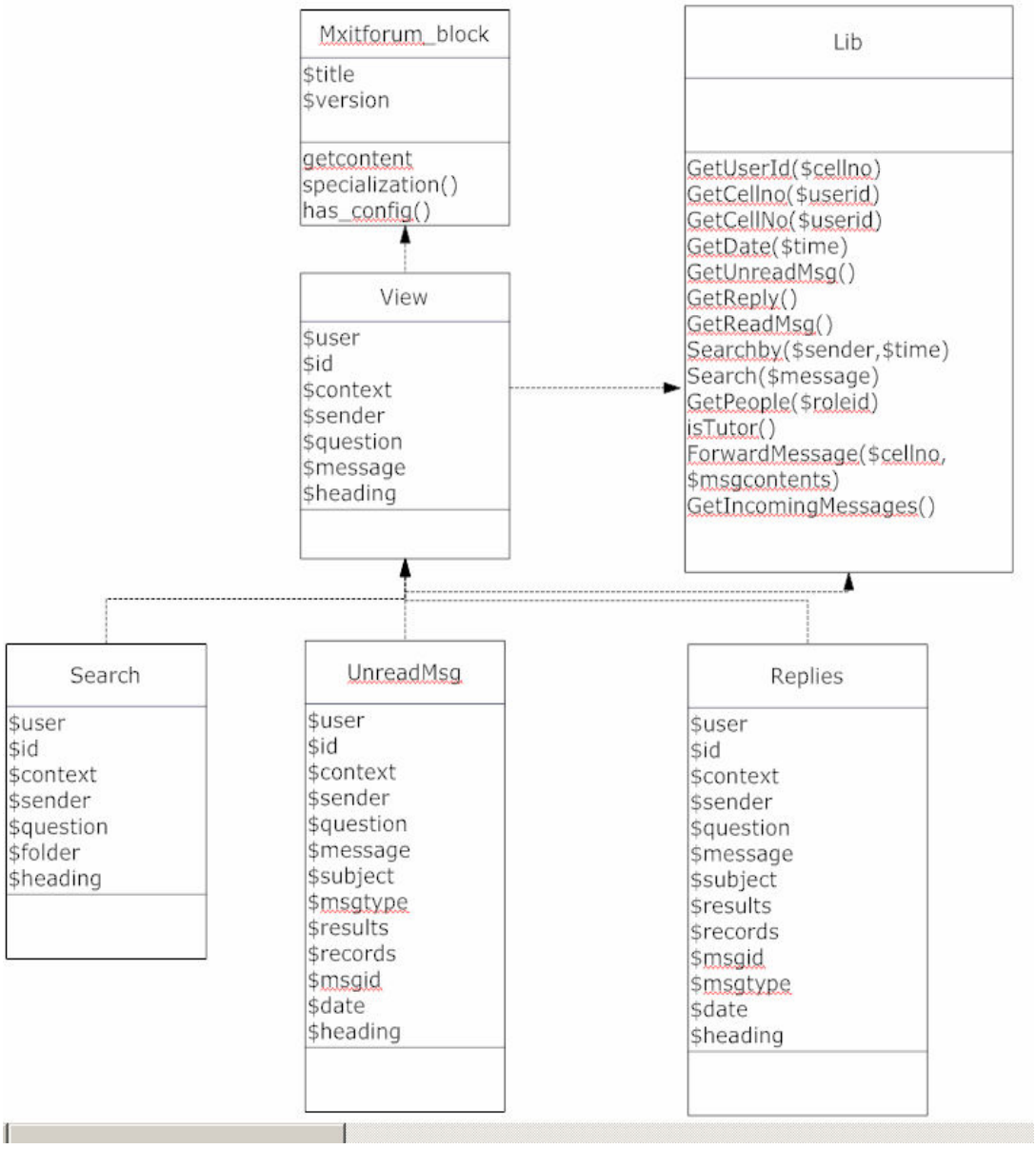

Figure 11: PHP Scripts Diagrams for MXIT Forum Module

The diagram above shows the relationships between activities in the MXIT Forum Module. The "View" is a script that depends on the MXIT Forum Block and the library. The Search script is used to search for messages and uses the "View" scripts to view the messages that were found during the searching process. The "Replies" also depend on the

"View" scripts. The reply lists questions and replies that are accessed through the "View" script. The UnreadMsg retrieves all new questions that are waiting for replies.

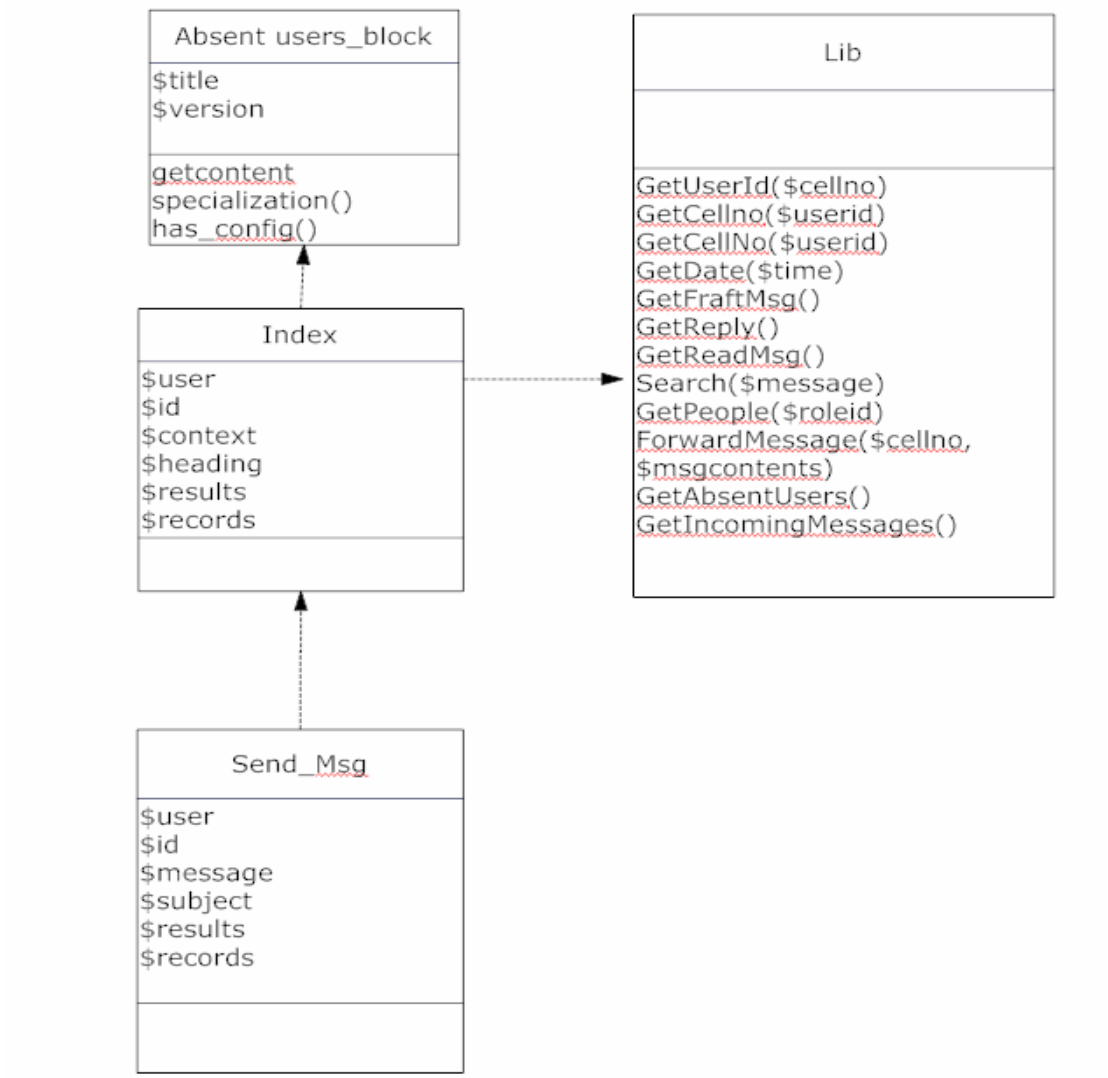

Figure 12: PHP Scripts Diagrams for Absent Users (Future Work)

The diagram above shows relationships between the activities in the Absent Users Module. The "Index" script depends on the library to access the database tables and the block. The "Send_Msg" script depends on the "Index" scripts in order to send messages to absent users.

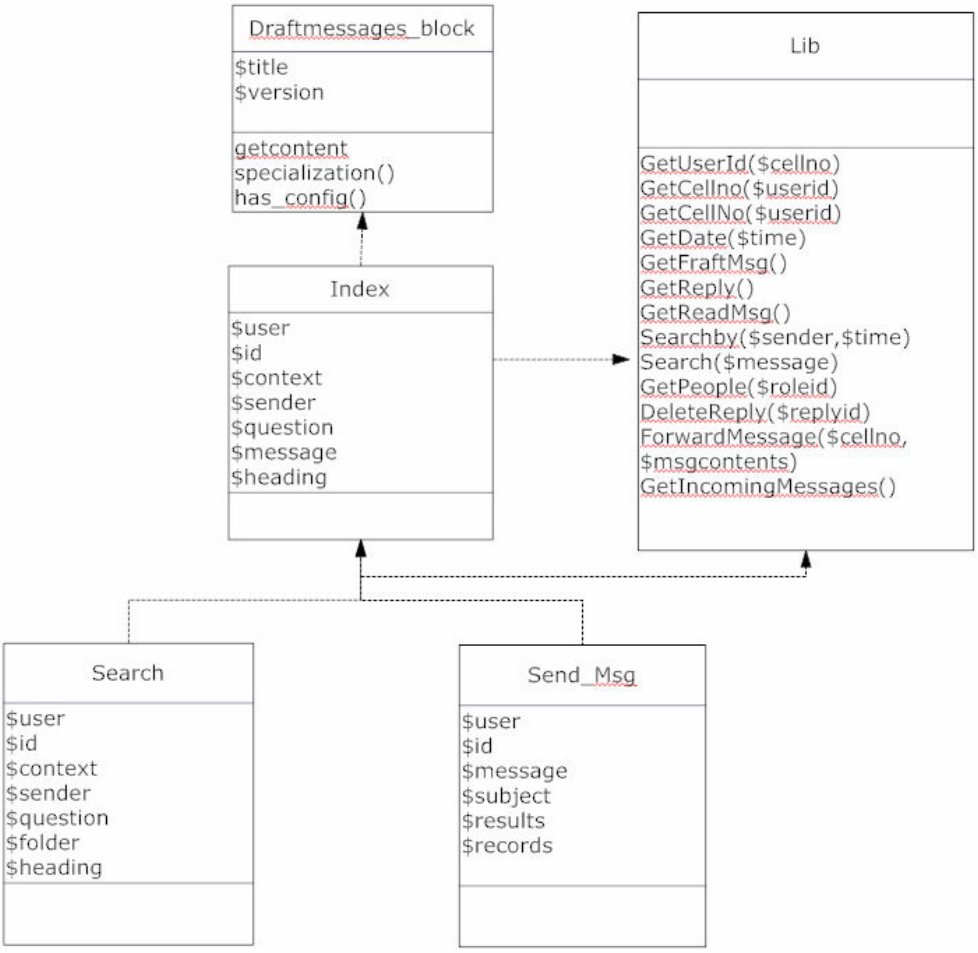

Figure 13: PHP Scripts Diagrams for Draft Messages Module

The diagram above shows the activities in the "Draft Messages" module. The "Draft Messages" block is an entry to the module. All the Scripts depend on the "Index" script. In addition, the "Index" scripts depend on the "library" to access the database. The "Search" script searches for draft messages that have been sent to the students. The "Send_Msg" sends messages to the students and the messages are then stored in the database as draft messages.

3.2.6 Jabber Server Listener Class Diagrams

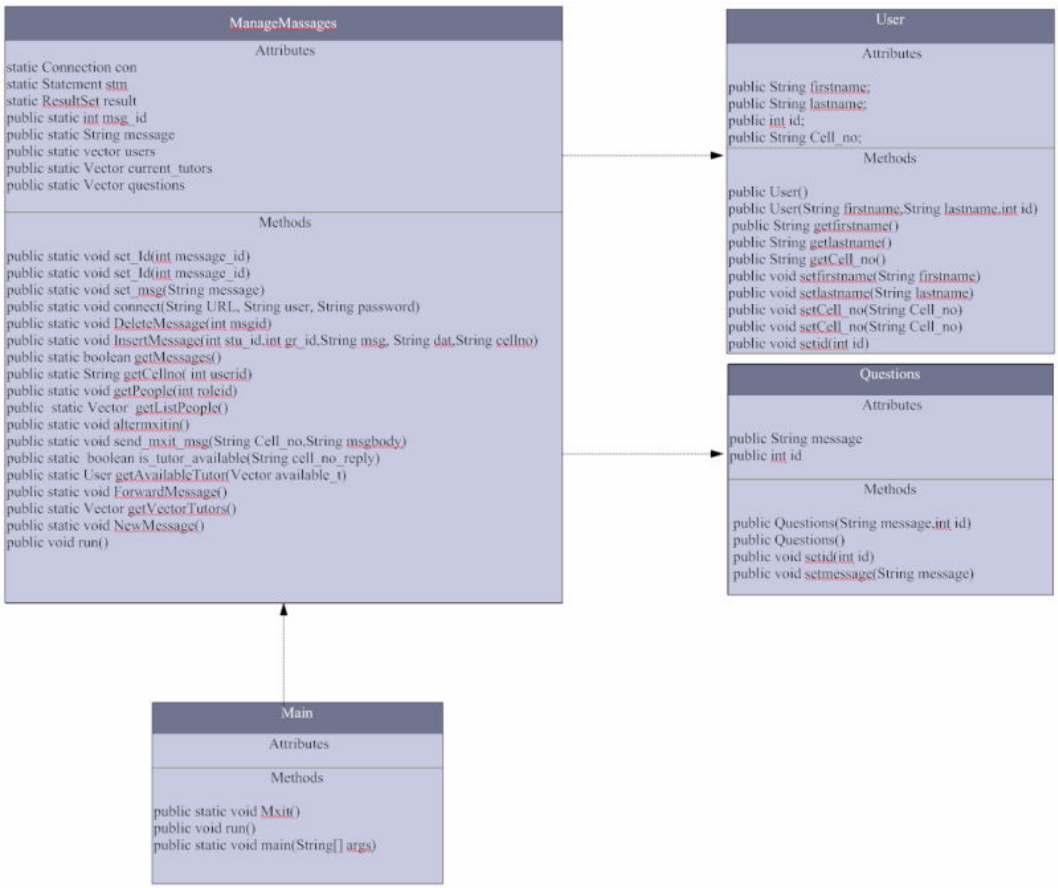

Figure 14: Class Diagrams Communicating with the Jabber Server

This class diagrams are of the Jabber Server Listener that serves as the bridge between PHP and Java through the database. Java thread are use to manage messages by continuously pooling the tables checking for new messages that need to be sent. In addition, messages received from the Jabber Server are written to the database to be read by the PHP scripts. The User class stores the attributes of the users such as lastname, firsname and mobile number. Questions store the attributes of the question messages as shown on the diagram

3.2.7 Sequence Diagrams

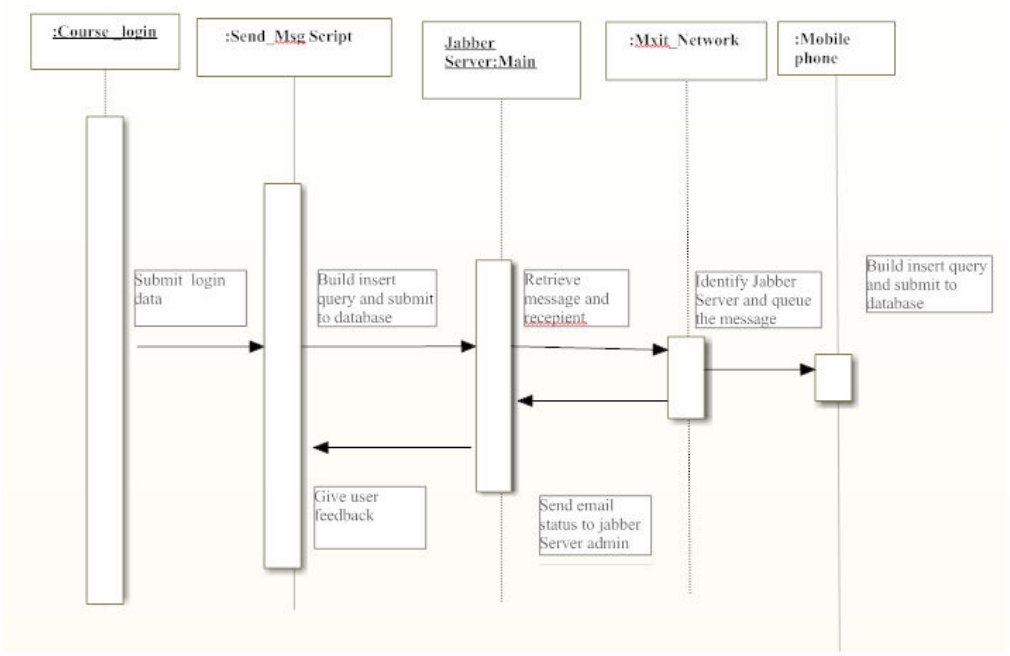

Figure 15: Sequence Diagram for the sending message process

The above diagrams show the sequence of steps that the system follows to send a message. After the user has logged in and presented with a user interface to send a message and triggered the sending message process. The system receives the information from the form and writes to the outgoing table using PHP Scripts. Jabber listener server spawns a process to retrieve the information from the database and send it to the recipient cell phone. The system does not wait for the message to be sent since the message is put on the queue of messages to be sent.

3.2.8 Database Tables Design and Relationships

The main functionalites of the following tables are explained as follows. The “Mxitint” table stores all the incoming messages that are received from the students while the “Mxitout” tables stores all the outgoing messages temporarily. The java program is then used to read and forward the message to the appropriate students. After the message is sent, it is deleted from the table. The “Mxitforums” stores all the questions that where posted by the user and the “Mxitforumsreply” stores all the replies for asked questions.

Field Name	Type	Description
Msg_id	Bigint(10)	Primary key to differentiate messages
Cell_no	Varchar(50)	Sender cell phone number
Msg_contents	Varchar(255)	Contents of the message
Current_date	Timestamp	Time the message was received

Table 6:Mxitin: Tables to Store New Received Messages

Field Name	Type	Description
Msg_id	Bigint(10)	Primary key to differentiate messages
Cell_no	Varchar(50)	Recipients cell phone number
Msg_contents	Varchar(255)	Contents of the message
Current_date	Timestamp	Time the message was sent

Table 7:Mxitout: Tables to Store Outgoing Messages

Field Name	Type	Description
Id	Bigint(10)	Primary Key to differentiate the messages
Userid	Bigint(10)	The User Identity
Group_id	Bigint(10)	Differentiate between different types of users
Sender_cell_no	Varchar(50)	The user to reply to the question
Msg_contents	Varchar(255)	The contents of the question received
Msg_subject	Varchar(50)	The subject of the message
Timemodified	Bigint(10)	The time the question was received
Tutor_cell_no	Varchar(50)	The tutor to reply to the question
Msg_type	int	The type to differentiate between new messages
course	Bigint(10)	The course identity

Table 8:Mxitforums: Tables to Storing Questions from Students

Field Name	Type	Description
Id	Bigint(10)	Primary Key to differentiate messages
Userid	Bigint(10)	The User Identity
Parent_id	Bigint(10)	Identity of the parent question
Group_id	Bigint(10)	Differentiate between different types of users
Tutor_cell_no	Varchar(50)	The user to reply to the question
Msg_contents	Varchar(255)	The contents of the question sent
Msg_subject	Varchar(50)	The subject of the message
Timemodified	Bigint(10)	The time question received
Sender_cell_no	Varchar(50)	Sender of the question
Msg_type	int	Differentiate between different types of messages
course	Bigint(10)	The course identity

Table 9:Mxitforumreply: Tables to Store Questions Replies

Field Name	Type	Description
Id	Bigint(10)	Primary Key to differentiate messages
Userid	Bigint(10)	The User Identity
Group_id	Bigint(10)	Differentiate between different types of users
Msg_contents	Varchar(255)	The contents of the question received
Msg_subject	Varchar(50)	The subject of the message
Timemodified	Bigint(10)	The time the question was received
Tutor_cell_no	Varchar(50)	The tutor cell phone number
Msg_type	int	The type to differentiate between new messages
course	Bigint(10)	The course identity

Table 10:Mxitdraftmessages: Table to Store Draft Messages

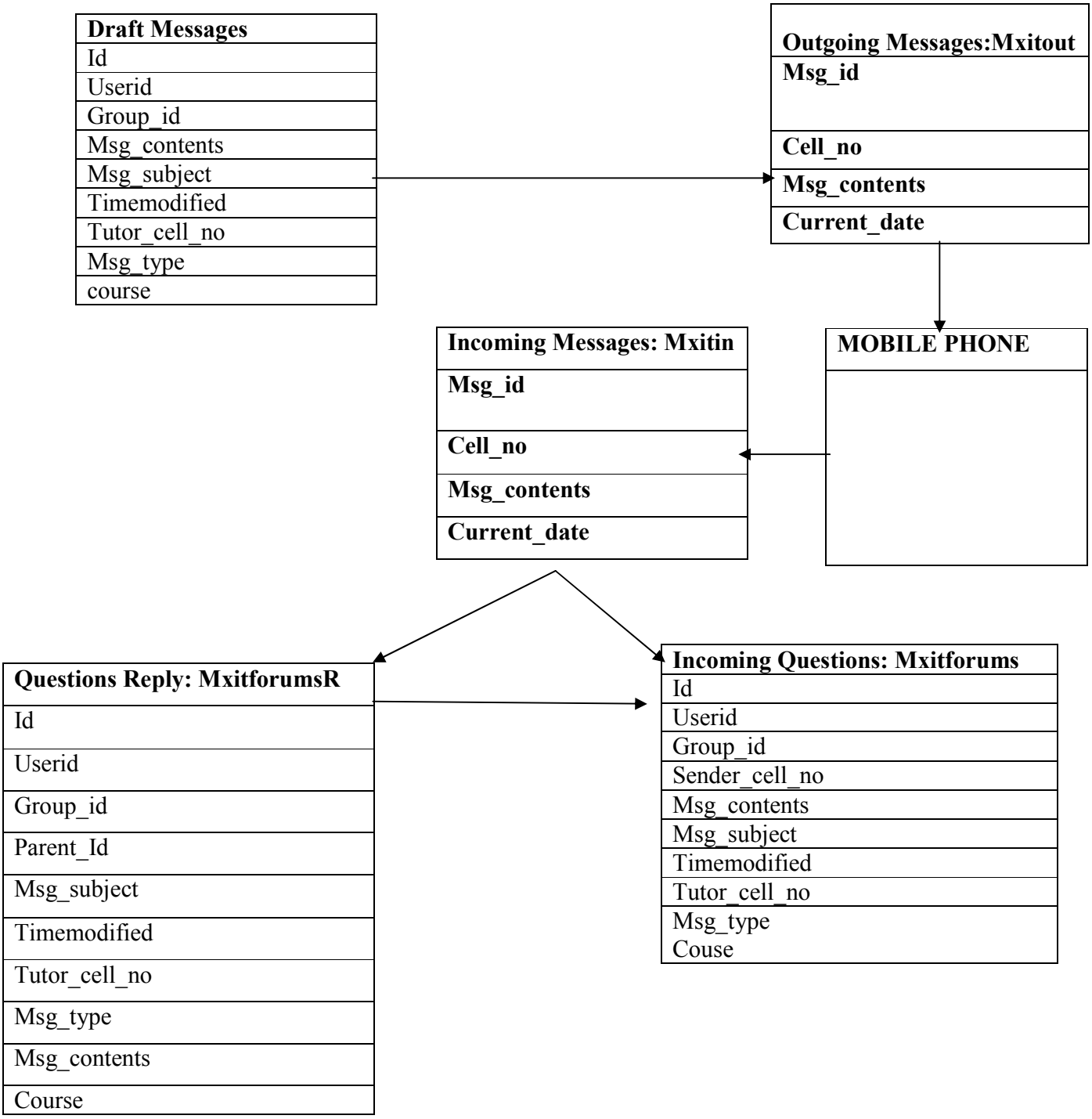

Table 11: Flow of Messages between Tables

4 Integration and Implementation

4.1 Hardware

4.1.1 Developments Systems

The table bellow shows the specification for the machine that was used to develop the system

COMPONENT	SPECIFICATION
CPU	Intel(R) Core(Tm)
SPEED	16300 @1.86GHZ
RAM	1.86GHZ,0977GB
HDD	80Gb
OS	Windows XP SP2

Table 12: Table of the Development Machine

4.1.2 Test Systems

The same machine was used to perform system testing while the SHAWCO K2 Center systems were used to perform user experiments and evaluations

4.2 Integration of Modules

Since the proposed solution need to conform to Moodle‘s architecture and capability of adding new blocks and activities, the system‘s features were grouped into separate blocks. In addition, the case study was conducted in order to gather more requirements and understand client’s problems and expectations. Based on the analysis of the Moodle architecture, case studies with the clients and the understanding of clients problems and need, the system‘s features were grouped into the following Modules:

4.2.1 MXIT Draft Messages Module

The case studies with Jonathan (SHAWCO) showed that there was no way to inform student of tutoring session status during rainy days and emergencies. The Blocks serves as a solution to the problem and are described as follows:

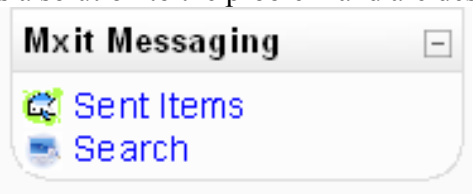

Figure 16: MXIT Messages Block

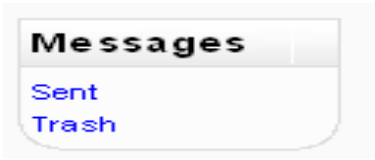

Figure 17: MXIT Messaging Block

- **MXIT Messaging Block**

MXIT Messaging block group and deal with all the notifications messages that tutors send to the participants, volunteers and volunteers' parents. This allows tutors to notify the students and volunteers of any emergencies. In addition, the block consists of two links such as Search and Sent Items. Search allows the user to search for a message that has been sent or deleted using message attributes.

- **MXIT Messages Block**

This MXIT Messages block serves as a block to be plugged into MXIT Messaging Activity due to the fact that the interface followed the email system design (see MXIT Messaging activity). This block is a container to the folders of the messages that have been sent to the volunteers, participants and parents. In addition, the block consists of two hyperlinks such as Sent Items and Trash. The folders provide the user with a choice to select which folder to go to when the folder is clicked. Both the Trash and Sent Items uses restful service to send folder identification in order to choose which folder to use.

- **Draft Messages Activities**

Draft Messages Activities are plug in to the MXIT Messaging block. The user can view the Module pages by clicking the Sent Items hyperlink on the MXIT Messaging block .This Module carries out all the necessary activities and features such as Composing , Deleting, Un-deleting, Searching for messages in the current folder (Send or Trash).

Several implementation decisions were taken to implement the features managing draft messages. When Deleting and un-deleting messages, One table was used to deal with the Draft Messages Module in order to reduce the redundancy of information and use less storage size to store the messages. When the volunteer Compose a new message to the parent(s), participant(s) and volunteer(s); the messages are stored into the Draft Messages table. To delete the message(s), the user selects an appropriate checkbox associated with the message(s). Lazy deletion is then used to mark the status of the selected message(s). This status serves to differentiate between the deleted and un-deleted messages. Each and every time the Delete or Un-delete button is clicked, the system checks the message(s) status before deleting or un-deleting. The message is sent to the Trash folder when deleted from the Sent Items folder and delete permanently from the system when

deleted from the Trash folder. When a message is un-deleted from the Trash folder is sent marked or sent back to the Sent Items folder

In order to compose a new message, the user clicks the Compose button and presented with a new pop up window shown below. The Send Message popup is another activity provided by the Draft Messages Module. The only difference is that it is achieved through the Sent Items activity instead of using the MXIT Messaging Block.

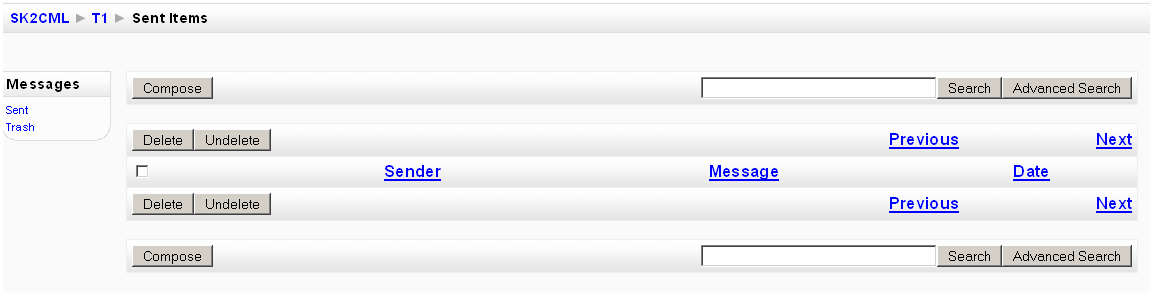

Figure 18: Sent Items User Interface

Figure 19: Search Messages User Interface

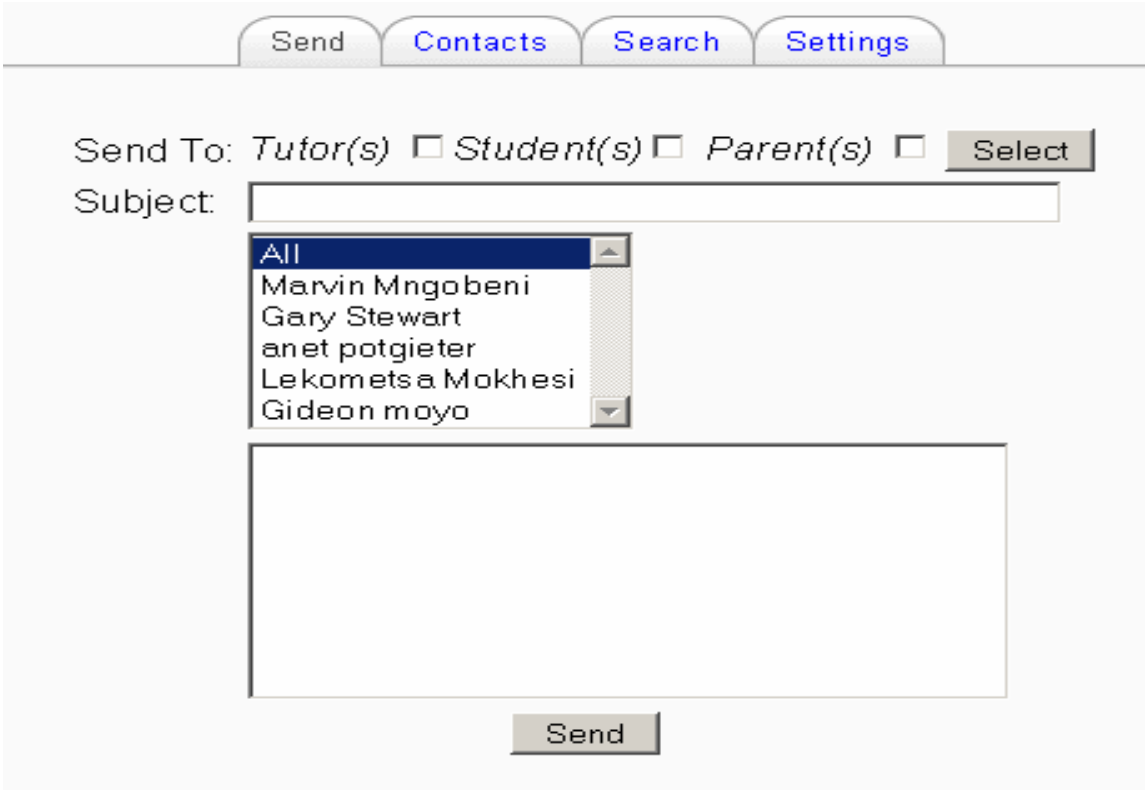

Figure 20: Send Message User Interface

4.2.2 MXIT Forum Module

The main problem of the project states that the current used infrastructure has no facility for student to ask question after hours. MXIT Forums block is a solution to the problem and is described as follows:

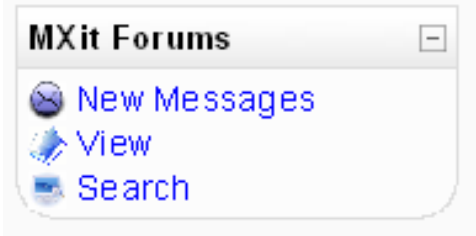

Figure 21: MXIT Forums Block

➢ **MXIT Forums Block**

This block group and deal with the communication of messages between volunteers and participants. The messages between volunteers and participants can be routed in two ways depending on the availability of volunteers. The response is sent back to the user when the volunteer(s) are available to answer the participants' questions within 30 minute of the questions arrival using the Moodle Web Interface. When the volunteers are not available to answer participants' questions within thirty minutes, the system marks each and every question that it receives to indicate the status of the question. The status can indicate whether the question has been replied, not replied or waiting for a reply from a tutor. The system maintains checking the status of the message after every 30 minutes. If the question has not been answered, it is forwarded to one available volunteer and the status of the message changes. Finally, the reply is received from a volunteer and sent to the appropriate participant.

In addition, the block consists of three hyperlinks such as New Messages, View Messages and Search. The New Message hyperlink directs the users to MXIT Forum View Activity list the newly received messages with a waiting time of less than 30 minutes. The View hyperlink directs the user to the MXIT Forum Module View Activity that lists all replied questions and their replies. The Search hyperlink directs the user to the MXIT Forum Module Search activity that allows the user to search messages using the messages' attributes.

➢ **MXIT Forums Activities**

MXIT Forums Module is a plugging to the MXIT Forums block that process the Search, New Messages, and View hyperlinks.

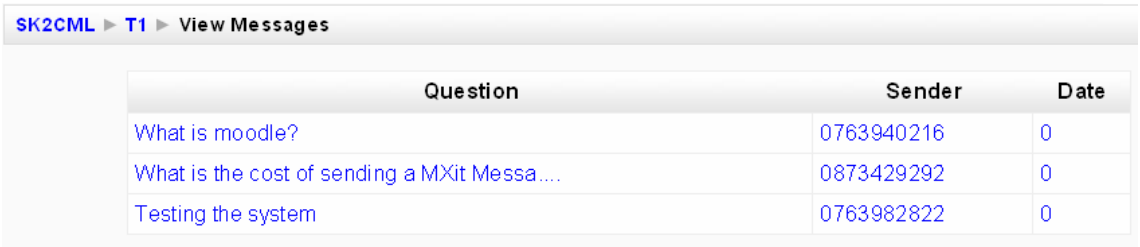

Figure 22: View Messages User Interface

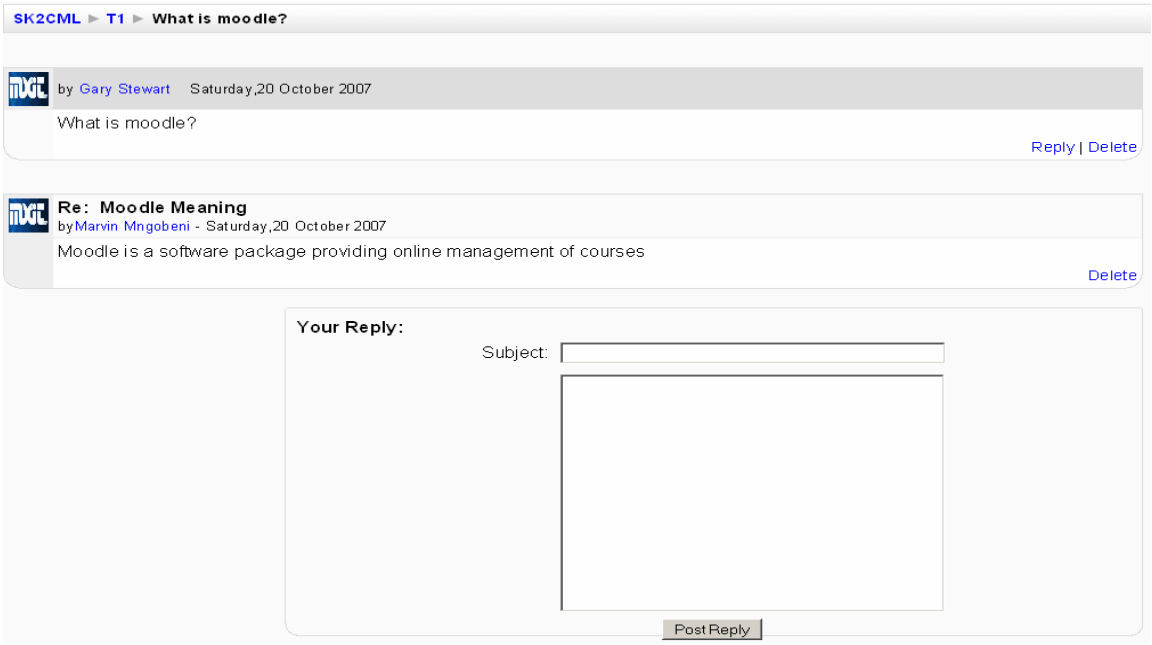

Figure 23: Send Reply User Interface

4.2.3 Absent Users (Future Work)

The case studies with Jonathan (SHAWCO) showed the need for a quick efficient way to send message(s) to the users that were not available for the tutoring session. This Block serves as a solution to the problem.

- **Absent Users Block**

Absent Users group and notify participants that were not available for tutoring sessions for the current week. This will allow volunteers to notify the participants about their absence for a certain tutoring session during the current week. In addition, the block should consist of the links to all the participants that were not available during current day and an option to send a notification to all the absent participants. In addition, there should be an option to display the absent participants by day of the week.

4.3 Key System Features

To develop a useful system that provides tutors and students with an OLE that facilitate the communication using mobile phones through forums and simple notifications with lower cost, time and effort; it was decided that the quality of the system also depends on the user friendliness of the system. It was from this understanding that the system was developed from an end-user perspective. In addition, it was decided that the user interface should allow user to complete the task with the minimum amount of work; should follow Moodle design rules and guidelines; should use conventional symbols or icons to elicit the meaning of the features; and should follow the interface design of the existing systems. Listed below are the lists of key features of the system:

- **Facility to send students notifications and notify of upcoming events**

In South Africa there is a need for projects that bridge the digital divide, due to the fact that majority of the citizens in this country do not have access to computers. Since ML customises Moodle ,and due to the system 's user interface guidelines mentioned above; and due to Moodle 's similar functionality to send internal messages, the user interface was modified to send messages to mobile phones. In addition, Moodle's existing functionality of sending internal messages is difficult to access. It can either be accessed through the user profile with maximum amount of work or through the messages block when there are new internal messages with the least amount of work. Moreover, during project meetings and research, it was found that most of the experienced Moodle users are not familiar with the Moodle functionality of sending internal messages due to the fact that the feature is hidden and required maximum amount of work to access it.

- **User interface to manage notifications**

Because of the nature of problem to manage and send notification to student, the email user interface design of the current existing systems was used to provide tutors with an easy familiar way to manage messages. The user interface allows the deletion, composition and the searching of messages and the navigation between pages and folders.

- **The forum facility to answer students questions**

This customizes the current Moodle forum to send messages externally to mobile phones. This gives students the opportunity to post question after hours.

- **User interface to manage forums**

Since the ML system need to conform to Moodle's current user interface, the current Moodle user interface was used. The only difference is that the thread of a question consists of one parent thread which is the student question and many replies. This implies that there could be only one question a thread and many replies.

4.4 Implementation Strategies and Protocol Used

Based on the limitation of resources, case studies with the clients, meeting with third readers and good software principles of implementing good software that is easy to use, efficient and requires less storage, the tools and decision were made as follows:

4.4.1 Restful Service

The POST and REQUEST methods were used to exchange information between PHP Scripts by encoding parameters on the URL and requesting information from a form. Restful service provides an easy way to pass parameters between applications. However, the parameters can be viewed by the users of the system. This service was only used to pass non-secret parameters.

4.4.2 Sending MXIT Messages Using Pooling

Pooling is a process of continuously observing the status of the new incoming messages. This process is used to manage the incoming and outgoing message to and from Moodle by continuously inspecting two tables (mxitin and mxitout tables). In order for the system to send messages, two operations are performed. The system first uses PHP to write the contents and cell phone number of the message to send mxitout table. Java threads are then used to read the cell phone number and the message contents from the output tables and forward the message thought MXIT to the appropriate user. The sent message in then deleted from the outgoing message table to ensure that no message is sent twice. In order to receive a new message Java receive a MXIT message and write it to the incoming message table, thus PHP is used to read new message.

4.4.3 Looking For Available Volunteer

The system forward participants questions to an available tutor if the question was not answered within 30 minutes. The question and the tutor status change to indicate that the question is forwarded to a certain tutor. In addition, the tutor can only be forwarded one message at a time. This allows the tagging of reply from a tutor by a tutor cell phone number in order to associate the reply with its question. When the reply is received from the tutor, it is stored and forwarded to the appropriate student. The tutor status is set to accept new questions and the question status is changed to read messages.

4.4.4 Lazy Deletion

The system uses lazy deletion to mark messages as to indicate the status of the message. Draft Message Module Sent items activity uses lazy deletion to differentiate between messages in the Trash folder and Sent Items folder by changing the message type attribute of the message.

Lazy deletion provides an opportunity to use less number of tables and avoid high movement between tables, thus less redundancy of information, less number of database access and less storage size.

4.5 Analysis of Implementation Strategies and Protocol Used

4.5.1 Pooling

Pooling is disadvantageous as it consumes lot of CPU processing time because of continuously checking the incoming and outgoing messages. Java Bridge provides an opportunity to bridge between Java and PHP by calling Java Methods inside PHP Scripts, thus avoid using process of continuously pooling messages from tables.

Because of the technical problems of installing Java Bridge into Moodle, pooling was used as a solution to the problem. In addition, PHP cannot be used to send MXIT messages because of the way MXIT protocol is implemented. However, Java provides an easy feature for using Java Threads to create independent concurrent processes and route messages to MXIT.

In reference to the sending of MXIT messages, Java Threads provides an opportunity to create a process for each and every question that was not answered within 30 minutes of the question arrival. This is very advantageous for efficient management of incoming and outgoing messages.

4.5.2 Lazy Deletion

Lazy deletion provides an opportunity to use less number of tables and avoid high movement between tables, thus less redundancy of information and less storage size.

4.5.3 Looking Available Volunteer

The algorithm to find the next available tutor sequentially selects the available tutor in sequence until all the tutors are occupied. This algorithm was tested to perform better compared to randomly selecting the tutor. During the experiments numbers between the ranges of the number of available tutors were generated. The problem was that the probabilities of choosing a certain tutors were not the same.

5 Experiments and Testing

5.1 System Testing

5.1.1 Black Box Testing

Black Box testing was used to test the correctness of data by sending messages from the system to the mobile phone and vice versa. Five users where entered into the Moodle tables with valid cell numbers, named and surnamed and assigned different roles. Three users where assigned the teacher role and the two users where assigned the student role. When sending a message, the group to send messages to need to be selected first. The first test was passed when the student and tutors check boxes were selected, in order to list all the students and tutors to send message(s) to. Secondly, all the different cases of sending messages to one student and all students were tested and the system passed. Furthermore, when the send button to send the message(s) was clicked the messages attributes were printed on the page and received by the recipients on a mobile phone

TEST CASE #1	Send Message
OBJECTIVES	User compose the message, press the send button and expert the student to receive the message
PRE-CONDITIONS	User has logged in as a tutor, has enough airtime, recipients exits and both sender and recipient uses and invited each other to MXIT
INPUT DATA	Cell Number: 0763940216 Subject : MXIT Cost Message: What is the cost of sending a message?
EXPECTED OUTPUT	Sender: Phetola Japhta Maake Subject: MXIT Cost Message:What is the cost of sending a MXIT message?
OUTPUT	Sender: Phetola Japhta Maake Subject: MXIT Cost Message:What is the cost of sending a message?
MAIN SUCCESS SCENARIO	➢ User press the "compose" button ➢ User select the recipient type and press select ➢ User selects the recipient(s) to send the message to ➢ User enter the subject and body of the message ➢ User press the "send" button ➢ System read the data from the form, saves the message into the database, write the message contents and cell number into the outgoing message table ➢ System reads the message contents and recipients cell number from the outgoing table and send it to the recipient ➢ System displays the message in the "Sent items" activity
PASS/FAIL	PASS

Table 13: Send Message Test Case

TEST CASE #2	Delete Message
OBJECTIVES	User selects an item and expects the item and its associated attributes to be removed from the database.
PRE-CONDITIONS	User has logged in as a tutor and there are messages in the inbox.
INPUT DATA	User clicks the checkbox then, Message Identity: 55
EXPECTED OUTPUT	
OUTPUT	
MAIN SUCCESS SCENARIO	➢ User select and item ➢ User presses the delete button ➢ System removed the item and its associated attributed from the database ➢ The deleted item is not displayed in the "Sent items"
PASS/FAIL	PASS

Table 14: Delete Message Test Case

TEST CASE #3	Search Message
OBJECTIVES	User enters enter the attributes of the message, click the search button and expect a list of messages matching the category to be displayed.
PRE-CONDITIONS	User has logged in as a tutor and there are messages that match the input in the "sent item: folder.
INPUT DATA	Keyword: cost
OUTPUT DATA	Sender: 0763940216 Message: What is the cost of sending a message? Date: Thursday, 11 October 2007
OUTPUT	Sender: 0763940216 Message: What is the cost of sending a message? Date: Thursday, 11 October 2007
MAIN SUCCESS SCENARIO	➢ User enter the keyword ➢ User presses the search button ➢ System reads the input and compares with the messages in the database. ➢ System displays the result(s) to the user
PASS/FAIL	PASS

Table 15: Search Message Test Case

TEST CASE #4	Un-delete Message
GOAL IN CONTEXT	User selects an item and expects the item to be removed from the list of messages
PRE-CONDITIONS	User has logged in as a tutor and there are messages in the trash folder.
INPUT DATA	User select the checkbox and undelete button Message Identity: 55. Message is sent to ”Sent items”
OUTPUT DATA	
OUTPUT	
MAIN SUCCESS SCENARIO	➢ User select and item ➢ User presses the un-delete button ➢ System change the item type or status, this the item moves from the “Trash” folder back to “ Sent items”
PASS/FAIL	PASS

Table 16: Un-delete Message Test Case

5.1.2 White Box Testing

White box testing was applied to fix errors that were identified during black box testing. Black box testing was showing the flow of data manipulated by the system. One of the biggest problems that were fixed using white box testing was the logical errors causes by the retrieval of forms from html forms and the involvement of restful services to exchange data. The problem was that PHP Scripts allows the usage of variables without initialization and declaration. The main problem of causing the retrieval of data from forms was the wrong spelling of variables and the scope that defines the boundaries when a certain variable can be accessed.

5.1.3 Backtracking Debugging Technique

Backtracking debugging technique was also used to track how the data changes during the program execution. This method tracks the problem from the error back to the source code by printing the values. Only small programs such as for loops were tested using this method.

5.1.4 Functionality Testing

This testing was performed to test the validity of the system by concentrating on the users' requirements and needs. The meetings with the SHAWCO K2 manager, Jonathan were scheduled in order to ensure that we are building the right product. In addition, the second reader and the Co-supervisor meetings were scheduled to look at the system closely and provide feedback of how to make the system better.

5.1.5 Recovery Testing

XMLDB is an XML Editor for creating database tables that automatically installs itself when the system start running or when the new module is added to the system. Modules were recovered by removing and deleting them from the system's modules. In order to test their functionality, they are copied back to system's module. In addition, the backup's settings of each and every Module and Block were set to automatically create Backups of Modules and Blocks. Furthermore, after each and every huge change or implementation, the version of Moodle was kept for backup purposes. The tests were successfully completed without errors.

5.2 Experiments and User Testing

Learning Management system like Moodle are widely used online systems to manage courses. In order to provide the educational institutions with a user friendly online system, the system need to be critically evaluated to meet user's expectation and needs. The aim of the evaluation is to find out whether the system sending and management of messages is easy to use. In addition the evaluation finds whether existence of the system improve the communication between tutors and students. The evaluation is based on the direct observation constructive interaction evaluation methodology [16]. Moreover, the questionnaires were also decided to be part of the evaluation process due the difficulty of capturing all the information performed by the users. In addition to questionnaires, it was decided that the interviews are going to be used to gather more information.

5.2.1 Proposed Evaluation Methodology

The initial plan to evaluate the system was to deploy the application at the SHAWCO K2 Center for a period of one week or more. This procedure would allow students and tutors to use the system in a real situation. However, due to the limitation of time and resource, the direct Observation constructive interaction evaluation method was decided on. Direct Observation constructive interaction is another form of think-aloud evaluation technique. [16]. It allows users to work on the on the same task simultaneously in order co communicate and share ideas with each other. The method was selected to avoid biasing the result of the experiments. In addition, the discussion of task with other testers allows the user to be free and discuss common problems. Moreover, the discussions give the facilitator the opportunity to records common problems and listen how other users respond to those questions. In addition, the following were decided before the experiments:

- The users to test the system and location to perform the experiments
- The measure that defines what makes our system better and easy to use
- The functionality to be tested derived from the use case diagrams based on what need to be evaluated.
-

5.2.2 The Evaluation Process

The user experiments were conducted at the SHAWCO K2 Center in Khayelitsha, a township in Cape Town. Six tasks to test the functionality of the system were drawn as follows:

- Sending a message
- Delete and un-delete message
- Post reply
- Delete post
- Post question

Due to the limitation of resources such mobile phones capable or running MXIT application, three tutors and two students were used to evaluate the system. To start the evaluation process and avoid biasing the results, the main purpose of the evaluation and the functionality of the system were clearly explained. Two students were given one mobile phone and two different scenarios of questions each to post to the system. Three tutors were assigned four tasks each to be solved simultaneously through discussion using different computers. Tutors understood and discussed their task and problems very well. However, most of the tutors where not familiar with Moodle‘s user interface.

5.2.3 Finding the Solution

Each and every task has a list of questionnaires and a scale to evaluate it. The scale ranges from 1 to 5, where scale 1 shows the user had difficulties using the system and scale 5 indicates that the user found it easy to use the system. Scale 1 implies that the user interface is not easy to use while scale 5 implies that the user interface is easy to use.

In order to find the solution and test the hypothesis, the table of results is going to be drawn. The table will show the list of talks against different users. The rows indicate the task by different users while the columns indicate the users. This will allow finding the average usability scale by user and by talk. The table of results will be showed in the next section

6 Results and Conclusion

The results from the experiments were gathered and recorded on the tables as shown below. These results will then be used to measure the system according to the key success features such as usability, functionality and the user interface as follows:

6.1 Usability

Based on the results from the experiments, it may be drawn that the users found it very easy to use the system. According to some of the tutors, the user interface can still be improved. Some of the comments state the following:

- The usage of hyperlinks in the forums to delete and reply to new question can be improved by using buttons.
- Chris and Alex said that Moodle should be personalized to have a "Home" hyperlink to allow easier navigation and make browsing easy.
- The "Back" button and the "Jump To" feature can also be useful to allow much navigation flexibility. In addition, it was mentioned that the location of the "Back" hyperlink should be at the top and bottom left and right of the page.
- The continue hyperlink should redirect to the list of question after the message has been deleted
- The send message should have a clear description indicating its purpose.

6.2 Functionality

Students and tutors show interest in using the system. However, the survey showed that most of the students have no access to MXIT or Chatting services while tutors have access to the mobile phones. However, students are familiar with GPRS Mobile phones and MXIT. Both tutors and students stated that the system could be useful to facilitate the communication between tutors and students. However, it will be difficult to access MXIT mobile phone. Students and Tutors were able to communicate using the system. This shows that the system solve the communication problem between tutors and students despite the system requirements of requiring MXIT mobile phone. This means that the system could also be useful in a different situation where students have access to MXIT or the Chatting services such as GTalk, MSN or AIM.

The tutor's evaluation table shows the task results performed by the tutors. The rows show the name of the tasks and the columns shows the users that were performing the experiments.

Task #	Tasks	User 1	User 2	User 3	Average	Total Avr
1	Send Message	4	5	4	4.33	
		4	5	5	4.67	4.50
2	Remove Message	5	5	5	5.00	
		5	5	4	4.67	4.83
3	Delete Message	5	5	5	5.00	
		5	5	4	4.67	4.83
4	Post Reply	4	5	2	3.67	
		5	4	2	3.67	3.67
5	Delete Post	5	5	4	4.67	
		5	4	4	4.33	4.50
6	**Total**	**47**	**48**	**39**	**44.67**	**22.33**

Table 17: Tutors Evaluations Task Results

The student's evaluation task results table shows all the tasks performed by different users and their scale on the scale of 1 to 5.

Task #	Tasks	User 1	User 2	Average
1	Post Question 1	5	5	
		4	5	
		3	5	**4.5**
2	Post Question 2	5	5	
		4	5	
		3	5	**4.5**
3	**Total**	**24**	**30**	**9**

Table 18: Student Evaluation Task Results

The MXIT Mobile Phone survey tables, shows the number of people that have access to MXIT mobile phones.

No #	Name	Education level	Occupation	MXIT/MSN/Gtalk	MXIT Hours	Computer
1	Nicole	Varsity	Tutor	Yes	6	Yes
2	Mlaleki	Grade 8-12	Student	No	N/A	No
3	Acola	Grade 8-12	Student	No	N/A	No
4	Alex	Varsity	Tutor	Yes	5	Yes
5	Lungu	Grade 8-12	Student	No	N/A	No
6	Onele	Grade 8-12	Student	No	N/A	No
7	Chris	Varsity	Tutor	Yes	5	No

Table 19: MXIT Mobile Phone Survey

6.3 General Comments

It is clear that some of the comments stated by the user are dependent on the whole Moodle interface. Users preferred the use of buttons over hyperlink(s) in the forum activity. In addition, user state that the Moodle need to be personalized to have a “Home” or “Back” hyperlinks at the top and bottom corners Moodle pages. In addition, user stated that the sending of message page should have a description of its purpose. This will allow users with no knowledge of the system to easily read and understand what the system is supposed to do.

6.4 Conclusion

The system was implemented to answer the usability and useful research question, thus the question will be discussed below.

6.4.1 Usability

The research question find out whether the system‘s capability to send and manage messages is easy to use and efficient. Usability is one of the most important features that improve the quality of the system.

More time was needed to deploy the system at the center for two weeks or for few months to gather more data and allow users to use realistically use the system. Although, the selected user gave the positive results, it is not clear enough that the experiments will give the same results under different contexts. In addition, the results gave positive results but the user had lot of comments about the user interface as mentioned in the general comments. It might be that some of the user give pleasing results to please the facilitator since the facilitator observe the users during the experiments. It can also be possible that the system can be useful; in that case user will be forced to use the system because of its usefulness not because of its usability. The deployment of the system would be the best possible solution to evaluate the system’s usability of sending the messages. However, based on the experience of tutors who are familiar with the learning management system, we conclude that system is user friendly.

6.4.2 Communication Improvement

The research question find out whether the system‘s existence would improve the communication between tutors and students.

Although the system provide positive results that the system will improve communication, it is insufficient to conclude that the system improve communication between tutors and students. Since the current Moodle does not route external messages using mobile phones, users can give random positive results because of the MXIT technology. It might be that tutors and students might not even use the system because of the unavailability of MXIT mobile phones. The development of the system at the SHAWCO K2 Center was also required to get more data and make relevant conclusions.

Based on the results and the type of users the system is build for, it us clear that the system failed to improve communication.

7 Recommendations and the Way Forward

During the evaluation, users gave lot of feedback about hyperlink(s) replacements with buttons, the medication of the navigation facility to have “Home” and “Back” hyperlinks at the bottom and top, left and right corner of the page. This can be useful to solve to the usability research question. However, there was no comments about the system‘s improvements of the communication between tutors and students.

Based on the findings, limitation of resources and time constraints, the following recommendations were drawn:

7.1 Both SMS and MXIT Should Be Used to Send Messages

Since the current system uses MXIT to send messages and most of the students at the K2 Center do not have MXIT mobile phone. It will be reasonable to use both the SMS and MXIT technologies to exchange messages, thus accommodate everyone with and without MXIT mobile phone. During the MXIT mobile phone survey, it was clearly shown that most of the people have access to simple mobile phones. This mobile phone will allows easier communication between tutors and students. In addition, it will improve the usefulness of the system.

7.2 Moodle Web Interface Should allow Students to Send MXIT Messages

The current Moodle interface to send internal messages between tutors, teaches and students, allows everyone to send a message to users. It would be reasonable to customize Moodle mobile learning to allow students to send and read messages. This will also improve the communication between tutors and students

7.3 Need A Way to Tag Replies from Tutors

MXIT Library does not allow the tagging of new incoming messages in order to associate the reply with its question. The current system uses the tutor mobile number as a way to tag the message. The disadvantage of the usage of mobile number to tag messages is that there is no one tutor that can be sent two messages at the same time. If one tutor can be sent two messages at the same time, it will be impossible to identify the replies that will be sent by a tutor. If more messages than tutors are sent to the system, the system will delegate all the jobs to all the tutors and the system will be overloaded especially if the tutors don not reply in time.. This feature will increate the response time of questions posted by the student.

7.4 Time to Deploy the System Should Be Extended

It was mentioned that although the experiments gave positive results, it is not evident enough to prove or disprove the research question. In the future, it would be reasonable to deploy the system at the SHAWCO K2 Center for more time. This will allow the users to realistically use the system and give a more relevant and reliable feed back.

7.5 Students spent most of their Time outside their Classrooms

It was mention earlier on during the analysis of the communication between tutors and students that students spent most of their time outside their classrooms. This means that students spent most of their time with friends, parents and families. Furthermore, parents could be used as teachers to teach students after schools. However, because of other commitments, parents do not have an opportunity to teach their children. The best possible solution is for students to use mobile phone to communicate or post questions through forums to their tutors. In addition, one could say that the schools should extend the period of time student spent in their classrooms and offer them more courses.

7.6 The SHAWCO K2 Center Should Implement a Strictly Tutoring Strategy

During the user experiments, it was observed that students spent time at the center serving the internet, playing music and downloading games. Since, the tutoring session is an opportunity for student to learn computer skills; students should be strictly controlled to follow the prescribed curriculum.

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Appendix A: User Tests

Task 1: Sending a Message

- Log in to the System
- Navigate to the "Sent Items" by clicking the "Sent Items" hyperlink
- Click the "Compose" button to start sending message(s)
- Select a group to send message(s) to by ticking the appropriate checkbox and press the "Select" button
- Enter the message subject and contents and click send

1. I had no difficulties sending a message.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

2. When sending the message, I felt like I have seen or used the system before.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

3. How would you the sending message interface to be improved?

4. General Comments

Task 2: Delete and Un-delete Messages: Draft Messages

- Log in to the System
- Navigate to the "Sent Items" by clicking the "Sent Items" hyperlink
- Choose a message to manipulate by selecting the appropriate checkbox aligned with the message
- Click the "Delete" button to delete the message
- Navigate to the trash folder by clicking the "Trash" hyperlink
- Choose a message to manipulate by selecting the appropriate checkbox aligned with the message
- Click the "Undelete" button to undelete the message or the "Delete" button to delete the message.

5. I had no difficulties deleting and Un-deleting draft messages.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

6. When deleting and un-deleting draft he message, I felt like I have seen or used the system before.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

7. How would you the deleing and un-deleting interface to be improved?

8. General Comments

Task 3: Post a Reply (Question Should Be Available)

- Log in to the System
- Navigate to the "New Messages" by clicking the "New Messages" hyperlink
- Select the question to reply to by clicking the appropriate hyperlink under the "Questions" column
- Click the "Reply" hyperlink to reply to the question
- Enter the Message subject and contents and click "Post Message" to send the reply to the question

9. I had no difficulties posting a reply or answering student's questions.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

10. When posting a reply, I felt like I have seen or used the system before.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

11. How would you like the posting of the reply interface to be improved?

12. General Comments

Task 4: Delete Message: MXIT Forums (Question Should Be Available)

- Log in to the System
- Navigate to the "View" messages by clicking the "View" hyperlink
- Select the question to reply to by clicking the appropriate hyperlink under the "Questions" column
- Click the "Delete" hyperlink of the question to delete the question
- Navigate back to the "View" messages.

13. I had no difficulties deleting and un-deleting MXIT Forums questions and replies.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

14. When deleting questions, I felt like I have seen or used the system before.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

15. How would you like the deletions of questions interface to be improved?

16. General Comments

Task 5: Posting Questions (Students)

- Use the given Cell phone to post the following questions to MXIT
- Hi there, I just bought a new cell phone. How do I download MXIT to my cell phone?
- What is the cost of sending a MXIT Message?
- Can I post questions to tutors at anytime of the day?
- Schools are closing this week; can I still post questions during the December vacation?

17. The system can be very useful to ask tutors questions.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

18. If this system can be deployed in the future, I would definitely use it beyond doubt.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

19. I would definitely buy a Cell phone in order to use this system.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

20. What other service would you like the system to provide except the forum?

21. General Comments

Task 6: Posting Questions (Students)

- Use the given Cell phone to post the following questions to MXIT
- How does one create a new student account?
- How does one log into Moodle to register for the current course?
- How does one upload an assignment to Moodle?
- I succeeded uploading an assignment to Moodle but the assignment is not visible when different Computes are used, what is the problem?

22. The system can be very useful to ask tutors questions.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

23. If this system can be deployed in the future, I would definitely use it beyond doubt.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

24. I would definitely buy a Cell phone in order to use this system.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

25. What other service would you like the system to provide except the forum?

26. General Comments

Appendix B: Mobile Learning Application (MXIT) Users

Note: These questions are used as part of research and the development of SHAWCO K2 Center Mobile Learning System. The questions marked with an asterisk (*) are optional due to the high sensitivity of personal information.

*** Name:** _____

*** Cell Number:** _____

*** Parents Cell Number(s)** _____

1. Age (Please select one)
   - ☐ 12-17
   - ☐ 18-29
   - ☐ 30+
2. Education Level(Please select one)
   - ☐ Grade 8-10
   - ☐ Grade 11-12
   - ☐ Varsity
   - ☐ Other
3. Gender (Please select one)
   - ☐ Female
   - ☐ Male

4. Occupation (Please select one)
   - ☐ Participant
   - ☐ Tutor
   - ☐ Parent

5. Own MXIT Cell Phone (Please select one)

- Yes
- No

6. Hours Per Week Spent On MXIT (Please select one)

- 0- 5
- 6-10
- 10-15
- 16+

7. Own a Desktop Computer (Please select one)

- Yes
- No

8. Use MSN, GTalk or AIM Chat Services (Please select one)

- Yes
- No

9. Apparently, MXIT cannot handle data traffic due to the large number of users. If you were chatting to your fried about a very important issue. How long are you willing to wait for MXIT to respond?

- 1-30 minutes
- 1 hours
- 2 hours
- More than 2 hours