The My.Aral Project: Towards Developing A Mobile Learning Platform

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ABSTRACT

This paper explored the utilization of mobile devices for instructional delivery at Mindano State University-Iligan Institute of Technology (MSU-IIT) by developing a mobile learning application called My.Aral. The core components of the system are web-based and SMS-based applications. The system allows sending and receiving messages, taking of quizzes, replying to forum posts and viewing quiz results. Koole's Frame Model was used for the design of mobile learning platform. The system follows the 3-tier architecture for the web-based interface implemented using CodeIgniter and jQuery Mobile Frameworks, and Gnokii Daemon for implementing SMS server. Majority of the respondents in the usability testing "Strongy Agree" on the effectiveness of the implemented of the system.

CCS Concepts

•Software and its engineering → Software design engineering; Software design techniques;

Keywords

m-learning, Mobile Application, Koole's Frame Model

1. INTRODUCTION

The progress of mobile technology and the plethora of available applications in the digital market, have encouraged academicians to venture into what is now known as mobile learning. Its impact have influenced researchers in finding ways to put instructional materials into mobile devices and develop learning pedagogies to enhance the learning experiences of the "learners on the go" [3]. The rise of mobile learning and its impact to research community is unprecedented, local and international venues have been prepared to meet researchers and the like minded to discuss theories and breakthroughs that will contribute further to its development[10].

Perhaps one of the contributory factors to the rise of mobile learning utilization is the way telecommunications company offer services to mobile users. Nowadays, connecting to the internet using data is much more cost-effective compared to few years back and the so-called *"all-net text" promos* will surely be beneficial to systems like My.Aral and TXT-2-LRN [9], to name a few,which implemented its own SMS server. This phenomenon will allow "learners on the go" [3] to use connected devices to access learning materials wherever they are thus, breaking the distance barrier. New forms of learning can also be designed and tested empowering self-directed learning [1, 4].

Published scholarly articles [3, 7, 11] illustrated how short-messaging system (SMS) works and used in mobile learning. Bandalaria [3] mentioned that, *the m-learning program has been described as for "learners on the go" and designed for individuals to spend idle time productively by increasing understanding of important topics and help develop skills that are vital in today's knowledge society.* The study of Viljoen[11] et. al., discussed how Short Message Service (SMS) is used for basic administrative support in three existing teacher training programs for in-service teachers offered. While the study of Lim[7] et. al., discussed how the mobile learning via SMS enhanced the blended learning approach for undergraduate distance learners. Bandalaria[3] discussed the m-learning application using SMS for delivering short lesson topics of general interest, such as proper diet and nutrition, health risk factor assessment, calculating large numbers without using calculator, and spelling commonly misspelled words.

TXT-2-LRN System [9] utilizes SMS to add interactiv-

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ity in the classroom instead of the traditional "raise-hands" method, the system provided a means for the students to use SMS to participate in class discussion. The instructor will receive the messages in the laptop and may either response or disregard the messages, this classroom dynamics design is called open channel. Meanwhile, during lectures the instructor may present questions on a presentation software answerable by either A, B, C or D and students will then reply the answers through SMS, this classroom dynamics design is called m-quiz. It has been found out that the additional channel of communication is beneficial because classes are more interesting and interactive.

In MSU-IIT, instructions are mostly done in a physical environment. However recently, it has been observed that there is an increasing number of faculty members adapting the use of internet technologies for learning. They used web 2.0 tools to supplement learning and have been utilizing the MSU-IIT Online Learning Environment that uses the moodle CMS platform. Though very beneficial, the use of such technologies is limited to students who have access to internet and computers.

It is in this light that the researchers developed another approach to learning which is the use of mobile technologies to make learning more accessible to a greater number of students in MSU-IIT. This can be useful in times when classes are suspended due to holidays or when regular class hours are insufficient for the content to be covered. They can receive notifications, answer quizzes, ask question via SMS, and participate in forums via 3G, WIFI, or mobile data connection during or outside class hours.

MSU-IIT has been using the MSU-IIT Online Learning Environment (MOLE) to supplement instruction and learning. However, the utilization of mobile devices using SMS and mobile web to provide instruction delivery has yet to be explored.

The system from this study is capable to handle multimodal input from the identified user groups utilizing web and SMS technologies. Voice input and unstructured supplementary service data (USSD) code were not implemented and the SMS input mode only provides link to learning materials. Further, taking quiz will require a printed copy of multiple-choice questionnaire and answers are concatenated in the specified SMS format so the system can respond with the result of the quiz.

2. SYSTEM ARCHITECTURE

The system follows a three (3) tier architecture with client, application and server tiers. The server tier houses the database and web server for persistent storage and content delivery, respectively. The middle tier is where the SMS-server runs along with the web-based applications where the users using different devices interacts for different requests provided by the application. The client devices can either be connected using the internet, mobile data or Telco SMS gateway. Figure 1 illustrates the relationships.

2.1 Mobile Web-based User Interface

The mobile web-based interface was developed using model-view-controller (MVC) framework and user interface was encoded using widgets and events that supports multimodal input from the device's screen and other supported input mechanisms.

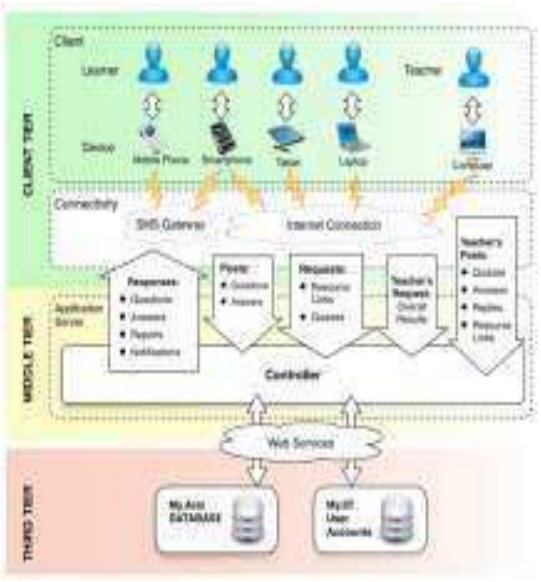

Figure 1: My.Aral System Architechure

2.2 SMS Server

SMS server is a software application enabling the users to send and receive SMS message directly into their computer and/or mobile devices. The user can write SMS messages even from the personal computer and send to mobile and other connected devices. The following are the specifications:

1. The system must have load credits in order for the user to perform the mobile learning activities like sending messages (notifications, quiz results).
2. Forum is not available.
3. For quizzes, supported type will only be single answer multiple choice and only one SMS will be sent containing all the answers from the quiz item in concatenated format (e.g. abcadacdba.).
4. No explanation will be given after answering the questionnaire.
5. For announcement module, regarding course materials only the link shall be sent, not the file.
6. SMS keywords will be used by the students to answer quizzes, ask questions and requests (e.g. <MY-COURSES> and <ANSWERQUIZ>).
7. Questionnaire will not be sent through SMS but only the external link.

3. MODEL FOR MOBILE LEARNING

Koole's Frame Model[6], see figure 2, serves as the basis for designing the mobile learning environment. It is composed of device usability, learner, and social aspects of learning. This model considers the mobile device's properties as well as its impact in personal and social aspects when applied to learning[5]. Having combined the synergy between the mobile device and the learner, it is thought of that it can

Figure 2: Koole's Frame Model

fuel the reason to discover new knowledge. The model hopes to make impact in the design of mobile devices and the development of learning modules for mobile education. On the other hand, the model describes a scenario wherein the learners access materials irregardless of location and time – *anytime, anywhere*. The learning experience may then be amplified by the interactions with other people which may include the facilitator and co-learners[6].

4. CHARACTERISTICS OF MOBILE LEARNING

According to Ozdamli[8], et. al., the following are the basic characteristics of mobile learning:

1. **Ubiquitous/Spontaneous**: Mobile learning breaks the boundaries of traditional classroom set-up of learning. It is not anymore confined to the four corners of the room and materials will be available anytime, anywhere as long as gadgets are connected to the mobile network.

2. **Portable size of mobile tools**: Mobile learning gadgets sizes varies, from small screens (SMS only phones) to bigger screens (Phablets, Tablets). It is for this reason that B'Far [2] reminded those who will develop mobile application to consider multimodal interactions with the application and to make sure that contents are accessible and readable on the different gadget's screen orientation and inputs.

3. **Blended**: Mobile Learning does not and should not replace interactions in the classroom, instead it can be used as a tool to augment the learning experience of the students. It is this blending that makes mobile learning more effective and desirable for both teachers and learners.

4. **Private**: Mobile learning access is individualized meaning the learners interacts with the environment independently with the other students. This environment should be able to support self-directed learning[4], where individuals proceed after completion of the current task.

5. **Interactive**: Mobile learning environments provides different levels of interactions, allowing the teacher and students utilize the platform for teaching and learning activities.

6. **Collaborative**: Mobile learning environments utilizes current technologies that allow users (teachers and students) to interact, this augments the traditional consultation process and responses are spontaneous helping the learner achieve more[4] at any time and place while connected.

7. **Instant Information**: B'far[2] enumerated the conditions of mobile users and one of those is immediacy. Immediacy refers not only to the responsiveness of the system but also to the availability of information. It has been pointed out that the high turn-over for response time and poorly designed display of information dissolves the interest of the user to use the application. In Mobile Learning environment, educational materials should be designed to guide the user into the information immediately[8] and the response time must be tolerable enough to engage the user into seeing more contents.

5. METHODOLOGY

There are three (3) types of users in the system, the administrator, instructor, and student. The administrator can fully access all the system's modules. The instructor can access same modules as the administrator except for managing users, courses and SMS server. The student can only access the message, quiz, forum, courses, and grades modules but the student can only view and take quizzes, reply to forum posts, view quiz results, view and enroll course(s).

5.1 Mobile Learning Development Process

The mobile development process as suggested by B'Far[2] serves as the guiding principles for the realization of mobile learning platform. Figures 3 and 4 are the use-case diagrams derived from the discussions of sections 2.1 and 2.2, respectively. Initial user-interface has been developed addressing platform proliferation by utilizing a framework, jQuery mobile, capable to access low-level device functionality and could be ran using a mobile web browser, see section 6.3. It was then modified and enhanced according to user suggestions.

B'far[2] emphasized multimodal interaction to enable different devices, low-end or high-end or text-based, access to the system. This study only enabled SMS-based input mode and section 6.2 discussed the different approaches utilized in developing the server.

The user-interfaces was then evaluated, tested and modified in accordance to user comments during usability testing, see section 7.

5.2 Pedagogical Process

In creating a sample mobile course, pedagogical process was followed as illustrated by the following steps:

1. *Select the topic to be used as a sample course input.* Familiar topics were selected in consideration of the users.

2. *Formulate appropriate learning objectives.* Learning objectives were carefully crafted to fit in the features of the developed mobile system.

3. *Develop or identify a sample course material that students can refer to while learning.* For the purpose of

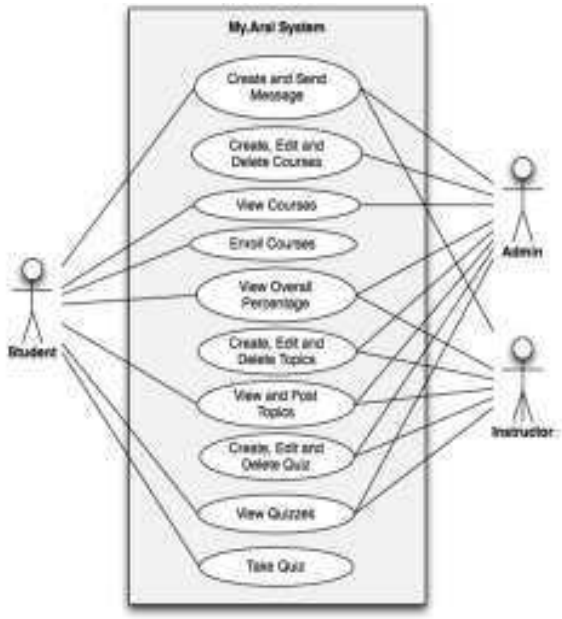

Figure 3: Use Case Diagram in Web-Based Application

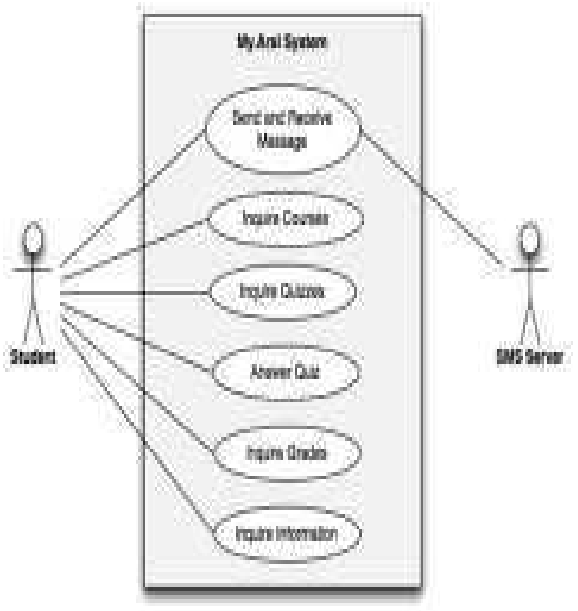

Figure 4: Use Case Diagram in SMS-Based Application

this study, the course materials were from Computer Programming (CSC 101) and Educational Technology. These materials were available during the usability test sessions.

4. *Design instructional activities.* This was done by identifying the possible methods of interaction applicable using the identified mobile use case. Activities can be in a form of Forum discussions or an exercise for the purpose of knowing if students are ready for assessment or if they are able to grasp the content that they read, viewed or heard.

5.3 Usability Assessment

Instant information are just some of the characteristics of mobile learning[8] which requires equally important attention if one has to succeed in developing the mobile application. Considering the limited screen capability, it is best that the teacher develop skills to present the lesson to the learner in a clear and concise format faithfully following the suggestion of mobile pedagogical process as mentioned in section 5.2.

In user interaction, the ease of use in navigating through the user interface and as well as its user-friendliness were evaluated by the respondents. In performance, the capability of being bug and error-free; the ability to run smoothly without delay; and the clarity of directions while using the system were evaluated. Lastly, the usability of the system was evaluated through clarity and naturality of dialogue (texts), consistency of terms used and understandability of error messages.

Usability assessment was done with the use of an assessment tool. In the test, the users performed tasks in order to observe and measure the user interaction, performance, and usability.The expected users for the assessment are administrator, instructor and student. Assessment test was done to a minimum of three (3) administrators and teachers, and to students in two (2) classes. One class used the SMS-based application while the other used the web-based application. The minimum number of student participants for each class were ten (10). The administrator and instructor were allowed to test the web-based application. Assessment focused on user interaction, performance and usability. Likert scale was used to rate and evaluators were encouraged to provide comments in open-ended feedback form. After gathering the results, quantitative and qualitative measures were taken. Table 1 shows the scale interpretation of results for usability testing.

Table 1: Likert Scale for Usability Testing

Scale	Meaning
1.00-1.80	Disagree
1.81-2.60	Somewhat Disagree
2.61-3.40	Somewhat Agree
3.41-4.20	Agree
4.21-5.00	Strongly Agree

5.4 Fine-Tuning

The results of the evaluation were used as basis in fine-tuning the system. Fine-tuning refers to a process of making small adjustments or modifications to improve the system

usability. In performance, the bugs and errors of functionalities were corrected and the response time were improved. In the user interface, the concerned area were dialogues and may be changed as the need arises. The error messages were crafted carefully in order for it to be clear and concise.

5.5 Deployment Process

The deployment of the system took place after the code is appropriately tested and ready to be transferred to the customer's site, however other activities such as verification phase (e.g. deploying components in a special testing environment) and continuous integration tests were also part of quality assurance.

6. IMPLEMENTATION

6.1 Koole's Frame Model

To follow are the discussions on how the model were implemented in My.Aral. Recall, key components of the model are device usability aspect, learner aspect, social aspect, context learning, social computing interaction, interaction learning, and mobile learning process.

In device usability aspect, the choice of mobile framework, jQuery mobile, for supported high-end devices and the implementation of SMS server for low-end devices makes the application accessible to wide variety of users. This enables the "learners on the go"[3] access the course contents and do social interactions by simply using their device at hand.

My.Aral was designed in a way that capacitates the users, especially the learners. The terms used in the system are easy to understand and familiar to learners that guided them in performing different tasks. The user interface is simple and intuitive which guided them all throughout the process. For example, when the learner takes the quiz, the learner will be guided with messages and icons that shows what to do and how to proceed from there. Because of this, the learners can make decisions, understand, imagine or remember lesson concepts.

Forum was designed so that users can exchange information to gain knowledge enabling learner-learner, learner-instructor and learner-content interactions. The users meet together in forums to discuss certain topics, share knowledge and experiences, and learn from one another. Also, forum was created in order for the instructor or administrator to post course materials and links. The students can then access the course materials and comment if the content is appropriate to their needs. This way, students can acquire skills to appropriately select, manipulate, and apply information to their own unique situations and needs.

Aside from the forum, message module was also implemented in which the student can send private messages to the instructor about some concerns like the topics that they do not understand and the instructor can then reply.

To measure learning from the activity, the instructor can choose to construct a scheduled online quiz with expiry. Currently, My.Aral only supports multiple choice type of exam with only one correct answer. If the student takes a quiz, there is an immediate feedback coming from the system summarizing the total score and percentage rating.

6.2 SMS Server

During the implementation of SMS server, the researchers explored different types of approaches for its realization. One of which was to set up an SMS Server using Python programming language and AT Commands. AT Commands are instructions used to control a modem. Modems and mobile phones support a limited command set specific to the GSM technology which includes SMS-related commands such as AT+CMGS (Send SMS message) and AT + CMSS(Send SMS message from storage), AT + CMGL (List SMS messages) and AT+CMGR (read SMS message). The problem with this approach is that it is not generic and will have an issue in scalability and portability for future implementations.

The second approach was to use a toolkit called ActiveXperts SMS and MMS which only runs on Windows operating system. With this approach, it is easier to implement the server since there will be no AT Commands needed in order to provide SMS functionality. There were also problems with this kind of approach. One was the communication between the Toolkit and My.Aral, and another was the limitation of hardware support. Only a few number of GSM modems were supported that in effect, became a major problem in terms of the feasibility in setting up the SMS Server.

The third approach was the most convenient and was done by using a tool called Gnokii. Gnokii provides tools for using mobile phones under various operating systems with Linux as the most tested operating system known to work. Ginokii's hardware support is considerably better than ActiveXperts SMS toolkit since Gnokii offers more variety of supported devices. This provides many functionalities of different areas for a user to manipulate mobile phone. It also communicates with the phone over serial cable connection, USB connection, infrared connection and bluetooth connection. The communication between the system and Gnokii only uses a database which is a functionality the researchers needed in setting up the server.

6.2.1 SMS Quiz Module

In the implementation of the SMS quiz module, sending questionnaires in taking quizzes through SMS was really an issue due to the inherent 160-character limitation. As a remedy, the researchers redesigned the SMS quiz module by assuming that the questionnaires are provided by the instructor on either hard or soft copy accessible in a link. In answering quizzes, the student will just text the keyword together with the quiz ID and concatenate letters of choices (e.g. ANSWERQUIZ 348 abcadddaba). This gives convenience to the students as it will just send a single SMS provided that the total number of characters, corresponding the answers of the quiz items, does not exceed the total SMS character count limit.

6.3 Web-based User Interface

User friendliness is one of the things considered in designing a mobile learning platform. Due to platform proliferation, it is hard to design a single application for one device because it might not function effectively on another. Good thing, current web technologies introduced tools for responsive web technologies like Twitter Bootstrap that allows adaptability on different device's screens. However, adaptability is only one issue, if a mobile learning platform has to be implemented, one has to consider the multimodal[2] input specific for mobile devices like swipe-events and provide touch friendly widgets. jQuery mobile provides the input needs outlined previously and it is for this reason that the

Figure 5: Login Interface

Figure 6: Administrator Page

web user interface was implemented using this technology.

6.3.1 Login Interface

The three (3) types of users: Administrator, Instructor, and Student need to input their username and password in order to access the system, see Figure 5. On successful login, the user can perform the mobile learning activities as defined by their privileges.

6.3.2 Administrator

The modules that can be found in the home page of an administrator are message, SMS server, manage users, courses, quizzes, forum and grades. There are some modules that are available to other users such as message, courses, forum, quizzes and grades but only the administrator and instructor have the privilege to create quizzes and post forum topics.

The forum page adds up to the interactivity[8] of the teachers and learners. It is where topics are posted and anyone from the class can share their ideas using the mobile device may it be a feature phone or a high-end device.

In courses module, the administrator can only create and assign course(s) to instructor(s) while the student can enroll to a particular course.

The administrator account is merely designed to control the system. Figure 6 shows the home page and figures 7 and 8 for the different modules accessible at the sidebar.

6.3.3 Instructor

The instructor's page, see figure 9,allows the management of quizzes and grades. The instructor can input details of the quiz including the start and end times. A notification will be sent to the students together with the quiz details. The students can then access the scheduled quiz. After which, the instructor can then view the grades and perhaps send a congratulatory message for top performers or a follow-up message to those that did not perform well.

6.3.4 Student

Figure 7: CRUD operations in Course Module

Figure 8: CRUD operations in User Module

Figure 9: Instructor Interface

Figure 10: Student Interface

Figure 11: Taking a Quiz

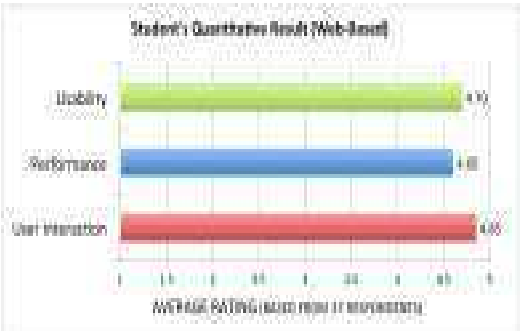

Figure 12: Web-based Quantitative Evaluation Result (Student)

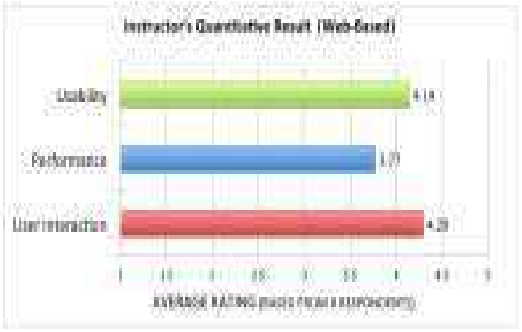

Figure 13: Web-based Quantitative Evaluation Result (Instructor)

Figure 10 is the interface where the students can view and enroll a particular course, create, send, delete, and view messages, view announcements, grades and forum topics, take a quiz in a particular course, view and edit contact number in profile module. After receiving notification for a quiz, the student can take the quiz provided the current time stamp is still in accordance to the start and end time specified by the instructor. And after the questions have been answered or the time has lapsed, the student will be redirected to the results page. Figure 11 show the different interface for quiz notification, answering a quiz item and the quiz results respectively.

7. USABILITY ASSESSMENT

For the assessment, the users performed different kinds of tasks while using the system and followed by evaluation using the form. The first usability test was conducted at the Information and Communications (ICT) Laboratory in the College of Education (CED). The second was held at the Computer Laboratory in College of Engineering (COE). For the administrator and instructor, the testing was conducted at the Department of Science and Mathematics Education in CED Accreditation Room and Computer Science Department located at the School of Computer Studies (SCS). The same respondents who evaluated the administrator, instructor and student account also evaluated the web-based application, while students with registered contact numbers were the only ones allowed to evaluate the SMS-based application. There were different types of devices used in testing the web-based application (i.e., desktops, laptops, netbooks, and tablets), while mobile phones were used in evaluating the SMS-based application.

7.1 Web-Based Application

The advantage of My.Aral from that of TXT-2-LRN System [9] was the inclusion of mobile web interface for multimodal user input.

There were twenty five (25) Educational Technology students from the Department of Science and Mathematics Education (DSME) of the College of Education (CED) and twelve (12) CSC 101 students from the College of Engineering (COE) who participated in testing the student's web-based user interface. Figure 12 shows the system evaluation results using quantitative measure from thirty seven (37) respondents with the scale interpretation of "Strongly Agree" in terms of usability, performance and user interaction.

In testing the quantitative measure for instructor's web-based user interface, there were eight (8) respondents who evaluated the system. Figure 13 shows the instructor's quantitative results for web-based user interface, with the scale interpretation of "Agree" in terms of usability and performance and "Strongly Agree" in terms of user interaction.

There were four (4) respondents who evaluated the system's administrator module, figure 14 shows the quantitative results for web-based user interface with the scale interpretation of "Strongly Agree" in terms of usability, performance and user interaction.

In qualitative measure, there were five (5) students who participated in giving feedback to the system. One (1) student gave a feedback and said that the system must have

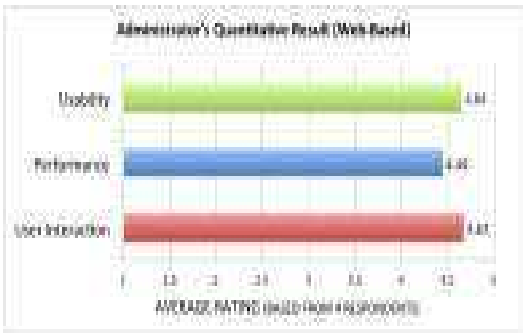

Figure 14: Web-based Quantitative Evaluation Result (Administrator)

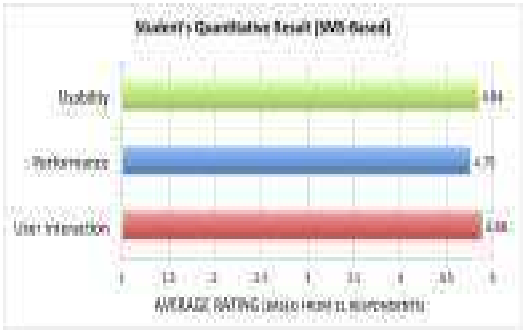

Figure 15: SMS-based Quantitative Evaluation Result

a password confirmation and the quiz must be arranged as SET A and SET B. Two (2) students also said that the user interface color scheme is appealing or pleasing to the eyes. Another student commented that the mobile learning system could really help in having school works or activities done easily. On the other hand, some students suggested that the name of the user must be in the home page and there should be a profile picture.

The respondents from the instructor and administrator accounts gave the same remarks as far as creating a new quiz is concerned. They suggested to minimize the number of text fields in filling out the form or design the system using drop down menus to minimize the user input.

7.2 SMS-based Application

The My.Aral SMS-based application was evaluated using the same learning materials and users were directed with objectives for system interaction.

There were eleven (11) CSC 101 students from College of Engineering (COE) who participated in the system evaluation. Majority of the respondents gave a rating of five (5) in terms of performance, usability and user interaction. This was attributed by the concise and easy to remember keywords used in inquiring and taking the quiz. Being able to inquire through SMS using the four (4) modules facilitates the student's convenience in taking quizzes and viewing grades. Figure 15 shows the results with the scale interpretation of "Strongly Agree" in terms of usability, performance and user interaction.

7.3 Overall Evaluation

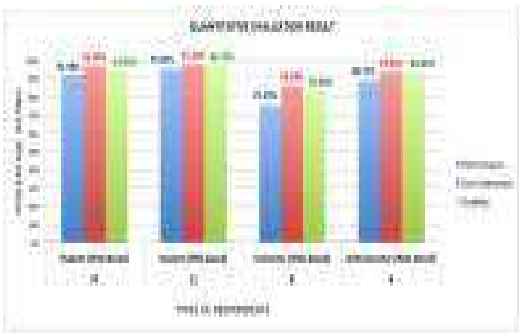

Figure 16: Quantitative evaluation overall results

Based on the overall results of quantitative evaluation, the four types of respondents gave the highest rating in terms of user interaction, see figure 16. This can be attributed to the user interface which is easy to navigate and understand. The performance rating from all types of respondents was slightly lower compared to user interaction or even the usability because there were minor bugs found during the test and some of the functionalities were not easy to follow.

Based on the evaluation results of the course module, sixty (60) respondents rated "Strongly Agree" for user interaction, "Strongly Agree" for performance, and "Strongly Agree" for usability.

In the overall system performance rating, usability and user interaction rate was 4.546752759 which fits between the scale interpretation of "Strongly Agree". The user-interaction got the highest rating from all types of respondents, which performance had a slightly lower rating due to the minor bugs observed during the test.

7.4 Fine-Tuning

From the results of usability assessment and open-ended feedback, majority of the respondents from instructors and administrators focused suggestions on the quiz module. Adding a new quiz by entering lots of trivial information was really an issue. As such, the researchers added a new module for the instructor account which is the Courses Module. Restructuring the whole instructor user interface was the solution to have the ease of use in creating quiz and other functionalities.

Adding new quiz to a particular course using the restructured instructor user interface made it even simpler since the user will just add the quiz title and time stamp fields. This advantage is brought about by having a course module that will just carry the information of the registered course upon entering "My Courses" menu.

8. CONCLUSION

The core components of the system such as the web-based and SMS-based applications were implemented. In SMS-based, Gnokii SMS Daemon server was used to send SMS and receive SMS requests from the students. The modules of the system which were designed for different groups of users: administrator, instructors and students, were implemented each with different accessibility levels and options.

Based on the evaluation results, majority of respondents rated "Strongly Agree" for user interaction, performance, and system usability.

The ratings obtained from evaluation results are indicators of successful implementation of the mobile learning platform – ***My.Aral***. In addition, the results will support the conclusion that developing a mobile learning platform should be influenced by Koole's Frame Model for it to be acceptable to mobile learners.

9. RECOMMENDATION

The My.Aral system has been developed and showed promising results for integration and adaption. My.Aral can be used to augment the existing student information system services to facilitate mobile learning. Further, a methodology has to be developed in order to facilitate text-based version of learning materials using the SMS-platform without using links. Such methodology should also be applied to taking quiz in order to eliminate the need of having a questionnaire during evaluation activities.

On the other hand, future works and integration are recommended to be evaluated using ISO 25010 to include other system aspects not covered by the current evaluation form.

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