Usability Testing and Evaluation of a Cloud Computing-based Mobile Learning App: Students' Perspective

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Abstract

Usability testing and evaluation is a crucial path in order to ensure that software developed meets the requirement definition and specifications. Mobile Application Framework for Higher Institutions of Learning (MAFHIL) is a cloud computing based web app that provides a platform for students to carry out their academic activities online. This paper focuses on the usability evaluation of MAFHIL so as to find out the students' needs and requirements, and also to investigate the usability issues in MAFHIL. This paper tries to uncover the usability related problems faced by the students which are helpful in analyzing the MAFHIL (SaaS) and its importance. Think Aloud (TA) and Questionnaires were the adopted techniques. The result from the evaluation showed that 85.9% of the students agreed while 4.7% disagreed and others undecided; this indicated that the app was accepted and that it had impact on the learning ability of the students.

Keywords: SaaS, Usability testing, Cloud computing, MAFHIL, Think Aloud Technique.

1. Introduction

Complexity of Software has increased over time owing to the intricacy of task to be carried out and the integration of various technological features and functionalities needed to meet users' requirements. Consequently developers carry out improvements to fulfil these requirements by designing a system that is closer and explicable for the users because the users are increasingly unwilling to face difficulties in those applications that require much user efforts.

The traditional methods for the development of software and web applications often results in difficulties and are unable to help the users to find out the desired goals [1]. So the purpose of this usability evaluation is to focus upon the usability issues in MAFHIL as well as for further improvements. The role of usability is to make the application user responsive and design the app in a way to satisfy users during their use in an effective and efficient manner. Usability is being able to do the things you want to, not the things you have to [2].

The use of online applications platforms is very common among students for searching valuable information in their studies because it provides a very cheap way for learning and research. The cloud is a smart, complex, powerful computing system in the sky that people can just plug into [3]; it provides the platform in which the applications are hosted.

Mobile Application Framework for Higher Institutions of learning (MAFHIL) which is a cloud based app provides the platform for students registration, download of learning materials from the e-library, collaborative study via virtual course-room discussion, e-assessment of students, amongst others; consequently providing a platform for learning with the use of mobile computing devices via Internet [4]. MAFHIL is a web based app, thus there is no need to download and install it on the computer.

This paper looks at how MAFHIL supports the students' for academic purpose and what are their further requirements for improvement. The role of usability is to ensure the effectiveness, efficiency and satisfaction for users regarding the application and for other necessities they feel to be in MAFHIL. By applying usability test and evaluation on MAFHIL we attempts to locate the student's difficulties, interest, satisfaction and desire for the future.

The services of MAFHIL were evaluated from students' perspective so as to gather the students' needs and requirements for academic, research purposes and how it could be more helpful for them. In evaluating MAFHIL, usability was used as a tool to perform an experiment on students using this application and to find out their remarks with usability testing and gather their requirements through the questionnaires.

2. Cloud Computing

According to [4], Cloud computing has to do with the use of computing resources (hardware and software) that

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are delivered as a service over a network (typically the Internet). There has been dramatic increase in the development of Internet applications daily for academic and non-academic purposes so as to utilise the proficiency of the cloud technology. Cloud computing could also be seen as a general term for anything that involves delivering hosted services over the Internet.

It can also be seen as away of computing in remote locations (in cloud) instead of personal computers. Cloud computing is a strong, powerful and complex technology available in the sky which users/people can easily plug into; it has been a burning issue nowadays because of its importance among users[3]. It is a style in which all the information technology related capabilities are providing services and transfer technology, data and software application from a local system thought network into the cloud. Users who connect to the cloud can access these services and products anytime and anywhere, meaning away from the desktop computer and at some other places at any point in time the user can acquire these services according to his/her demands. According to [5]the aims of the cloud computing is the migration of users, data and processing from Desktop PCs (client system) and corporate servers to the cloud. Cloud computing means computing power can be used as a commodity or service to be circulated and consumed through the Internet [6].

The cloud computing concept is also divided into three different service models also referred to as infrastructure models or services delivery models are generally categorized as Software as a Service (SaaS), Platform as a Service (PaaS) and cloud Infrastructure as a Service (IaaS). MAFHIL and Google Docs are examples of software as a service.

2.1 Software as a Service (SaaS)

SaaS is used to provide software and application services to users as they need to access. Today, most of what we use the web on a day-to-day basis aren't just web pages they are applications. In this model software applications are no longer monolithic. Applications and processing of applications are segregated into distributed application logic and user interaction logic. Application logic and the user data reside on network cloud but interaction logic is delivered to users in the form of web pages; users can view and interact with application by using web browsers [7]. Figure 1 portray the relation of MAFHIL with cloud computing.

This concept gives the user the opportunity to only use an internet enabled thin-client connected to cloud (where all processing power has been transferred to) to access the app. The major advantage of these online applications is a decrease in the need for flash drives or the extra space for storing the documents and files on desktop
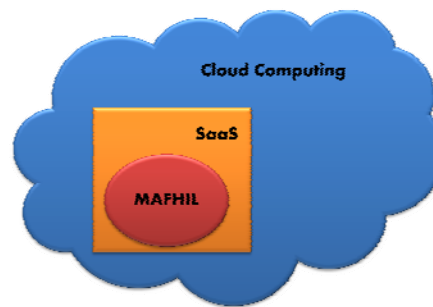

Fig. 1: Relation of MAFHIL with Cloud Computing

2.2 MAFHIL

MAFHIL is used solely for academic and research based activities. It's mobile in nature in the sense that it can be accessed via the use of mobile handheld computing devices without lost of originality in content rendering. Students access MAFHIL using any browser via the URL http://mafil.abuango.net. With the use of MAFHIL, only registered students can download academic e-books and other instructional materials, upload and submits assignments, be involved in a virtual course room via the Internet which facilitates communication among the participants by allowing students and lecturers to meet virtually in forum discussion (asynchronically) in chat.

They can also participate in e-testing (e-assessment) using the multiple choice question kind of testing and essay type and register courses. It also provides a platform for learning and information dissemination via short message service to students using their mobile phone numbers; and also used for advertisement purpose [4]

3. Usability Evaluation for MAFHIL: Methods and Techniques

Usability refers to the quality of a user's experience when interacting with products or systems, including websites, software, devices, or applications. Usability is about effectiveness, efficiency and the overall satisfaction of the user. Usability is not a single, one-dimensional property of a product, system, or user interface. It is a combination of factors including:

- Intuitive design/Aesthetic: a nearly effortless understanding of the architecture and navigation of the site
- Ease of learning: how fast a user who has never seen the user interface before can accomplish basic tasks
- Efficiency of use: How fast an experienced user can accomplish tasks
- Memorability: after visiting the site, if a user can remember enough to use it effectively in future visits
- Error frequency and severity: how often users make errors while using the system, how serious the errors are, and how users recover from the errors

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- Subjective satisfaction: If the user likes using the system [8].

[9]stated that an interactive system with high degree of usability has the following characteristics and goals: efficiency, learnability, errors, memorability and satisfaction. The purpose of the usability evaluation is to test the products and services for users, approaching and measuring how effectual, resourceful and satisfied the users are while they interact with it.

In this work we shall perform usability evaluation to gather students' opinions/judgements regarding MAFHIL and also to determine how students can effectively use the app via their mobile devices to access course materials, download course materials, participate in e-testing, virtual course room discussion, registration of courses, etc and the contribution of MAFHIL to academic/research purpose.

3.1 Think Aloud Technique

Usability testing is a type of usability evaluation method that represents the participants and users working on typical tasks while interacting with a system (or the prototype) and the usability evaluators use the results to see how the user interface supports the users to complete their tasks. There are different methods that can be used for usability evaluation but according to the surveys the think aloud techniques is familiar and valuable for usability testing used by the usability tester and evaluators [10].

Sometimes it seems very difficult and unnatural for participants to keep the steady stream for expressing when they are using the system but it is the most valuable method to evaluate the usability of a system. The main benefits of Think Aloud technique is better understanding of the participant's mental model and their interaction with products. Its second benefit is the way of expression which the participants use in the experiments that are incorporated into the products designing or also into documentation for improvements [9][2].

In the Think Aloud technique, the participants have to perform a number of tasks in the experiments. During experiments, they have to verbalize their thoughts and experiences while interacting with the system and the observer observes and records their suggestions and comments on experiments.

[11]gave the merit and demerit of Think Aloud Technique as follows:

Merit: These tasks are performed in run time environment and all the values and comments are noted at the same time.

Demerit: It may be difficult to get all the participants think out aloud.

3.2 Experimentation

The adopted technique for the experiment was the Think Aloud technique which was applied on MAFHIL. Twenty (20) students were selected from the University, to participate in the test.

In testing the usability of MAFHIL, the students were asked to complete tasks on the MAFHIL and the task list was given to every participating student, which they performed during the usability test. According to the tasks list, the students participating had to interact with MAFHIL using their mobile devices. A total number of twenty (20) students participated in the experiment. The tasks that were given to the students to perform in the experiment are shown in Table 1.

Table 1: Task for Students

THINK ALOUD TECHNIQUE TASKS LIST FOR STUDENTS	
Tasks	**Actions**
Task 1	1. To login in to MAFHIL type in the Web browser address bar (http://mafhil.abuango.net/index) 2. Enter the your user ID and Password to login
Task 2	1. After login then click on "Register more" to register one or more courses 2. Follow the prompts to easily register any course 3. Repeat steps 1 and 2 to register as many courses as possible 4. Select any registered course then click on "Topics" to see the topics and other related course details 5. Click on "Dashboard" to return to the Student's dashboard
Task 3	1. Click on "See books" to view all available e-books/course materials 2. Click on "Download book " to download course material 3. Click on "Dashboard" to return to the Student's dashboard
Task 4	1. Click on "See All" to see all postings in the Forum 2. Click on "Create POST" to post a message in the forum 3. Click on "Comment" to add your own view on any post in the forum
Task 5	1. Click on the upcoming test (CS 142) link to see the details about that particular test (assessment) 2. To partake in the test press "Take Test" button and the test

	question will appear and the timer starts counting 3. Provide appropriate answer for each question, if it is multiple choice question then you are to select the correct option; if essay-type question then you are expected to type-in the correct answers. 4. After answering then press the "Submit" button to submit the test 5. In multiple choice question, test if after submitting the test is graded automatically and the score is displayed. 6. Repeat the step 1 again and you will be prompted with the message "You have already taken this test" 7. Click on "Dashboard" to return to the Student's dashboard
Task 6	1. Click on "Read All" to view all messages in the student's inbox (internal mails) 2. Click on "Compose" to send a message to a fellow student or Lecturer 3. Click on "Sent" to view all Sent messages 4. Open a message in the inbox to read and after reading click on "mark as unread" to return the status of the message as unread 5. When a message is open then Click on "Delete" to remove message from inbox 6. Click on "Dashboard" to return to the Student's dashboard
Task 7	1. click on "Update profile" to update a student's profile(here you can change student's detail) 2. click on the "Update" to save all changes made in the database 3. Click on "Dashboard" to return to the Student's dashboard
Task 8	1. click on "Sign-out" to exit from the application

3.3 Result of Experiment and Analysis

The results obtained from the experiment are as follows:

- all the students participating completed the tasks given them as specified in the task schedule.
- time taken to complete all tasks varied amongst participants in the range of 40 - 70 minutes.
- some participants had problems downloading course materials. In some instance, it took longer

time before they could download a material irrespective of the byte size of material, some could not download materials, while some other participants downloaded successfully and all these were attributed to internet connectivity problem.

From the result of the experiment, it was discovered that:

- By using MAFHIL, students can collaborate with one another to share data and ideas as they study a course or work on a project.
- The interface of the login page is very simple as it provides direct and clear instruction on how to login.
- By using the app students can have access to up-to-date course materials and can as well download them.
- With this application, there is no need for paper and pencil style of conducting assessment as it provides the platform for e-testing.
- Most students will no longer miss test in any course as the system is used to send prompt information/alert to students on upcoming assessment.

The major defect of the app as observed was in the area of course material download as not all participants were able to easily download course materials. It was also discovered that the app has no provision for participants to open or preview content of any course material before downloading it, which is a major requirement that has to be incorporated into the app. Screen shots of MAFHIL can be found in Appendix A.

3.4 Questionnaire for Usability Evaluation

Questionnaire is a well known tool used to collect demographic data and users' opinions. It consists of a sequence of questions which are structured together in a coherent manner so that they would be simple, clear and easy to understand. The questions to measure the user's satisfaction can be quite sophisticated. The questions in the questionnaire were carefully designed so that they give the clear meaning for which they are asked.

[12]said that questionnaire is used due to the following reasons: cost effectiveness; evaluator analyzes the usability issues by user's points of view and the last one is to make a reliable comparison on the basis of data gathered from questionnaire. It is designed to check the reliability, interactivity and usability aspect. For the evaluation of any system, the questionnaire is a very important tool that can be used to get data from users, it has been in use since 1990 as the cheapest tool for usability evaluation [9][13].

The questionnaire for the evaluation was carefully designed to elicit usability information from participants. It was distributed to the participants after the experiments. The questionnaire was designed to collect the users' understanding and experiences with MAFHIL. Twenty (20) students from the university of

Agriculture, Makurdi participated in the experiment the Statistics/Computer Science laboratory. The questionnaire was designed to measure the usability of the MAFHIL and students' judgement and requirements regarding it.

The selected criteria for the questions in the questionnaire for MAFHIL evaluation, are Satisfaction, Simplicity, Learnability, Aesthetic, Completeness, Consistency, Motivation, Error Prevention, Memorability, Reliability/Security, Predictability, and Adaptation.

The questionnaire was designed with the entire possible questions that support the task of finding out the students' opinions/requirements as well as usability issues. Closed-ended questionnaire was used in the course of this work; this can be found in Appendix B.

4. Evaluation Results and Analysis

The results obtained were derived after analyzing the collected data from students with usability evaluation methods. Two types of results are given in this evaluation, first is the result extracted from the Think Aloud (TA) technique which has been discussed already in section 3.3 while the second results were derived from the questionnaire.

4.1 Questionnaire Results and Analysis

Twenty (20) responses from students were collected. The students had different thoughts and thinking regarding MAFHIL, but they made relative comments that were very significant for the evaluation. Statistical Package for Social Science (SPSS) and MS-Excel 2007 were used to analyse the data collected from the questionnaires. Table 2 shows the feedback result obtained from the questionnaire administered on students. It indicated the percentage of the students' response against the criteria that were chosen for the evaluation of MAFHIL and also to find their opinions, requirements, comments in the use of MAFHIL for academic and research purposes. Each of the criteria is composed of one or more numbers of questions in the questionnaire that was distributed. The percentage for each criterion was obtained by computing the average percentage of all the questions that made up a criterion. Figure 2 and Figure 3 depicts the graphical representation of the responses obtained from the questionnaires administered.

Table 2: Feedback from students Questionnaire

| S/No.	Criteria	Questions	No. of response	Level 1: (Strongly Agreed) A	Level 2: (Agreed) B	Level 3: (Undecided) C	Level 4: (Disagreed) D	Level 5: (Strongly disagreed) E
1	Satisfaction	1,7,8, 10,18	20	52%	34%	8%	4%	2%
2	Simplicity	6,11	20	65%	20%	10%	5%	0%
3	Learnability	15	20	60%	30%	10%	0%	0%
4	Aesthetic	16	20	60%	40%	0%	0%	0%
5	Completeness	2	20	70%	10%	20%	0%	0%
6	Consistency	12	20	30%	60%	10%	0%	0%
7	Motivation	5	20	40%	40%	10%	10%	0%
8	Error prevention	14	20	60%	30%	0%	10%	0%
9	Memorability	19	20	40%	40%	10%	10%	0%
10	Security/reliability	3, 17	20	55%	30%	5%	10%	0%
11	Predictability	4	20	70%	20%	10%	0%	0%
12	Adaptability	9, 13	20	55%	25%	20%	0%	0%
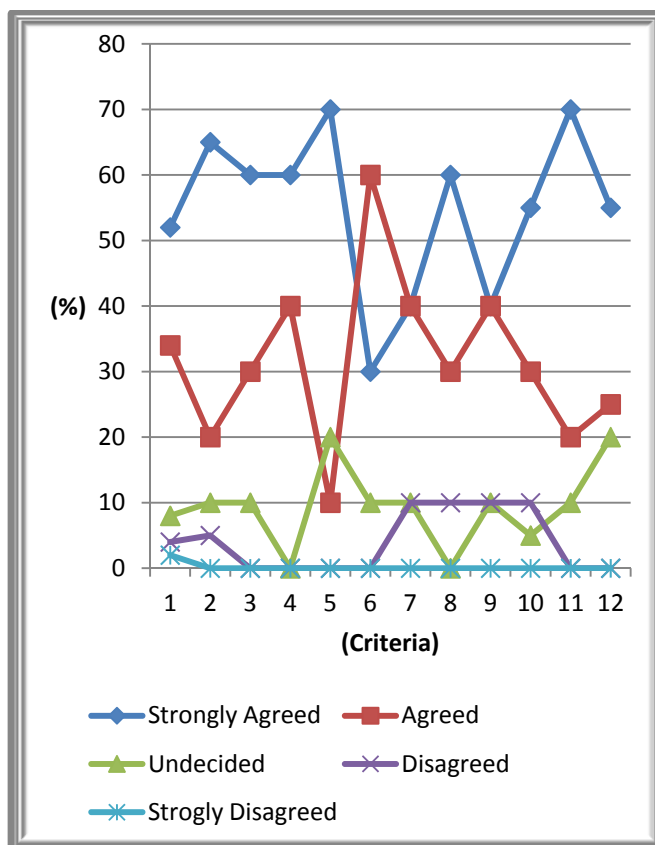
Fig. 2: Feedback from Students

Figure 2 depicts the weightage in graphical format where the given numeric values from 1 to 12 shows each criterion as illustrated in table 2.
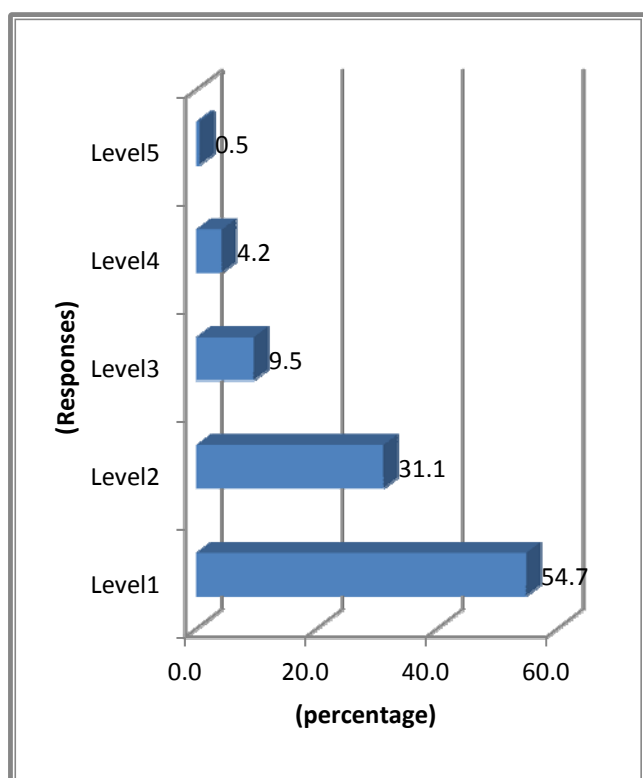

Fig. 3: Overall results of Questionnaire

Level1: Strongly agreed, **Level2:** Agreed, **Level3:** Undecided, **Level4:** Disagreed, **Level5:** Strongly Disagreed.

Figure 3 shows the overall result of the questionnaire with regard to the response levels of the students on the administered questionnaires. It showed that 54.7 percent of the students strongly agreed with statements in the questionnaires while 31.1 percent agreed and 9.5 percent students were undecided. In disagreed statements the percentage of the students is 4.2 percent and 0.5 percent students are in the category of strongly disagreed.

5. Conclusion and Discussion

This work analyzed the usability of the cloud-based mobile app (MAFHIL) and the Students' attitude and requirements towards the app. MAFHIL gives the students' the opportunity to explore the prowess of the cloud computing technology. Students from the University of Agriculture, Makurdi were selected for the usability testing and evaluation. None of the students' had a previous experience in using MAFHIL.

In gathering the student requirements, after due analysis of the results gotten from the experimentation various issues and difficulties came to light. The work showed the careful usability evaluation of MAFHIL in order to find the usability problems in the system and students opinion/requirements against these problems and services. The Think Aloud technique and questionnaires were used for the Usability evaluation. The results and statistics were derived from the usability testing and questionnaires. The result obtained from the evaluation showed that 85.9% of the students were on the agreed platform while 4.7% disagreed and 9.5% were undecided. The statistic clearly indicated that the app was accepted and that it had impact on the learning ability of the students. It further illustrated that the results obtained after the usability testing and evaluation the application passed the requirement for acceptance by the users and equally improved the performance of the students.
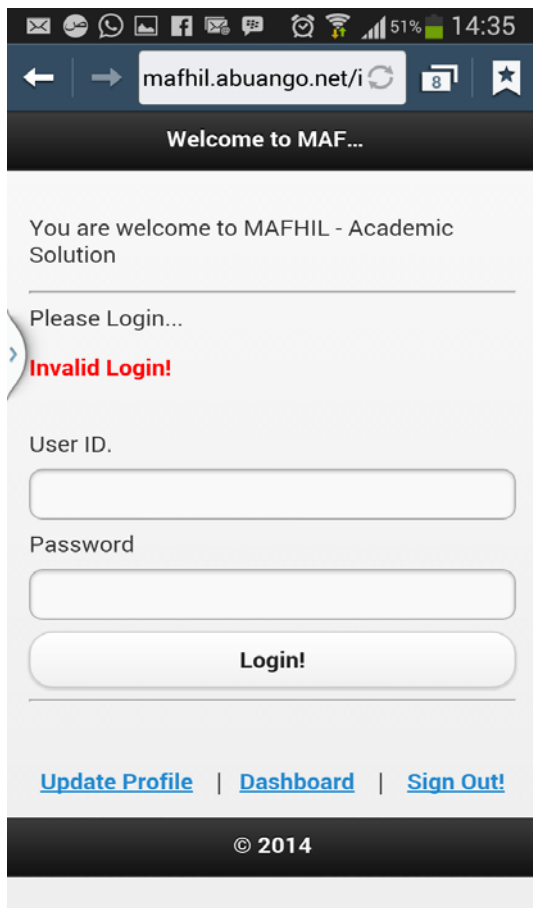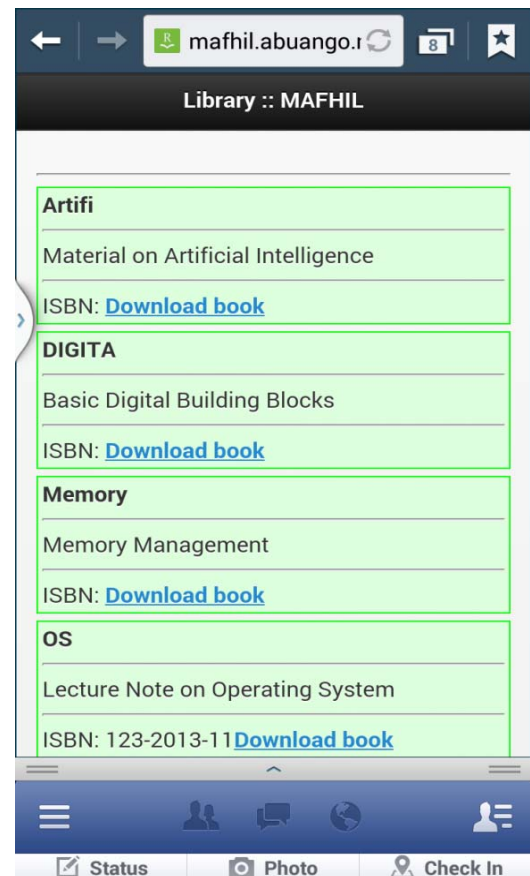
APPENDIX A

Fig. 4: login

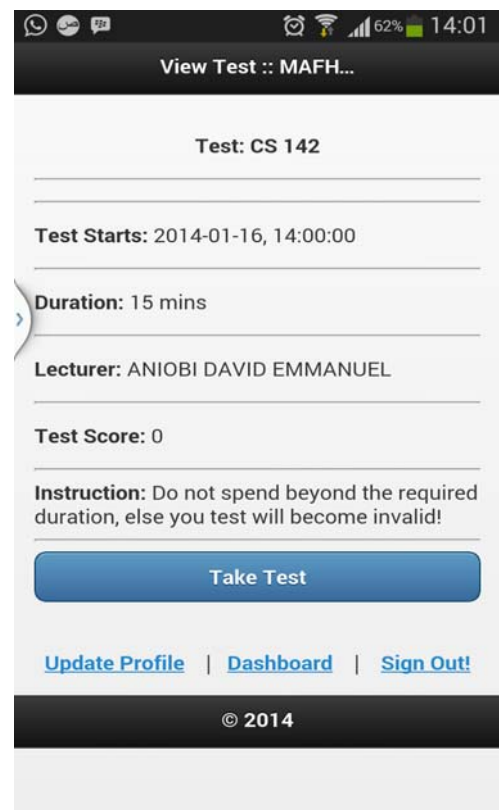Fig. 6: E-books download
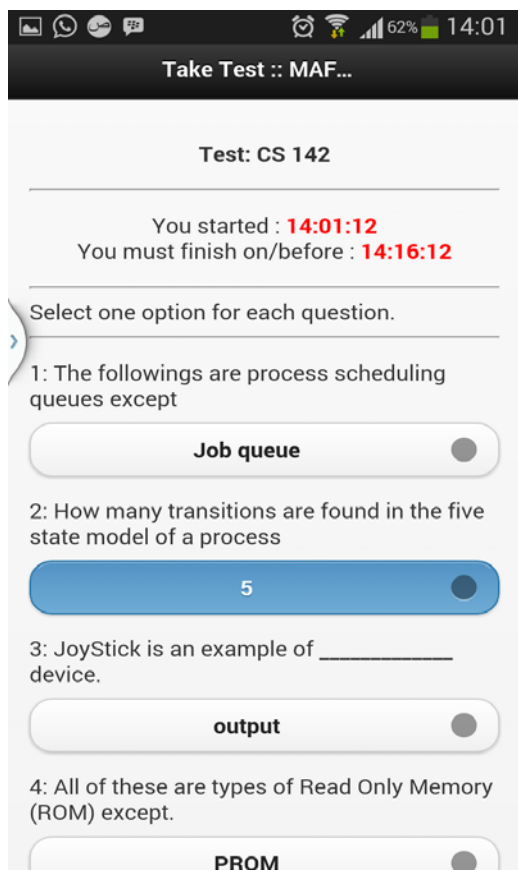

Fig. 5: Student Dashboard

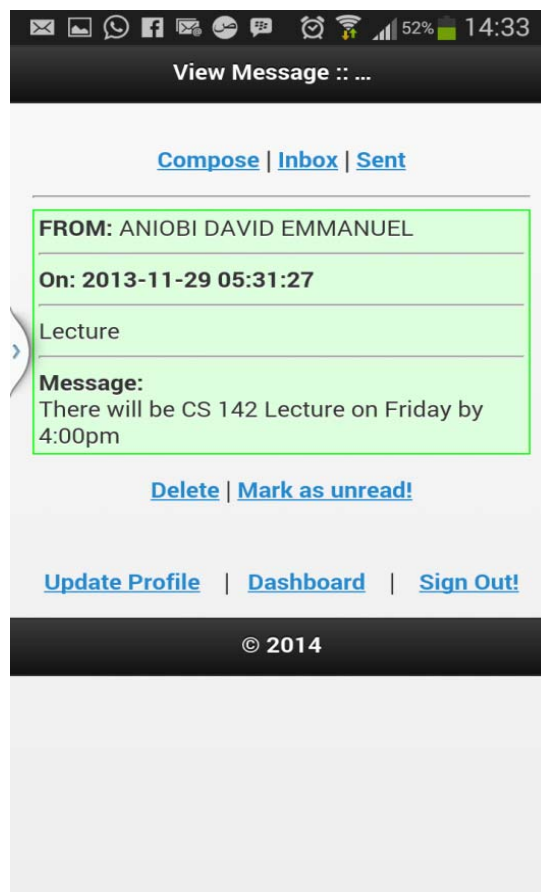Fig. 7: starting test

Fig. 8: Assessment(test) in progress

Fig. 9: messaging interface

APPENDIX B

The table below shows the number of statements used for evaluation.

Usability Evaluation Questionnaire for Students

MOBILE APPLICATION FRAMEWORK FOR HIGHER INSTITUTIONS OF LEARNING QUESTIONNAIRE

PURPOSE : This questionnaire evaluates the usability of the developed Mobile Application Framework for Higher Institutions of Learning (MAFHIL) prototype. MAFHIL is a mobile app meant for academic purposes. Your fair response is humbly solicited in the next few minutes.

S/No.	Questionnaire statements	Strongly Agree d[A] Level 1	Agreed [B] Level 2	Undecided [C] Level 3	Disagreed [D] Level 4	Strongly disagreed [E] Level 5
1	It makes course materials easily accessible					
2	It helps me to discuss my academic problems with fellow students and lecturers via virtual course room(i.e. Forum)					
3	Registered users login successfully and can easily update their profiles, unregistered users don't have access to the app					
4	Makes assessment (testing) easy and scores are promptly made available with regard to multiple					

	choice question testing					
5	It enhances academic process as it helps me to carry out most of my academic activities with ease					
6	Messaging (communication) among participants is easy(internal mail)					
7	I get instant message (SMS) about tests which has made it possible for me not to easily miss any test(assessment)					
8	Course materials are easily downloaded					
9	Learning with mobile devices is good and recommendable					
10	**MAFHIL** as a LMS, its use is satisfactory.					
11	It is simple to use and user-friendly					
12	The system is consistent					
13	I would recommend this framework to others					
14	I can easily recover from mistake while using it					
15	It is easy to learn how to use it					
16	Each of the interfaces is well designed and reading characters on each of the interfaces very effective					
17	It is secure and reliable to use					
18	It helps me to be more productive					
19	I can easily remember how to carry out tasks I had previously done on the app without a guide					

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