Online Assessment System

Performance Evaluation

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Abstract—Online Assessment has not gained much popularity in Nigeria, primarily due to the perception that it is less efficient as compared to the traditional method. However, its flexibility, convenience, and security, have proven otherwise. This work entails the implementation of an Online Assessment System in a tertiary Institution. The system performance is thoroughly tested in order to emphasize the need for adopting this new technology in Nigeria.

Keywords: Online Assessment; Web Application; Usability test; Website performance evaluation

I. INTRODUCTION

The advent of the Internet has led to many changes; to the way, we interact in school, at home, with our peers, in public places, while commuting, in fact, in almost every aspect of our lives. People now surf the web via computers and even mobile phones. Online assessment is presently conducted in almost all institutions in developed countries. Of course, exam in tertiary institution is a big challenge [1], as it requires large human resource, funding, structures, security and means of ensuring integrity. Thus, the Internet and its flexibility, offer a way of reducing the problem associated with the former way of assessment. Online assessment is not a new thing to Universities worldwide. Unfortunately Nigerian Universities are still reluctant to leave the traditional form of assessment for this modern flexible and more secured form of examination. As a result, this paper is aimed at developing and implementing an online assessment system in a tertiary institution here in Nigeria. Then the system is evaluated thoroughly in order to quantify its level of acceptance and the possibility of deployment in other institutions around the country.

II. RELATED WORK

In their article Rashad et al implemented and tested An Arabic Web-Based Exam Management System at Mansoura University. The application also computes students’ grade automatically after the exam. PHP, MySQL, and JavaScript were the development tools used [2]. However, only multiple-choice questions were supported by the system.

In his paper Vantaggiato, used the World Wide Web as a ubiquitous interface, using Lisp HTTP Server two experiments were made: An online Lisp Programming test, and advanced form of the first where online multiple choice exams was created. Scores were graded and displayed to the user [3]. The experiments did not allow a user to upload assignments and unfortunately Lisp has been criticized to have low efficiency, and its syntax is harder to read [4].

Running on Microsoft. NET framework, C#, ASP.NET web server, and Microsoft SQL Server were used for the development of an online multiple-choice exam at Ahmadu Bello University, Nigeria [4]. The drawbacks of the system include; ASP. Net is platform dependent (Windows), the database is not open source, and its performance is relatively below that of MySQL [6]. In addition only the ‘multiple choice’ type of examination was supported.

In an MSc thesis [7] Tadesse, developed a web-based distance learning tool using java. The system allowed a user to access text-based learning material, as well as to take a chapter test. The system also had a chat functionality which made communication between tutors and students easy. Unfortunately, besides the chapter test, the system does not provide a means of general/overall general/overall course exam. In addition the chapter test only supported multiple-choice questions.

An article by Bernardo et al illustrated online tutoring of medical students for a period of five weeks. The students were taught surgery via online reading, discussions, and online video quizzes. At the end of the online course, student’s level of understanding was promising, and the key factor was found to be the video quiz. The research also proved that undergraduate medical students could be thought and assessed online [8].

A paper presented by Hlaing at 2009 International Conference on Computer Engineering and Technology [9], a framework to allow students to carryout online assessment via a mobile user agent was developed. Security of the mobile agents was ensured by the use of public key and digital signature.

Prajapati, a Software Developer and Trainer at Mehsana - Gujarat India also developed an online exam system with the sole aim of tackling problems (time constraint, human error) associated with the manual system. The web application was developed using .NET Framework 3.5 and Microsoft access database [10]. The system allows an admin to add trainers and students, while the trainer is able to create text/questions. Unfortunately, MS access has disaster recovery, and performance draw backs, relatively small capacity (2 GB), and only supports 0-255 multi-users [11].

A research conducted at Pakistan using IT professionals (as sample), from a hundred companies revealed that staff
employed via objective online test did not get rapid promotion as compared to those who were employed after subjective assessment. It was therefore recommended that subjective skill test should also be implemented online in order to achieve the pros of online objective tests [12]. There is therefore, the need to develop online assessment systems other than the ‘multiple choice’ type.

However, object oriented design has proved to be more efficient methodology for software development. Its key features include; reusability, platform independence, and maintainability [13]. There is also much documented literature on online examination system which has been implemented using the OOD:

Using Visual studio as development tool, ‘CITO’ a Dutch based software company developed and managed online multiple choice exams for schools in Netherland [14]. In order to reduce the workload on English Teachers, an online exam system was developed by Xiaoyu and Yunhao[15], using Struts framework which is an open source web application used with JavaServer Pages(JSP) [22]. Based on J2EE platform and Model-View-Controller design the system’s reusability and maintainability were improved [15].

Furthermore, an object-oriented online examination system has been developed by Bo Hang [16], using Eclipse as the IDE and MySQL as the database management system. It was observed that the OOP Design made the application flexible, user friendly, and easier to maintain.

III. DEVELOPMENT

Being a very important phase of software development, the design of the application’s architecture was given much consideration. As stated by [17] architectural design involves a breakdown of the application into modules, thereby increasing the system’s ease of maintenance and reuse. The three-tier architecture was chosen due to its numerous advantages and popularity [17 - 19]. Three-tier architecture breaks the system into three parts; presentation, business, and data tiers [7]. The presentation tier also client tier interacts directly with the user; it’s the interface the user sees on his web browser. Data tier also called database tier is responsible for storing data which are either sent for or retrieved by the user. One important feature of the three architecture is the business or middle tier which accepts request from the client and sends it to the data tier, on the other hand response from the data tier are relayed to the user via the business tier [20].

Next the web application development tools were chosen to suit the architecture mentioned above. For the presentation tier, HTML written on Macromedia Dreamweaver MX 2004 as a text editor is used for designing the mark up used to convey output to the user via his web browser.

For the business or logic tier Hypertext Preprocessor (PHP) is used as the server side script, this selection was made due to its numerous advantages, which include: its open source hence free, easier to get bugs fixed [20], easier to learn, and can be sandwiched into the HTML code. However, the ease of writing PHP codes within HTML has its demerits, which include maintenance difficulty and violation of the modularity of the architecture. In this research Smarty template engine for PHP is used to separate the presentation tier (HTML) from the business tier [20, 21].

Another software used in the business tier is a web server. Its two main functions are to accept http request from the user's web browser, and to serve the resources fetched from the hosting server on to the client's browser [11, 12]. The web server of choice is Apache web server, it is open source and the most popular in the world. According to Netcraft web server survey of April 2012, apache is the most popular with 65.46% of the active sites using it [22].

The database management software used is MySQL, been an open source; in fact, its performance cannot be over emphasized.

Object oriented methodology was used for the implementation, because it produces more stable and maintainable software over time [23, 24]. The system’s requirements were decomposed into objects using a use case diagram (see Fig.1 below). It is obvious that the system has three categories of users, each having different levels of privilege: Student, Staff/Teacher, and admin.

![System’s Use Case Diagram](http://www.ijsat.com)

Fig. 1: System’s Use Case Diagram

IV. EVALUATION & DISCUSSION

Define Testing is of utmost importance in software development, hence it is carried out right from the start of the software development, and intensely after the implementation phase of the software development life cycle (SDLC) [17]. Insufficient and reliable Web application testing may eventually lead to a very big loss. Thus, the importance of conducting a thorough test for the online assessment system cannot be over emphasized.

During the course of implementation, most of the functionalities were developed as small chunks of code. Both the client side and server side scripts were tested via the unit test technique [25]. Also called developer testing, Unit testing helps to reduce the likelihood of encountering
errors when the pieces if code are integrated. Even though some people perceive that writing unit tests is an extra work, added difficulty, and waste of time, it has proven very important and time saving during code maintenance and debugging [25, 26]. Two frameworks were employed for unit testing the codes; QUnit framework for the client side scripts [27], and SimpleTest for the PHP server side scripts [28].

To thoroughly evaluate the application, the test was divided into six: Functionality test; Interface test; compatibility test; Performance test; Security test; and Usability test [4, 17]. Functionality test entails evaluating the new system, to ensure it conforms to the functional requirements. Furthermore, it entails four or more sub tests. The online assessment was tested to ensure all its functional requirements had been met. Then using ‘total validator’ one of the numerous web application testing tools available on the Internet [29], the application’s XHTML and CSS were validated, broken links and spellings were checked as well. Furthermore the XHTML and CSS were again validated using the W3C validation service [39] to make sure the application’s structure conformed to the world wide approved standard.

In order to ensure the system worked well on different platforms, two major compatibility tests were conducted as stated by Bukar [17]; browser and resolution compatibility tests were conducted. Five of the world’s most popular web browsers [30] as well as common screen resolutions were used for the test.

According to Shaw [31], web performance test is a measure of a web application's response time and delay. Since the developed system is intended to be used by an institution, there is the likelihood of having separate classes of students taking two or more online assessments at a point in time. Hence, web application loading speed and response time, are factor's worth considering. It will be unbearable and even a possible cause of panic, if a student taking an exam has to wait time and again for the page to load sluggishly. After all, students are subjected to limited time; hence any form of delay could affect their performance negatively. Hence, there is the need to test the system on load and during peak times. For the purpose of the aforementioned test, the tools used were; Neustra Web Performance Management, Page speed Firefox add-on, and Yslow.

YSlow and page speed are Firefox add-ons developed by Yahoo and Google respectively. These tools help reduce page loading time by grading the web page's speed as well as suggesting ways of improving the speed best on some best performance practices [32, 33], the tools go further to suggest ways of improving the performance. As stated by [33], Yslow test is conducted based on 34 rules (Minimization of HTTP requests, avoidance of empty src or href, and Reduction of DNS looks ups to mention but a few). These rules were identified by yahoos's web application performance team. On the other hand, page speed is a Firefox add on that is usually integrated into Firebug, it was initially used by Google developers to improve their page speed [34]. The tool works on some rules known as best performance practices aimed at improving the web page's performance. The rules which are categorized into six: request time minimization; caching optimization, payload size minimization, round trip time minimization, request overhead minimization; and web browser rendering optimization [33].

Initially, the Yslow test (YSlow 3.1.4) conducted gave an output of 82%, while the page speed (Page Speed 1.12.9) test score was 79%. After implementing the corrections suggested by the tools, the loading performance improved tremendously. Both tools reveal a better grade; 98% and 94% for Page Speed and YSlow respectively.

In addition, a web page test was conducted via the online tool provided on http://www.webpagetest.org/ [35]. The tool allows one to run web speed test from different locations of the world. Furthermore, it is conducted using the world’s most popular browsers. As stated on http://www.webpagetest.org/ “results will provide rich diagnostic information, including resource loading waterfall charts, Page Speed optimization checks and suggestions for improvements.”

Link Vendor professional SEO tools provide an online website speed checking tool [36]. The tool measures the duration (in seconds) that takes a website to load. Furthermore, it shows the estimated loading time for different types of Internet connections: Modem; UMTS; DSL; T1; and T3 connections. From the output shown below; the websites average speed is 0.5s, the result also reveals that to achieve higher loading speed T1 and T3 connections provide the best results of 0.08s and 0.03s respectively. Similar to the website speed checker is another online web monitoring tool; Octagone SiteTimer [37]. The web performance tool checks the speed at which a user accesses one or more of the website's pages. Amongst its numerous advantages is the fact that it estimates the time taken for each component (image, scripts, frames, and other resources) to load. The test was conducted on the home page of the online exam system, from the results obtained, image size optimization, page size reduction, and usage of HTTP compression to mention but a few were the recommended performance improvement techniques stated on the website [37]. As a result of that the home page speed was reduced to a relatively appreciated.

As defined by [38] usability testing is an assessment of the ease at which the intended user of the software interacts with it. The test is important because it determines whether a user will go on to use the software or not. As in the case of Online Assessment System, a bad interface could even affect the students’ performance. There are several ways of conducting usability test, but the best method is to use the audience for which the software has been developed as the participants. This is because the perception of the excellence of an application may vary from person to person. Hence, it is important to conduct the test on a specific group of user's who have much in common.

For the purpose of this research, the usability test was carried out on a group of 300 hundred students, and via the use of online feedback form which the students filled at the end of the exercise: The first hundred students were split into two, where each half took the Multiple-Choice Questions (MCQ) assessment in Mathematics and Chemistry (50 for each); The second group of 100 students was also split into two halves, and each half took the Fill in the Blank (FIB) assessment on Biology and Human Anatomy respectively; The Last thirds were given the task of uploading assignments in pdf, doc, and docx formats.
only. Submission deadline was specified. The results of the feedback retrieved from the participants are summarized as shown below (Table 1).

Method of presentation of the summarized test result(s) used by [17] was used. Thus, user response were categorized into three: Positive, Neutral (Indifferent), and Negative.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Positive (%)</th>
<th>Neutral (%)</th>
<th>Negative (%)</th>
</tr>
</thead>
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<tr>
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<td>9</td>
<td>7</td>
</tr>
<tr>
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<td>5</td>
</tr>
<tr>
<td>Font Face</td>
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<td>6</td>
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<td>87</td>
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<td>13</td>
<td>14</td>
</tr>
<tr>
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<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Ease of Upload</td>
<td>89</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Satisfaction with Grade</td>
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<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**V. CONCLUSION**

A fully functional Online Assessment System was successfully developed. Unlike most systems of the literature, it was made of MCQ and FIB assessments. The system was thoroughly tested, and results obtained, reveal that it is highly accepted by the students of Gombe State University. The graphical user interface, performance, as well as acceptance of the grading, show that deploying the application in Nigerian Tertiary Institutions is feasible.

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[27] D. Sheiko. "Ins


