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Design of Single-User-Mode Computer-Based Examination System for Senior Secondary Schools in Onitsha North Local Government Area of Anambra State, Nigeria

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Abstract

This work is concerned with the design of a single-user-mode computer-based examination system. It focused on trends in online computer-based examination and carried out a critical review of current paper-based test systems employed in Senior Secondary Schools in Nigeria. An alternative system to provide solutions to the current

challenges identified in the existing system was then proposed. The system was designed using the object SSADM methodology and implemented using rapid PHP IDE on a Windows 10 system, using PHP, HTML, CSS and MySQL technologies and Apache server as the application server. Source Code folder for the designed CBT system is available at <https://villagemath.net/journals/ver/v3i1/ABAH-HONMANE-AGE-OGBULE-CBT.zip> with the Installation Guide and Setup information provided in Appendix A.

Keywords: Computer-Based Testing, Single-User CBT System, Senior Secondary Education, PHP, HTML, MySQL, CSS

Introduction

In education, an examination is a test to show the knowledge and ability of a student. A student who takes part in an examination is a candidate, the person who decides how well the student has performed is the examiner. Habour-Peters (1999) defined examination as a systematic process of determining the extent to which instructional objectives are achieved by the learners. In her definition, she emphasized that the fact that, examination is a systematic process that is controlled with the aim of observing behavioural changes in the learner.

Maduka (1993) defined examination as a way to ascertain how much of a subject matter in a particular field of study the candidate has mastered. Homby (1995) defined examination as a formal test of somebody's knowledge or ability in a particular subject, especially by means of answering questions or practical exercises. Balogun (1999) also defined examination as the process through which students are evaluated or tested to find out the quality of knowledge they have acquired within a specified period.

Nnam and Inah (2015) notes that examination is a yardstick against which students' competence and progress are formally measured and appraised in the education sector. According to Emaikwu (2012), examination as part of evaluation in education is aimed at determining a learner's level of skill acquisition or intellectual competence and understanding after a given training. Evaluation usually enables the teacher to be effectively ready for further teaching as this forms a feedback.

Examination are used by schools to test how well a student have understood key concepts and topics covered in subjects they have been taught. They may be required to do one or a combination of the following examination forms:

- i. *Essay Examination:* This form of examination is also known as supply-test types or false report questions. These are questions in any subject area to which the student is required to provide short or extended written answers. In essay examination the student supplies the answers depending on the amount of freedom of response he/she is allowed, and show how theories have contributed to the knowledge areas.
- ii. *Objective Examination:* This is also referred to as selection type examination. The student is expected to either select the possible answer from a number of

available alternatives or required to answer the question by supplying a phrase, number or symbol.

- iii. *Oral Examination:* This form of examination is used to test the ability of the student to verbally key concepts, theories and ideas covered in a subject.
- iv. *Practical Examination:* This form of examination tests students on practical skills and techniques required for laboratory, clinical settings etc. Usually the tasks they are asked to perform is straight forward. A student will perform well in a practical exam if he/she reports the methodology and observations accurately

Examinations can be deployed in different types, though the two major types are the Paper-and-Pencil Test (PPT) and the Computer-Based Test (CBT). The first type, Paper-and-Pencil Test (PPT), has been the major type of examination used in Nigerian secondary schools. This type of examination refers to traditional student assessment formats such as written tests that ask students to use pencils to fill bubbles on a scannable answer sheet. In the classroom, PPT examination refers to examinations scored objectively, which are meant to measure memorized knowledge and lower levels of understanding. Fredeirco (1989) refers to PPT as a general group of assessment tools in which candidates read questions and respond in writing. This includes tests, such as knowledge and ability tests, and inventories, such as personality and interest inventories.

The inherent problem of the PPT type of examination the high rate of malpractice. Alutu & Aluede (2006) cited in Jimoh (2009) remarked that malpractice is any irregular behaviour exhibited by a candidate or anybody charged with the conduct of examination before, during or after the examination that contravenes the rules and regulations governing such examination. It is easy to involve in examination malpractice in the PPT type of examination. The forms of malpractices includes bringing in unauthorized materials, copying from other candidates, changing of scripts during exams, changing of scores by teachers, removal of booklets from the exam hall, writing on body parts, writing on walls and desks, and delay in result presentation. The delay in the process of providing final result is tedious due to manual marking, inconsistencies in marking, possible loss or damage of some scripts, and increased financial implications to conduct the exam.

Thus, there is the need for Computer-Based-Test (CBT). It is widely believed that, the PPT is marred with great irregularities including the ever increasing case of examination malpractice in each passing year amongst others, forcing examination bodies like the Joint Admissions and Matriculation Board (JAMB) to constantly improve, sought for replacement and a more effective examination method. All thanks to technological innovations, CBT came to the rescue to improve on the ever increasing challenges of traditional method of examination, PPT.

CBT provides several advantages over PPT including ease and flexibility of administration and grading of tests, as well as allowing for the development of novel technology-based testing environments (DeBoer *et al.*, 2014). CBT is aimed at overcoming the limitations of PPT and become a better agent in the administration of examinations in our educational system especially at the senior secondary school level.

The computer as a tool has permeated all spheres of human activities. The areas we see today includes deployment of computer systems in the process of teaching and learning in schools and provision of academic materials as well as provision of several innumerable tools for accessing these materials on the internet (Iji & Abah, 2018). According to Sadiq and Onianwa (2011) it is becoming common place to see institutions across the educational strata adopt the computer based test and assessments to admit or screen students for entrance into their institutions.

CBT is therefore simply testing/examinations conducted or delivered through the use of computers or computer related devices. The examination is thus based on technology and technology related devices. It may be conducted in a hall, but it has restrictions to one person per test and with a particular system. The environments are usually controlled and monitored from a server. For the ubiquitous tests available to students today, examination conduct and monitoring pose a severe challenge to any manager in the academic sector hence it has become necessary to modify our examination deployment methods. It is against this background that this study seek to address the challenges of the existing examination system by developing a more reliable and efficient system in the mode of a computer-based examination system.

Purpose of the Study

This research work aims at finding a modernized way of conducting examination for senior secondary schools in Onitsha North LGA of Anambra State, Nigeria. Specifically this study will seek to:

- i. Find out the core technologies powering the designed single-user-mode Computer-Based Examination system.
- ii. Find out the Back-End requirements of the designed single-user-mode Computer-Based Examination system.
- iii. Find out the Front-End requirements of the designed single-user-mode Computer-Based Examination system.
- iv. Find out the Use Case diagram of the designed single-user-mode Computer-Based Examination system.
- v. Find out the Class diagram of the designed single-user-mode Computer-Based Examination system.

Research Questions

The following research questions were raised to guide the study:

- i. What are the core technologies powering the designed single-user-mode Computer-Based Examination system?
- ii. What are the Back-End requirements of the designed single-user-mode Computer-Based Examination system?
- iii. What are the Front-End requirements of the designed single-user-mode Computer-Based Examination system?

- iv. What is the Use Case diagram of the designed single-user-mode Computer-Based Examination system?
- v. What is the Class diagram of the designed single-user-mode Computer-Based Examination system?

Literature Review

Theoretical Frame Work

Structured Systems Analysis and Design Model (SSADM)

The design of the system is based on Structured Systems Analysis and Design Model (SSADM). It is a set of standards for system analysis and application. It uses a formal methodical approach to the analysis and design of informative systems. It was developed by Learmonth Burchett Management System (LBMS) and the Central Computer Telecommunications Agency (CCTA) in 1980-1981 as a standard for developing British database projects. The SSADM is an open source methodology based on the waterfall model. It has been used by many commercial businesses, consultants, educational establishments and other various app developers. SSADM follows the waterfall cycle model starting from the feasibility study to the physical design stage of development. One of the main features of SSADM is the intensive user involvement in the requirements analysis stage. The users are made to sign off each stage as they are completed assuring that requirements are met.

Edwards, Thompson and Smith (1989) presented results of a survey conducted in 1987 on the use of SSADM in commercial and government sectors in the United Kingdom. The purpose of this survey was: to find out the degree to which the users of SSADM felt that the requirements and principles of the methodology had been met, to determine specifically whether practitioners would welcome the development of a formalized interface between the SSADM and JSP methodologies, to find out if SSADM will be a highly used methodology in the future, to find out areas for further research. Of the 310 organizations contacted only 72 or 23% returned forms that contained responses suitable for analysis. Of those organizations that responded, 68.1% used SSADM, 26.4% used LSDM (Learmonth Structured Design Methodology) and 5.6% used other variations of SSADM. Most of the organizations were civil service organizations (58%) using ICL computers, COBOL (64%) and 4GL (51%) programming languages and the IDMS database management system (53%). The automated tool that received the greatest use was Automate (Plus) (76%). SSADM was used mainly on projects that involved Commercial (DP) (70%), and Database (31%). SSADM techniques such as Data Flow Diagrams, Logical Data Structures, and Relational Data Analysis were found by 59, 54 and 42 respondents respectively to be effective.

The three most important techniques that are used in SSADM are as follows:

- i. Logical Data Modelling: The process of identifying, modelling and documenting the data requirements of the system being designed.
- ii. Data Flow Modelling: The process of identifying and documenting how data moves around an information system.

- iii. Entity Event Modelling: A two-stranded process; Entity Behaviour Modelling, identifying, modelling and documenting the events that affect each entity and the sequence in which these events occur, and Event Modelling, designing for each event the process to coordinate entity life histories.

Stages of SSADM

The SSADM method involves the application of a sequence of analysis, documentation and design tasks concerned with the following:

- i. Stage 0 - Feasibility Study: In order to determine whether or not a given project is feasible, there must be some form of investigation into the goals and implication of the project. At this stage the study outlined the aims and goals of the proposed system and investigation carried out to confirm the usability of the proposed system.
- ii. Stage 1 - Investigation of the current environment: The developers of SSADM understood that in almost all cases there is some form of current system even if it is entirely composed of people and paper. Through a combination of interviewing employees, circulating questionnaires, observations and existing documentation, the analyst comes to full understanding of the system as it is at the start of the project. The study applied the interview and observation method to investigate the problems of the existing system.
- iii. Stage 2 - Business System Options: Having investigated the current system, the analyst must decide on the overall design of the new system. To do this, he/she, using the output of the previous stage, develops a set of business system options. The study designed the system using the output from the previous stage.
- iv. Stage 3 - Requirements Specification: This is probably the most complex stage in SSADM. Using the requirements developed in stage 1 and working within the framework of the selected business option, the analyst must develop a full logical specification of what the new system must do. The specification must be free from error, ambiguity and inconsistencies. At the stage the specifications of the proposed system are outlined.
- v. Stage 4 - Technical System Options: This stage is the first towards a physical implementation of the new system. Like the business system options, in this stage a large number of options for the implementation of the new system is generated. The new system is first tested at this stage by implementing it using the XAMPP local server.
- vi. Stage 5 - Logical Design: Though the previous level specifies details of the implementation, the outputs of this stage are implementation-independent and concentrate on the requirements for the human computer interface. The logical design specifies the main methods of interaction in terms of menu

structures and command structures. Use case and class diagrams were used to design the system logically at this stage

- vii. Stage 6 - Physical Design: This is the final stage where all the logical specifications of the new system are converted to description of the system in terms of real hardware or software. At this stage all the modules of the system were integrated together to form a functional system.

Conceptual Framework

Examination

An examination is a test. Many things may be examined, but the word is most often used for used for an assessment on a person. It measures a test taker's knowledge, skill, aptitude, ability or standing in some other topic. The western knowledge acquisition system or formal education is measured on certificates. Yet, certificate is not a full proof of knowledge retention. Before certificate is awarded, the students have to be assessed or examined in the field they have been trained. Nnam & Inah (2015) notes that examination is a yardstick against which students or candidates' competence and progress are formally measured and appraised in the education sector. According to Emaikwu (2012), examination as part of evaluation in education is aimed at determining a learner's level of skill acquisition or intellectual competence and understanding after a given training. Evaluation usually enables the teacher to be effectively ready for further teaching as this forms a feedback. George & Ukpong (2013) opines that examination is the most common tool around which the entire system of education revolves, it is the instrument used to decide who is permitted to move to the next academic level. Malik & Shah (1998) cited in Akaranga & Ongong (2013) observed that examination is not only a process of assessing the progress of students but, it also motivates and helps them to know their academic strengths and weaknesses apart from providing teachers with opportunities to try new methods of teaching. But when examination is not properly conducted, the expected feedback may not result. Hence, the result of such evaluation leads to wrong decision and judgement which affect the teacher, the learner, the entire education industry, as well as the society (Ojonemi *et al.*, 2013). Whenever there is examination irregularity or malpractice, the validity and resulting outcome is questionable. The paper and pen (manual) method of writing examination, which has been in existence for decades, may not be appealing for use because of the problems usually experienced including examination venue capacity constraints, lack of comfort for examination candidates, delay in the release of results, examination malpractices, cost implication of printing examination materials and human error. The traditional method of writing exam is fraught with many fraudulent practices such as leakage of papers which often time is measuring impersonations of candidates by syndicates, lecturers or invigilators and sometimes those in higher authorities such as supervisors and management staff requesting stratification and bribe (Olawale & Shafiq, 2010). This brings about the need for automation of the examination system.

Computer-Based Test (CBT)

Computer-Based examination is an online examination that many educational institutions use to checkmate students' performance. These examinations may be administered at any

level of education from primary to higher institutions, although they are common at the higher levels. This research is focused on senior secondary II classes especially in Computer Studies. Computer-Based examination system serves three main purposes:

- i. To allow flexibility in the method of writing examinations in senior secondary classes.
- ii. Through careful planning and proper coding, enable the integration of database with the program, allowing the administrator to navigate the system easily.
- iii. To eliminate or reduce to the barest minimum, the menace of examination malpractice.

Technologies for CBT

The main building technology of the application, Computer Based Testing System is the HTML, The HTML is the mark-up language used to describe and define the content of web page. The HTML is used to tell the browser what to display on the page, like appearance of text such as bold or italics text and also used to specify images. The main HTML features used were form and Cascading Style Sheet. The form was used to collect LOGIN data, username and password-from a user and a submit button (Login) to send the collected data to a web document to act on the data.

The styling of the application was done using CSS. This include the Layout, Link Styling, Colouring, Picture Alignment and Menu Building.

Cascading Style Sheets (CSS) is a style sheet language used to describe the look and formatting of the document written in HTML. Presentation of information to the user by the browser was controlled by means of Cascading Style Sheet. Cascading Style Sheet is a cornerstone specification of the web and was used in the application to describe their presentation. CSS was designed to enable the separation of document content from document presentation, including elements such as the layout, colors, and fonts. This separation can improve content accessibility, provide more flexibility and control in the specification of presentation characteristics, enable multiple pages to share formatting, and reduce complexity and repetition in the structural content (such as by allowing for table less web design). It avoids those portions of markup that would specify presentation by instead, providing that information in a separate file. For each relevant HTML element (identified by tags), it provides a list of formatting instructions.

JavaScript is combined with HTML and CSS to create a dynamic HTML pages. JavaScript is commonly used on the internet to create web pages that respond to user actions, like when user moves a mouse pointer over an image or clicks a form button. JavaScript was used for the client side scripting and security, it was also integrated with JQUERY and AJAX to create Model Windows used in the application like:

- i. Generating Print preview display
- ii. To ensure the registrant does not submit empty forms

- iii. To ensure that the information requested is what the user enters using the JAVASCRIPT regular expression to match the data submitted.

The connection to the database was done using the scripting language PHP. In the project, PHP was used for Handling data validation; Editing and Deleting information in the database; Database connectivity; and Managing Scripting Functionality.

PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. PHP is used in the application to access database and provide server-side form, because it is closely integrated with MySQL database, open source, light weight and does not consume much server resources to render page. PHP code can be simply mixed with HTML code, or it can be used in combination with various templating engines and web frameworks. PHP code is usually processed by a PHP interpreter, which is usually implemented as a web server's native module or a Common Gateway Interface (CGI) executable. After the PHP code is interpreted and executed, the web server sends resulting output to its client, usually in form of a part of the generated web page – for example, PHP code was used to generate a web page's HTML code, an image, and some other data.

The database used for storing information in this project application is MySQL. Working together with PHP is MySQL, most widely used open-source relational database management system (RDBMS). The SQL phrase stands for Structured Query Language. MySQL is a popular choice of database for use in web applications, and is a central component of the widely-used LAMP open source web application software stack (and other 'AMP' stacks). LAMP is an acronym for Linux, Apache, MySQL, Perl/PHP/Python. Both PHP and MySQL instructions are used in this application are used together in the code to open the database, establish connection between it and the HTML code to insert data, retrieve data, delete data, etc.

XAMPP is a free and open source cross-platform web server solution stack package developed by Apache Friends, consisting mainly of the Apache HTTP Server, Maria DB database, and interpreters for scripts written in the PHP and Perl programming languages. XAMPP stands for Cross-Platform (X), Apache (A), MariaDB (M), PHP (P) and Perl (P). It is a simple, lightweight Apache distribution that makes it extremely easy for developers to create a local web server for testing and deployment purposes. Everything needed to set up a web server-server application (Apache), database (MariaDB), and scripting language (PHP) is included in an extractable file. XAMPP is also cross-platform, which means it works equally well on Linux, Mac and Windows. Since most actual web server deployments use the same components as XAMPP, it makes transitioning from a local test server to a live server extremely easy as well.

Empirical Studies

There is a growing body of research focused on developing better ways to manage e-exams Systems. Web-based Examination System is an effective solution for mass education evaluation as observed by Zhenming, Liand and Guoha (2003) who developed a novel online examination system based on a Browser/Server framework which carries out the examination and auto-grading for objective questions and operating questions, such as

programming, operating Microsoft Windows, editing Microsoft Word, Excel and PowerPoint, etc. It has been successfully applied to the distance evaluation of basic operating skills of computer science, such as the course of computer skills in Universities and the nationwide examination for the high school graduates in Zhejiang Province, China. However the system has a major limitation which was the absence of a relational database, the scores of candidates for a course gets deleted once another set of questions gets uploaded. The information of candidates were not saved on the system which led to creation of new profiles for every new exam. This research work seeks to address this limitation by developing a system with a relational on which data can be save and accessed whenever the need arises.

Another study by Rashid, Majid and Yen (2002) proposed web based online examination system. The system carries out the examination and auto-grading for students' exams. The system facilitates conducting exams, collection of answers, auto-marking the submissions and production of reports for the test. It supports many kinds of questions. It was used via Internet and is therefore suitable for both local and remote examination. The system could help lecturers, instructors, teachers and others who are willing to create new exams or edit existing ones as well as students participating in the exams. The system was built using various open source technologies AJAX, PHP, HTML and MYSQL database are used in this system. An auto- grading module was generalized to enable different exam and question types. The system was tested in the Mansoura university quality assurance centre. The test proved the validity of using this kind of web based systems for evaluates students in the institutions with high rate of students. The study differ from the present work in the use of web hosting services and dependence of internet availability which will be problem in remote areas that don't have strong internet network reception. On the other hand the current system is developed to be used without dependence on internet connection. It can be used easily in any location whether rural or urban area. It is also cheaper to set up due to the absence of web hosting and domain name fees.

El Emary and Al Sondos (2006) developed an online website for tutoring and e-examination of economic course aimed to present a novel software tool can be used for online examination and tutorial application of the syllabus of economic course. Also, among the main interests of the paper is to produce a software through it we make sure that students have studied all the concepts of economics. So, the proposed software is structured from two major modules: The first one was an online website to review and make self-test for all the material of economic course. The second part is an online examination using a large database bank of questions through it the level of students can be evaluated immediately and some statistical evaluations can be obtained. The study shares a couple of similarities with the current research work in the use of a database that enables the storage of questions and also the automatic scoring feature that helps makes the evaluation of students easier and efficient. However the two study differs in some aspects, while the cited study has an e-learning feature that allows students access course materials and also serves as a tutorial tool, the current study is focused solely on the evaluation of students.

Ayo *et al.* (2007) proposed a model for e-Examination in Nigeria where all applicants are subjected to online entrance examination as a way of curbing the irregularities as proposed by the Joint Admissions Matriculation Board (JAMB), the body saddled with the responsibility of conducting entrance examinations into all the Nigerian universities. This model was designed and tested in Covenant University, one of the private universities in Nigeria. Their findings revealed that the system has the potentials to eliminate some of the problems that are associated with the traditional methods of examination such as impersonation and other forms of examination malpractices. The model was later adopted for use by Covenant University and JAMB for its computer based examination paving way for a seamless transition from the PPT form of examination. A study by Ayo (2007) on Nigerian University stated that 81.3% of the applicants were computer literate, while the remaining 18.7% were guided through the examination. The total number 1023 (75.7%) of respondents who participated in the e-examination conducted in Covenant University took electronic examination for the first time and as such found the examination easy, a few found it a little challenging but adjusted with time. The study revealed that only 327 (24.2%) of the applicants had not been involved in any form of electronic examination before, and found it difficult. While the system developed in the study is web based, the present work seeks to develop a system that can function without network interference and cheaper to set up and maintain since it is targeted at secondary schools while does not have the same financial weight like the government agencies and higher institutions which the model of the study by Ayo *et al.* was aimed at.

Bodmann and Robinson (2004) conducted an experimental study to compare speed and performances differences among CBTs and PPTs. In the experiment fifty-five undergraduate students enrolled in the subject of educational psychology, participated in the studies which were already familiar with CBTs. Both CBTs and PPTs contained 30 MCQs items with 35 minute of time limit. The findings observed that undergraduates completed the CBT faster than PBT with no difference in scores. Research outcomes have thus supported the fact that when students are motivated and testing conditions are equivalent, there are no differences between the scores obtained via CBT or PPT (Lynch, 1997 & Marson, Patry, and Berstein, 2001; cited by Alabi, Issa and Oyekunle, 2012). During the testing of the proposed system in Treasure Land Academy Onitsha North LGA in Anambra State, the researcher observed that while a good number of students was able to navigate through the system with ease, a large percentage of students needed guidance to navigate the system. While the introduction of CBT to secondary schools in Anambra State is still at the infant stages, there are promising sign will be a success at the secondary school level.

The empirical studies reviewed indicated functionality of other systems that was limited due to the absence of a database since the application was operated from a browser. This research work fixed that glaring deficiency with the use of MySQL relational database for the storage and retrieval of data. The current sought to develop a cheap and reliable examination system that can easily adopted by secondary schools without leaving a hole in their pockets. It is easy to operate and eliminates the need for professionals to run the system which usually comes at neck breaking prices.

Methodology

Research Design

The research made use of the Structured System Analysis and Design Methodology (SSADM). Structured System Analysis and Design Methodology (SSADM) is a system approach to the analysis and design information system. SSADM methods involves the application of a sequence of analysis, documentation and design tasks concerned with analysis of the current system, logical data design and local process design.

System Investigation

Under this stage, the researchers made an in-depth and thorough study of the strength and weaknesses of the existing system regarding its procedures in working in order to introduce a system that will help to improve the already existing one. The researcher scaled two phases which are involved in system investigation. They are:

- i. The Definition Phase: This is the first phase of System investigation, here the researcher defines the problem of the old system like high rate of exam malpractice, loss of results, delay in compilation of results etc. The purpose of the study is to establish the need for a new system that can eliminate the shortcomings of the old system. The objectives of the new system include student authentication, flexible exams etc. The researcher carried out preliminary analysis and proposed alternative solution in the make of a Computer-Based Examination system.
- ii. Feasibility Study: The researcher studied the existing system at this stage, from the study the researcher was able to develop a model for the new system. The researcher visited 10 secondary schools in Onitsha North LGA in Anambra State during the examination periods to observe the existing system being put into use. The Paper-and-Pencil Test was the system used by the schools in conducting the examinations. As observed by the researcher the PPT system was marred with great irregularities including the ever increasing cases of examination malpractice, high cost, absence of proper recording and storage system and the toll that marking and recording of the results takes on teachers. However this stage helped the researcher to examine and determine the validity, workability and acceptability of the new system.

Sources of Data

The researchers made use of both the primary and secondary sources of data during the course of the study.

Primary Sources of Data: The researcher applied interview and observation methods which are all primary sources of data. In view to investigation, school representatives were interviewed during the researchers' visits, such as teachers, HODs and other administration staff and their response were found to be useful to this study, as it was obtained by physical contact. From the interview the following problems were revealed:

- i. The teachers usually have more than enough students to cater for under the conventional classroom paper exam. This puts a strain on their ability to carry out their duties efficiently
- ii. Traditional classroom examination could be sometimes inhibiting environment to students. Lack of proper ventilation, illumination and overcrowding made the traditional system of examination unpleasant to the students.
- iii. Student most times complain of time, starting and ending of the examination, hence, time insufficient by the human based timing of the examination.
- iv. Malpractices are at a high side, since the students can easily copy from one another due to inadequate spacing and scarcity of invigilators.

During the observation period, the researchers observed:

- i. The examination subjects
- ii. The marking system
- iii. The recording system

The researchers observed that a good majority of the teachers solicit for the help of students to help in the marking and recording of examination due to the large number of scripts to be marked and recorded, this led to mistakes in results due to inexperience of the students enlisted. There is increase in the rate of examination malpractice as the students marking and recording the exams deliberately add undeserved scores to their friends while deduction marks from their perceived enemies. This leads to the publication of error strewn results which defeats the main purpose of examination which is the proper evaluation of the ability and progress of the students. It is on the backdrop of these irregularities that the researcher proposed the need for a system that has the ability to eliminate the challenges bedeviling the old system.

Secondary Sources of Data. The researcher used the internet as a secondary source of data collection, models for the new system, related empirical studies, etc which aided the research work in no little way.

Proposal for the New System

Due to the problems of the existing system, there is need for the new system. Due to the manual system being used in keeping information about students examination processing, a lot of problems were encountered which includes:

- i. Takes a lot of time to retrieve a particular students result
- ii. Loss of vital documents as the filing system was not properly organized
- iii. Illegal removal of forms by fraudulent staff leading to insecurity
- iv. Delay in the time used in the computation of results

- v. High rate of examination malpractice

The new system will ameliorate and enhance the performance of the existing system. To reduce the workload and also remove human errors, it will improve the credibility of writing exams. This can be done in many ways, and are as follows:

- i. Improved Statistical Analysis: More improved analysis of students' performance can be done at no extra cost and faster.
- ii. Automation: Automate the examination delivery, assessment and recording process, thereby minimizing clerical mistakes and reducing examination malpractice to the barest minimum.
- iii. Serves as preparatory tool: To provide intending CBT examiners in any part of the world with a robust platform for practicing and preparing, thereby improving their performance.
- iv. Eco-friendliness: Cut down the use of paper thereby making it an eco-friendly initiative.
- v. Provision of Database: Availability of a database makes the recording and retrieval of students results easier and faster.

Objectives of the New System

The new system is expected to serve as a remedy to the problems and weakness observed in the existing systems. The objectives of the designed Design of Single-User-Mode Computer-Based Examination System for Senior Secondary Schools in Onitsha North Local Government Area of Anambra State, Nigeria, are as follows:

- i. Authenticate student: when they login into the system with their details. The systems only allow registered students to access the system by the way of authentication. Students only login to the system by providing a unique registration number and passwords; this effectively eliminates the problem of impersonation during exams.
- ii. Create sessions for each student: Each student has his/her own unique password, so when logged status on profile will be opened. Each student is not able to access the profile of the other students.
- iii. Restrict the student to make only one selection of the options to the question.
- iv. No students can select more than one options from the questions that is displayed (either is A or B or C or D).
- v. Allow the student to go back to review or modify already answered question. This is when the students have finished answering he/she can go back to review or click the options that has been answered and can change the options that has been chosen (i.e. from A to B to C to D).

- vi. Generate questions randomly: this is when the computer generate questions so that each of the questions is not the same question at the same time.
- vii. Prevent repetition of questions already generated this is when the question(s) that has been answered cannot show again.
- viii. Computations of students score at the end of the exam. When the student click submit within few seconds the result will be shown or displayed only on the admin dashboard. Only the system admin can access the results of the students hence reducing the manipulation of results
- ix. Flexibility: Examination can be taken at different places and at different time. The system has the ability to handle more than one examination simultaneously without infringing on each other.

Results

The results of this study are presented according to the research questions.

Research Question One

What are the core technologies powering the designed Single-User-Mode Computer-Based Examination System?

The following are the core technologies powering the designed Computer-Based Examination System:

- i. PHP: PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. PHP was used in the application to access database and provide server-side form, because it is closely integrated with MySQL database, open source, light weight and does not consume much server resources to render page.
- ii. XAMPP: It is a simple, lightweight Apache distribution that makes it extremely easy for developers to create a local web server for testing and deployment purposes. It was used in this research work as a substitute for paid web servers due to financial constraints. The study focused on a single user system so XAMPP was ideal in order to cut cost and its simplicity to setup and navigate through. Through the use of XAMPP the system can be launched locally from a computer without internet connection.
- iii. MySQL: The database used for storing information in this project application is MySQL. Working together with PHP is MySQL, most widely used open-source relational database management system (RDBMS). Both PHP and MySQL instructions used in this application were used together in the code to open the database, establish connection between it and the HTML code to insert data, retrieve data, delete data etc.
- iv. HTML: The main building technology of the application, Computer Based Testing System is the HTML. The HTML is the mark-up language used to

describe and define the content of web pages. HTML was used in the application to tell the browser what to display on the page, like appearance of text such as bold or italics text and also used to specify images. The main HTML features used were form and Cascading Style Sheet. The form was used to collect LOGIN data, username and password from a user and a submit button (Login) to send the collected data to a web document to act on the data.

- v. JAVASCRIPT: JavaScript was combined with HTML and CSS to create a dynamic HTML pages for the system. JavaScript was also used to make the web pages interactive such that it can respond to user actions, like when user moves a mouse pointer over an image or clicks a form button. JavaScript was used for the client side scripting and security, it was also integrated with jquery and ajax to create a highly interactive system.

Research Question Two

What are the Back-End requirements of the designed Single-User-Mode Computer-Based Examination system?

The back-end requirements for the designed system are:

- i. PHP: PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. PHP was used in the application to access database and provide server-side form, because it is closely integrated with MySQL database, open source, light weight and does not consume much server resources to render page.
- ii. XAMPP: It is a simple, lightweight Apache distribution that makes it extremely easy for developers to create a local web server for testing and deployment purposes. It was used in this research work as a substitute for paid web servers due to financial constraints. The study focused on a single user system so XAMPP was ideal in order to cut cost and its simplicity to setup and navigate through. Through the use of XAMPP the system can be launched locally from a computer without internet connection.
- iii. MySQL: The database used for storing information in this project application is MySQL. Working together with PHP is MySQL, most widely used open-source relational database management system (RDBMS). Both PHP and MySQL instructions are used in this application are used together in the code to open the database, establish connection between it and the HTML code to insert data, retrieve data, delete data etc.

Research Question Three

What are the front-end requirements of the designed Single-User-Mode Computer-Based Examination system?

The following are the front-end requirements of the designed computer-based examination system.

- i. **HTML:** The main building technology of the application, Computer Based Testing System is the HTML. The HTML is the mark-up language used to describe and define the content of web pages. HTML was used in the application to tell the browser what to display on the page, like appearance of text such as bold or italics text and also used to specify images. The main HTML features used were form and Cascading Style Sheet. The form was used to collect LOGIN data, username and password-from a user and a submit button (Login) to send the collected data to a web document to act on the data.
- ii. The styling of the designed Single-User-Mode Computer-Based Examination system was done using CSS. This include the Layout, Link Styling, Colouring, Picture Alignment, and Menu Building. Cascading Style Sheets (CSS) is a style sheet language used to describe the look and formatting of the document written in HTML. Presentation of information to the user by the browser was controlled by means of Cascading Style Sheet.
- iii. **JAVASCRIPT:** JavaScript was combined with HTML and CSS to create a dynamic HTML pages for the system. JavaScript was also used to make the web pages interactive such that it can respond to user actions, like when user moves a mouse pointer over an image or clicks a form button. JavaScript was used for the client side scripting and security, it was also integrated with JQUERY and AJAX to create a highly interactive system.
- iv. **Web Browser:** A web browser is used to access the system form the front-end. It is a vital tool of gaining access to the system because all the front-end development can only be launched through a web browser. Updated web browsers like Google Chrome, Opera, Firefox and Microsoft Edge can be used to access the system without internet connection.

Research Question Four

What is the Use Case Diagram of the designed Single-User-Mode Computer-Base Examination System?

Use case diagrams are used during requirements collection and analysis as a graphical means of representing the functional requirements of the system. Use cases focus on the behaviour of the system from external point of view. Use cases are developed during requirement collection and are further refined and corrected as they are reviewed (by stakeholders) during analysis. Also, this diagram shows a set of use cases, actors and relationships. Actors are external entities that interact with the system.

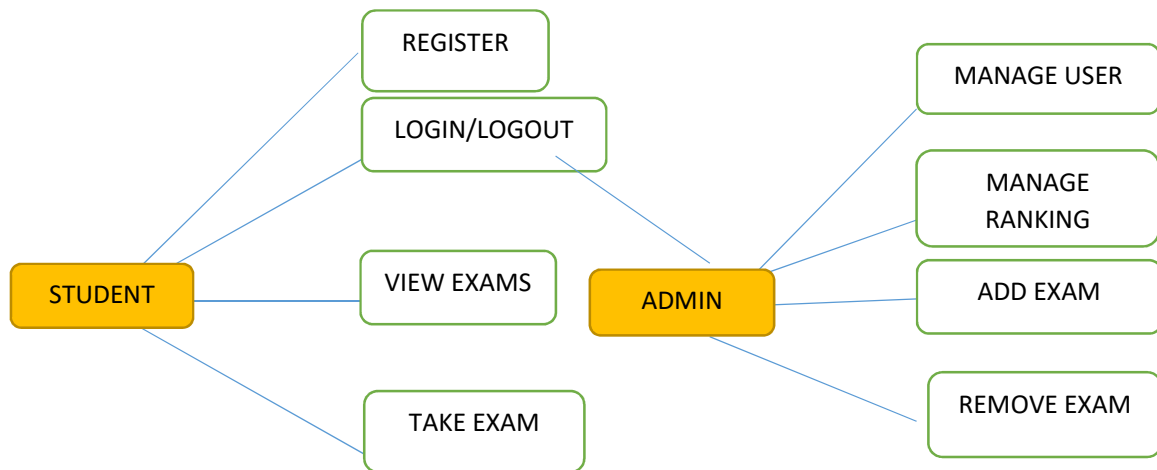


Figure 1: Use Case Diagram of the Proposed System

Student Actor: The student is one of the two actors that interacts with the system, under the student actor we have other sub-modules which are as follows:

Registration Module: Here the student can sign up for the examination by providing personal details like name, password and identification number. After registration the student can then proceed to login page for access into the system.

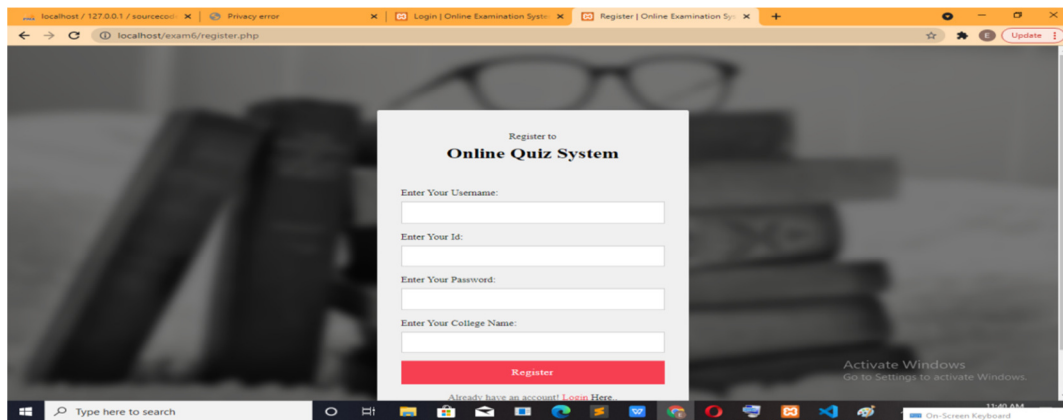


Figure 2: Students Registration Page

Login/Logout Module: After registration the candidate is then directed to the login page where he inputs his/her already registered details which is then retrieved from the database before access to the exam can be granted.

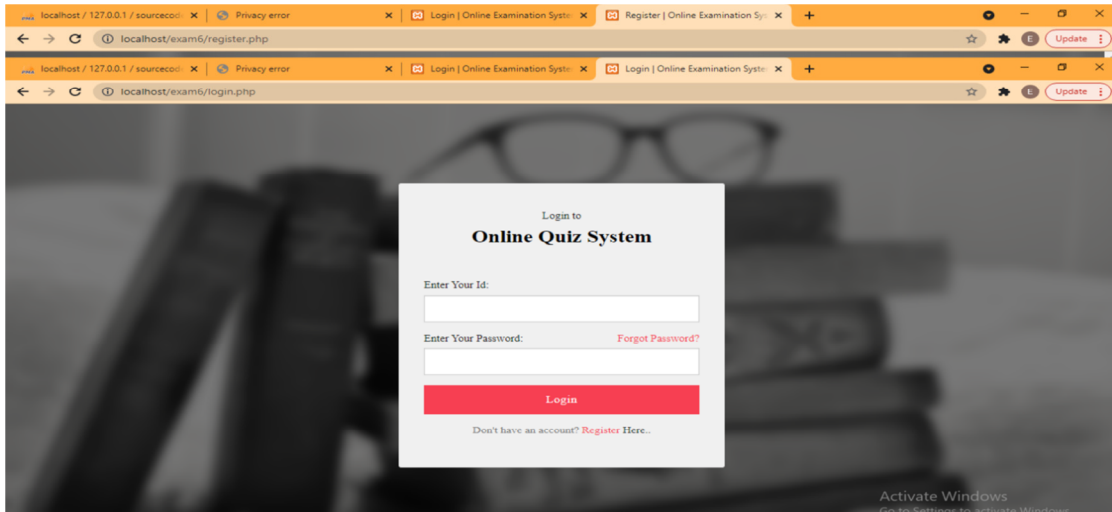


Figure 3: Students Login Page

View Exam Module: After a successful login, the student is then able to access the exam dash board and view the list of available exams. The student selects the correct exam and proceeds to the exam questions page.

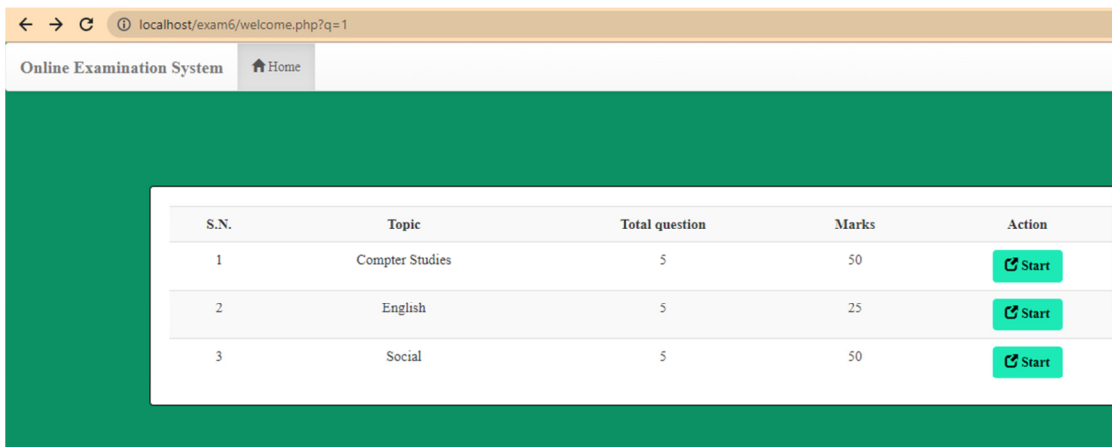


Figure 4: Examination Subjects Page

Take Exam Module: After selection the students now proceeds to answering of the exam questions proper. After the last question the click submit and proceeds to logout of the system.

Admin Actor. The admin actor is the one in charge of the system, he/she has control over how the system is run. The following are the modules under the control of the admin actor:

Login/Logout Module: Here the admin logs in to the system with a unique password in order to have access to the system.

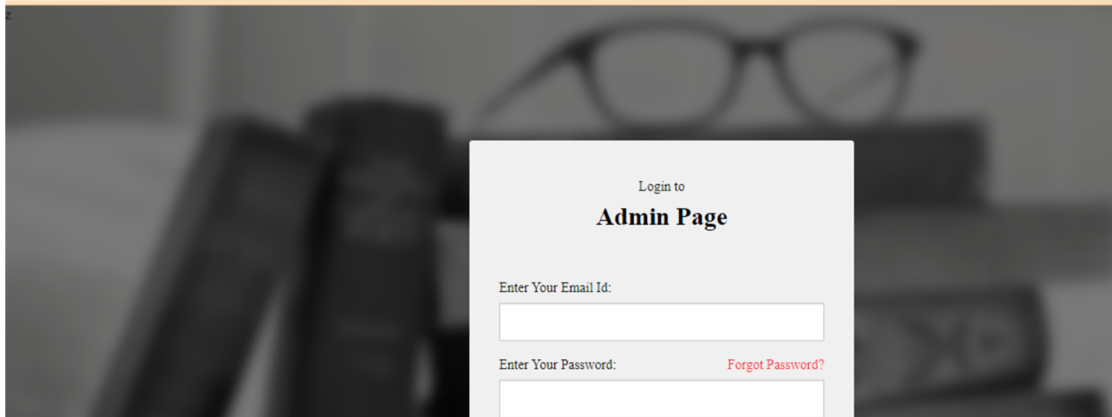


Figure 5: Admin Login Page

Manage User Module: Under this module the admin can view the number of registered users in the system, the admin can also delete a user from the system in case of any irregularities.

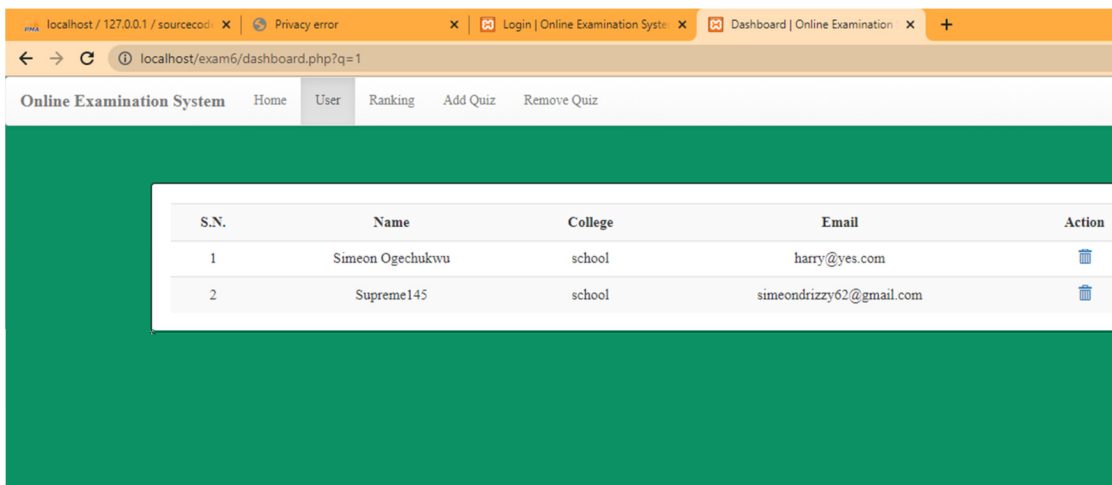
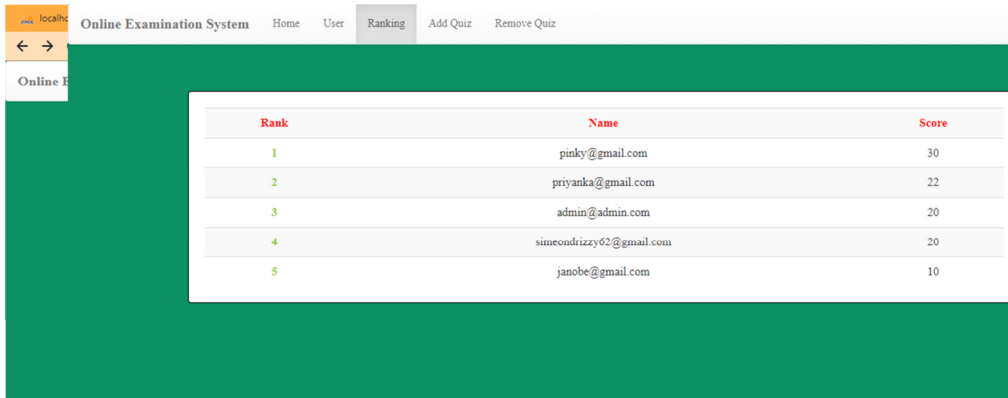


Figure 6: Admin User Control Module

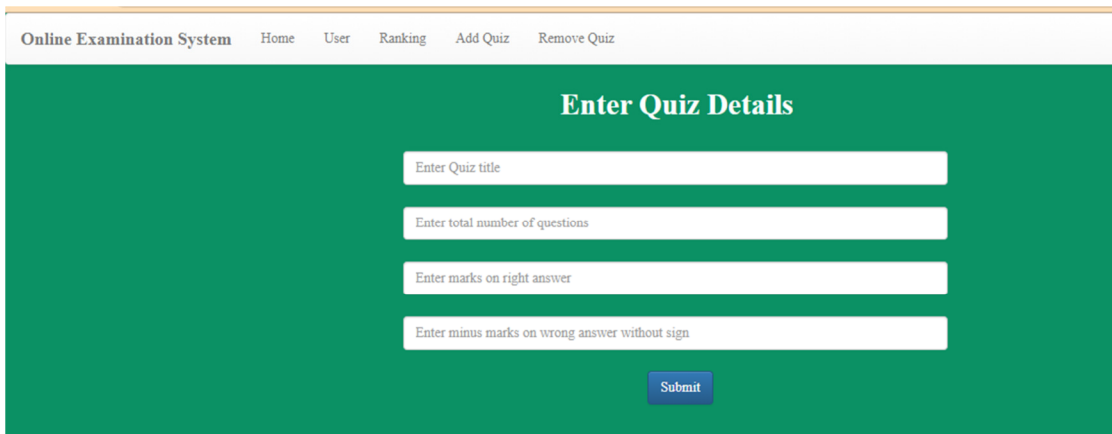
User Ranking Module: Here the scores of the students are displayed in ascending order, this makes the compilation of students' results easy and stressful.



Rank	Name	Score
1	pinky@gmail.com	30
2	priyanka@gmail.com	22
3	admin@admin.com	20
4	simeondrizzy62@gmail.com	20
5	janobe@gmail.com	10

Figure 7: User Ranking Module

Add Exam Module: The admin sets the questions in this module along with the answers for automatic grading by the system. Each questions comes with four possible answers with only one of the options being correct.



Online Examination System Home User Ranking Add Quiz Remove Quiz

Enter Quiz Details

Enter Quiz title

Enter total number of questions

Enter marks on right answer

Enter minus marks on wrong answer without sign

Submit

Figure 8: Add Exam Module

Remove Exam Module: Here the admin can delete an exam if it is no longer need or already completed by the students.

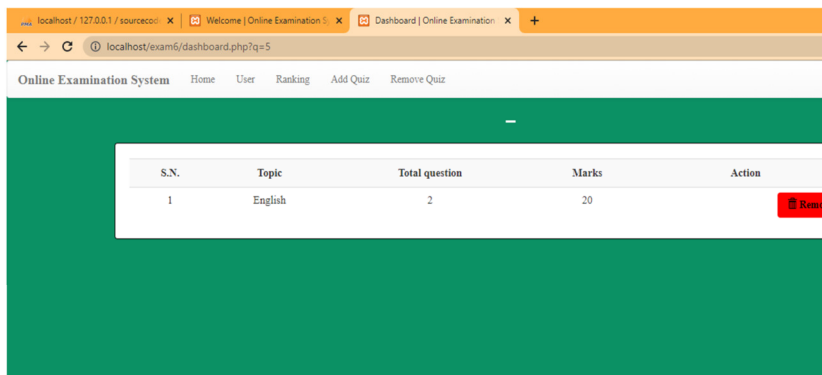


Figure 9: Remove Exam Module

Research Question Five

What is the Class Diagram of the designed Single-User-Mode Computer-Based Examination System?

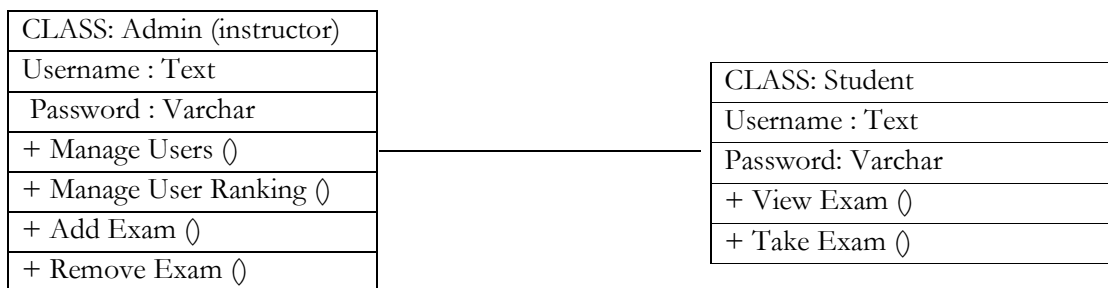


Figure 10: Class Diagram of the Proposed System

The class diagram describes the types of objects in a system and the various kinds of static relationships that exist among them. A class is represented by a rectangle with one or more horizontal compartments. The upper compartment holds the name of the class. The name of the class is the only required field in a class diagram. By convention, the class name starts with a capital letter. The (optional) centre compartment of the class rectangle holds the list of the class attributes/data members, and the (optional) lower compartment holds the list of operations/methods.

Discussion of Findings

In research question one, the study discussed the technologies powering the system in details. The technologies powering the system include PHP which served as the back-end

scripting language of the system, MYSQL which was adopted as the relational database of the system, HTML as the markup language used to describe and define the content of web pages. , JAVASCRIPT used for interactivity and responsiveness of the system and XAMPP for the testing and deployment of the system. The technologies used to power the system were similar to the ones used by Rashid (2002), who developed a system that carries out the examination and auto-grading for students' exams. The system facilitates conducting exams, collection of answers, auto-marking the submissions and production of reports for the test. It supports many kinds of questions. It was used via Internet and is therefore suitable for both local and remote examination. The system was built using various open source technologies AJAX, PHP, HTML and MYSQL database are used in this system. However the proposed system in this study is unique due to its ability to function without internet connectivity thereby saving the cost of internet services.

In research question two, the core back-end technologies required for the system were outlined. They include PHP used as the back-end scripting language of the system and for connection to the database, XAMPP for local hosting and MYSQL as the database. These technologies are similar to the ones adopted by Wang et al. (2004) who in their work developed an assessment system using Triple-A Model (assembling, administering, and appraising) as the baseline qualification in order to provide the most comprehensive form of Computer-Based Test (CBT) or Web-Based Test (WBT) and to be more suitable for student evaluation. The model made use of PHP as the back-end scripting language and adopted MYSQL as the relational database. While the back-end technologies of the two systems might be similar, Wang (2004) used a more complex Triple-A model while this study adopted the much simpler SSADM model which is easier and cheaper to setup.

Research question three dealt with the front-end requirements of the system which are HTML for description and defining the web pages, CSS used for the styling and positioning of elements on the web page, JAVASCRIPT for interactivity and responsiveness of the pages and WEB BROWSER for assessing the system from the front-end. These technologies are similar to the ones deployed by Zhenming (2003), who developed a novel online examination system based on a Browser/Server framework which carries out the examination and auto-grading for objective questions and operating questions, such as programming, operating Microsoft Windows, editing Microsoft Word, Excel and PowerPoint, etc. The two systems depend on the browser for accessibility to the system though the current study stands out due to the availability of a database which was a major shortcoming of Zhenming (2003).

The use case diagram of the system was provided in research question four. The Use case diagram was used during requirements collection and analysis by the researcher as a graphical means of representing the functional requirements of the system. The Use case focused on the behaviour of the system from external point of view. The Use case was developed during requirement collection and were further refined and corrected as they are reviewed (by stakeholders) during analysis. Also, this diagram showed a set of use cases, actors and relationships. Actors are external entities that interact with the system. In

this case the student and administrator are the two actors present in the study. Each of the modules present was explained in detailed with a accompanying screen shots.

Research question five dealt with the class diagram of the system. The class diagram described the types of objects in the system and the various kinds of static relationships that exist among them. A class was represented by a rectangle with one or more horizontal compartments. The upper compartment held the name of the class. The name of the class is the only required field in a class diagram. By convention, the class name starts with a capital letter. The (optional) centre compartment of the class rectangle holds the list of the class attributes/data members, and the (optional) lower compartment holds the list of operations.

Conclusion

In this work, a Single-User-Mode CBT system is developed and proposed for adoption in Senior Secondary Schools in Onitsha North LGA of Anambra State, Nigeria. The examination system is an online examination that delivers questions set by the teachers to the student and generates the report of the results of students who take the examination as well as overall examination result summary based on the user's query. The cost implication of conducting mass-driven examination will become drastically and significantly reduced, there will be no need to print questions or answer booklet anymore. The CBT system can store the records of each student and it can be recall when necessary reference is needed. The CBT will be very useful tool to have transparency, reliability and efficiency in writing school examination system.

Recommendations

In an evolving and technologically developing world such as Nigeria, where there is a dearth (lack or scarce) of lecturers who are saddled, with much responsibilities than they can handle, the need for a CBT that can take up some of their routinely but relevant task cannot be overemphasized. This work was aimed at designing and implementing CBT's that prevents the human error(s) that is prevalent in the existing system.

The researchers recommend the automation of examination, by automating the examination system it will minimize/remove human error(s) and overcoming their limitations by adopting ICT, since the technology promises compact storage, speedy retrieval of data and untiring diligent work. The following are benefits of automating examination system:

- i. Inadequate invigilators and exam materials, omission of students' results and human errors during marking/grading process will be automatically eliminated following the adoption of the E-examination system.
- ii. The new system will streamline the procedure for collation of exam records repetition of work will lead to duplication. There will be centralized, secure and robust database of the candidates appearing in the examination without duplication of records.

- iii. The computerization of examination system will lead to effective monitoring of examination process and the possibility of fraudulence will be minimized.
- iv. The computerization of examination will enable the management to see trends in results at various level and timely availability of compiled reports can be used to make strategic decisions in favour of the school and student.

Limitations of the Study

The designed system operates on a single user mode which requires that the application must be installed on each of the computers to be used for the examination. This is caused by the absence of a networking system which is beyond the scope of the study.

Suggestions for Further Studies

Future research work should accommodate theory based questions as opposed to only the multiple choice and structured questions formats that the CBT system currently accommodates. Also provision for video based e- assessment can also be investigated. More importantly networking can be added to the system to accommodate more users, web hosting is still a viable option.

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APPENDIX A: Installation Guide and Setup

Requirements

- Install local web server such as XAMPP/WAMP.
- Extract the provided source code zip file.

Installation/Setup

1. Open the XAMPP/WAMP's Control Panel and start Apache and MySQL.
2. If you are using XAMPP, copy the extracted source code folder (ABAH-HONMANE-AGE-OGBULE-CBT) and paste it into the XAMPP's "htdocs" directory. And if on WAMP, paste it into the "www" directory.
3. Browse the PHPMyAdmin in a browser i.e <http://localhost/phpmyadmin>.
4. Create a new database and name it sourcecodeste.
5. Import the provided SQL file. The file is known as sourcecodeste.sql.
6. Browse the Computer-Based Examination in a browser i.e <http://localhost/exam6>.

Sample User Access Information

Source Code folder available at: <https://villagemath.net/journals/ver/v3i1/ABAH-HONMANE-AGE-OGBULE-CBT.zip>

Admin:

Email: admin@admin.com

Password: admin