Computer-Based Test (Cbt) System For University Academic Enterprise Examination

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Abstract: As flexible and online learning mediated by ICT becomes more pervasive, there is a growing need for educators to consider modes of assessment using similar tools. Computer Based Test (CBT) is an effective solution for mass education evaluation. Though, a variety of *e*-assessment approaches and systems have been developed in recent times, yet lack of flexible timing functionality to automatically log-off candidates upon expiration of allotted time, result integrity comprise, stand-alone deployment, lack of flexibility, robustness and scalability as well as human error are major limitations of the existing platforms. In this paper, a web-based online examination system is developed to address these aforementioned drawbacks. The system is designed to facilitate the examination processes and manage challenges surrounding the conduct of examination, auto-submission, auto-marking and examination result report generation. The conceptual design including the Data Flow Diagram (DFD), the Use Cases and the Entity-Relationship Model (ERM) for the system developed is also presented. The programming tools used for the front-end development of the system are Hypertext Markup Language (HTML) and Microsoft Visual Studio 2012 integrated development environment while Microsoft SQL Server 2008 is used as the database backend. The CBT system was evaluated at the Federal University, Oye-Ekiti, Ekiti State prometric centre. Performance assessment was carried out by two-hundred and fifty (250) volunteer users of the CBT system and the average performance scoring indicate that the system scores high in terms of reliability, robustness and flexibility with easy to use graphical user interface. The volunteers comprise of software developers, students, lecturers and network engineers. The test proved the validity of using this web-based CBT system to evaluate a large mass of students in various institutions of learning across the globe.

Index Terms: Computer Based Test, University Examination, Manual, *e*-Assessment.

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1 INTRODUCTION

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. This brings about the need for automation of the examination system. Over the years, there have been various automated examination systems that have been developed with one or more limitations. Some of these limitations include lack of scalability, near-reaility, lack of robustness, lack of flexible timing functionality to automatically log-off candidates upon expiration of allotted time as a challenge (Ipaye, 2009); malpractice due to questions not randomly generated (Ayo *et al*, 2007); not well secured application domain in terms of data security and integrity (Levy & Ramim, 2007); most existing computer based test (CBT) systems are deployed as stand-alone applications that run on distributed networks making access to such applications restricted to the networked geographical domain and are only suited for the application environment only (Huszti & Petho, 2008). As such, no unified development model exists and this alone undermines the success of the *e*-examination platform for real-time adoption in practice. An online assessment however, is expected to offer several advantages for the institution and the learner. These include (Andrew *et al,* 2009):

- Time analysis of responses to the question level to better discriminate between candidates

- Including video in questions, particularly for scenarios in authentic assessment.

- Adaptive testing, where the next question to be posed is determined by prior response(s).

- Question banks and randomization of questions and response orders to reduce cheating.

- Automated analysis of results from entire candidate cohorts.

- Immediate feedback can be given.

In this paper, a unified, scalable and flexible CBT system that addresses the aforementioned limitations of the some existing *e*-examination systems is developed. The conceptual design including the Data Flow Diagram (DFD), the Use Cases and the Entity-Relationship Model (ERM) for the system developed is also presented. Hypertext Markup Language (HTML), Microsoft Visual Studio 2012 and Microsoft SQL Server 2008 are the tools used for the development of the CBT system. The result of the user assessment survey of the CBT system conducted indicates that setting, conducting and grading examination as well as generating and managing results become highly time-efficient, less prone to human error, more secured and at the comfort of both the lecturers and the students; thus preferred over the existing platforms for conducting examination.

2 RELATED WORKS

There have been a number of researches focusing on the development of automated examination systems and electronic learning information systems. Zhenming *et al* (2003) developed a novel online examination system based on a Browser/Server framework which carries out automatic grading for objective questions in computer related topics such as programming, Microsoft Windows operating systems and Microsoft Office applications. It was successfully applied to the distance evaluation of basic operating skills of students offering computer science in some Universities. Lei (2006) presented a web-based educational assessment system by applying Bloom's taxonomy to evaluate student learning outcomes and teacher instructional practices in real time. The system performance is rather encouraging with experimentation in science and mathematics courses of two local high schools. Emary & Abu (2006) developed an online website for tutoring and e-examination of economic courses.

336

This novel software tool was used for online examination and tutorial application of the syllabus of economic courses so as to ensure that students study 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 materials 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 developed software offers the following features:

a) Instructors could add any further questions to maximize the size of the bank of questions.

b) Different examinations for each student with randomly selected questions from the bank of questions can be done.

c) Different reports for the instructors, students, classes etc. can be obtained.

d) Several students can take their exams simultaneously without any problem inside and outside their campus. The proposed software has been designed to work based on the client server architecture.

Ayo *et al* (2007) proposed a model for electronic examination in Nigeria which enforces all applicants to be subjected to online entrance examination as a way of curbing the irregularities as in the Joint Admissions Matriculation Board (JAMB) examinations. This model was designed and tested in Covenant University, one of the private universities in Nigeria. Findings revealed that the system has the potential to eliminate some of the problems that are associated with the traditional methods of examination such as impersonation and other forms of examination malpractices. Akinsanmi *et al* (2010) developed a web application where tests in multiple choice formats could be taken online and graded immediately. The web application relies solely on Microsoft developed technologies. It runs on the Microsoft.net framework, uses the ASP.NET web server, C# as the intermediate language, ADO.NET to interact with the relational database and Microsoft SQL server as the relational database. Rashad *et al* (2010) developed an online examination system that carry out the examination and automatic grading for students examinations. The system facilitates conducting examinations, collection of answers, automatically marking the submissions and production of reports for the test. It supports many kinds of questions. It was used via Internet and also suitable for both local and remote examination. The system could help lecturers, instructors, teachers and others who are willing to create new examinations or edit existing ones as well as students participating in the examinations. The system was built using various open source technologies such as PHP, HTML and MYSQL database engine. An automatic grading module was developed to incorporate different examination and question types. The system was tested in the Mansoura university quality assurance center. The test proved the validity of using this kind of web based systems for evaluating students in the institutions with high rate of students. The limitations of the above systems are enormous: these systems are domain / application area-specific, so cannot fit into all deployment area needs; not well secured in terms of data security and integrity; do not present a generalized model for adoption by any user willing to migrate to the *e*-examination platform; most of the systems are stand-alone applications that only run on distributed networks and thus access is limited to the networked geographical domain. However, in this paper, these limitations are well addressed..

3 MATERIALS AND METHOD
In this section, the development life cycle and the conceptual design (the activity diagram, the use cases, the data flow diagram and the entity-relationship diagram) of the CBT system are presented.

3.1 Development Life Cycle of the CBT System
The Waterfall Model was adopted for the development of the CBT system. The model views the process of software development in five stages. The activities in one stage will be completed before moving to the other. Phases involved in the Waterfall Model are:

    i. Requirement Analysis and Definition

    ii. System and Software Design

    iii. Implementation and testing

    iv. System testing

    v. Maintenance

Requirement Analysis and Definition: In this stage, the users (students, lecturers) of the system were consulted in order to establish the goals, requirements, and services that the end-user requires and expects from the system. This involved proper definition of nature scope and peculiarity of problem. The problem on which this project is based is the design and implementation of a computer based test system that does not suffer the setbacks of the existing manual method of writing examination.

System and Software Design: the requirement specifications from the first phase were studied and a system design was prepared to help in specifying hardware and software requirements and also help in defining the overall system architecture. This includes the use of Data flow diagrams, Activity Diagram and Use cases.

Implementation and Testing: this stage involved the actual development of the system by developing the graphical user interface, implementing the model using C# and creating the system database using SQL server.

System Testing: this is the stage after coding where every unit of the program was tested and integrated as a complete system in order to ensure the system works according to required specification.

Maintenance: this is the final stage of development in which all necessary maintenance activities were carried out in order to see that the software continues to work even when there is a new development in the future.

337

3.2 Conceptual Design of the CBT System

The conceptual design of the CBT system was carried out using the activity diagram, the data flow diagram, the use cases and the entity-relationship diagram.

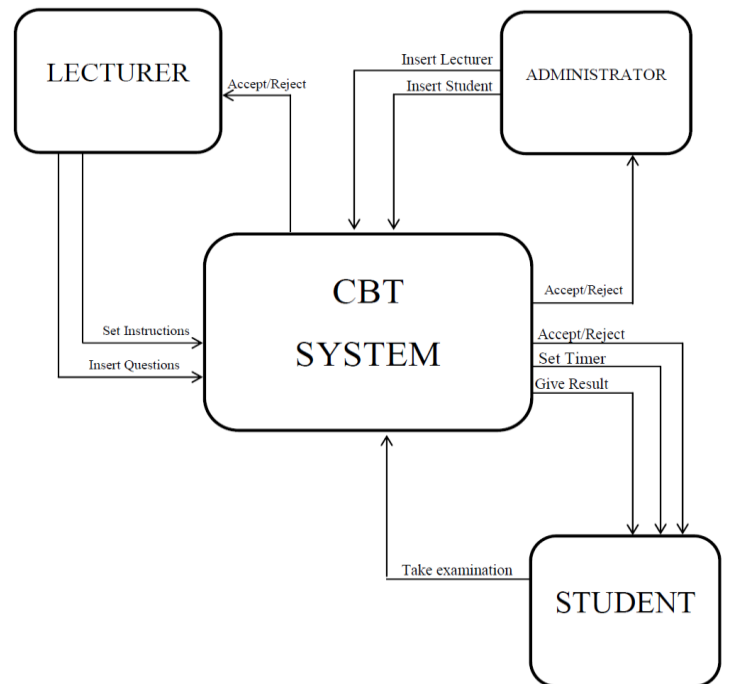### (a) Activity Diagram for the CBT System

Activity diagrams are graphical representations of workflows depicting stepwise activities and actions with support for choice, iteration and concurrency. In the unified modeling language, activity diagrams can be used to describe the business and operational step by step workflows of components in a system. An activity diagram shows the overall flow of control. However, figure 1 presents the activity diagram for the CBT system developed.
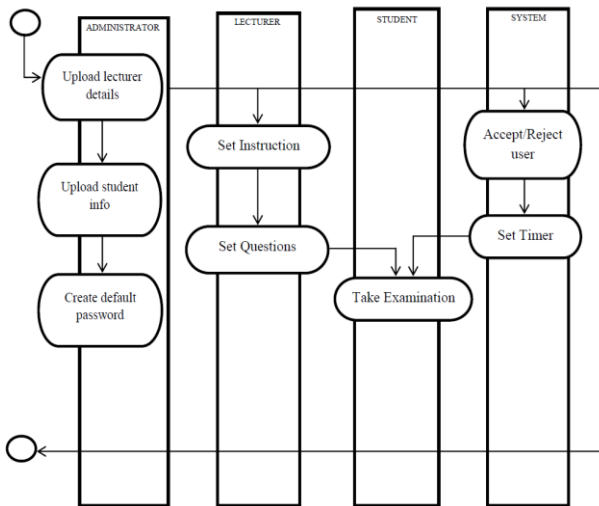
Fig 1: Activity diagram for the CBT system

(b) Data Flow Diagram (DFD) for the CBT System

A data flow diagram (DFD) uses a very limited number of primitive symbols to represent the functions performed by a system and the data flow among the functions. Starting with a set of high-level functions that a system performs, a DFD model hierarchy represents various sub-functions. The data flow diagram depicted in figure 2 below shows the relationship among the entities in the CBT system. The entity 'STUDENT' can take examination after he or she gains access to the system. The entity 'LECTURER' can upload questions to be answered by student into the CBT database using any preferred question format, set the examination instructions and configure the correct options or set of options for the questions. The entity 'ADMINISTRATOR' is saddled with the responsibility of inserting students, lecturer and setting the default password for the users of the system. The entity 'SERVER' is responsible for authenticating the users of the system and also provides the timing functionality for the examination. The system logs off a student upon expiration of duration for the examination.


Fig. 2. Data flow diagram for the CBT system

(c) Use Cases Diagram for the CBT System

Use cases diagram for each entity present in the CBT system is presented here. These include use cases diagram for the administrator, lecturer, system and student. The use cases diagram for the administrator is presented in figure 3. It shows the activities that are required of the administrator including the upload of lecturer's details, upload of students' details and creation of default passwords for users.
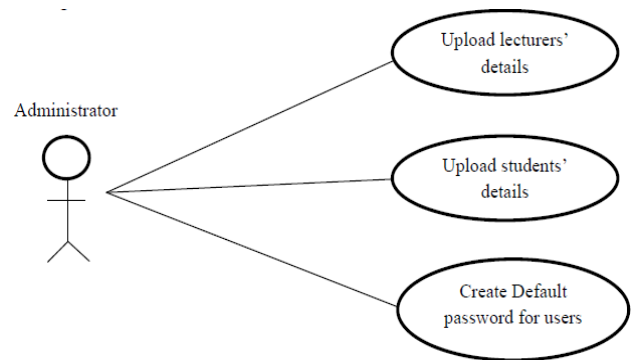

Fig. 3. Use cases diagram for the CBT Administrator

The lecturer use cases diagram as shown in figure 4 depicts the process of setting examination instructions, insertion of questions into database, insertion of options as well as the specification of correct answer(s) to question(s).
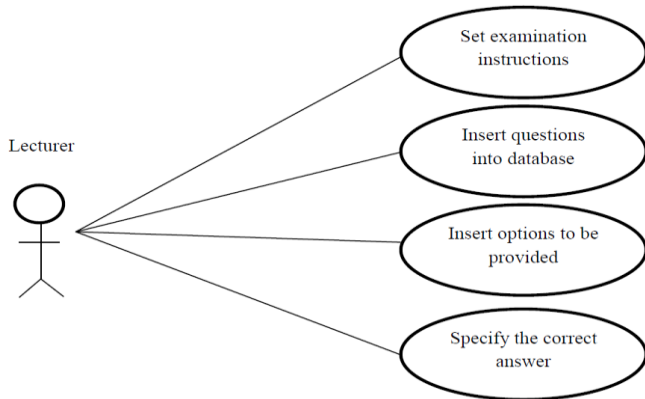
Fig. 4. Use case diagram for the Course Lecturer

The server use case diagram represents the responsibility of authenticating users of the system and providing timer functions for the examination are carried out. This is presented in figure 5.
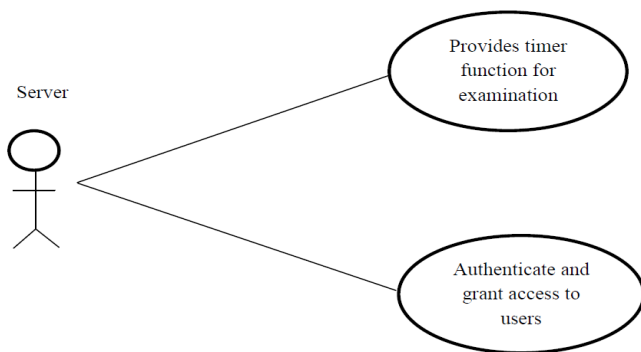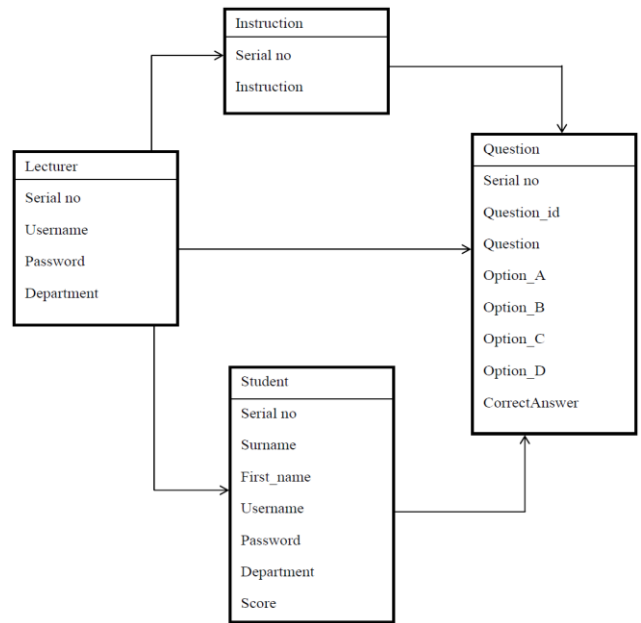

Fig. 5. Use case diagram for the CBT Server

The use cases diagram for student shows that the student can access the system and write his or her examination. Figure 6 presents the use cases diagram for the student.
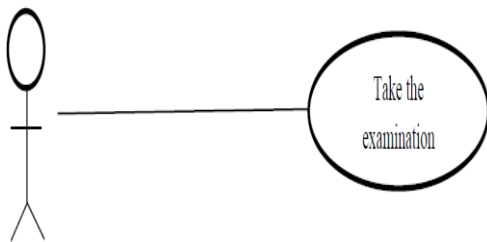
Fig. 6. Use case diagram for the Student

The relationship among the entities that make up the CBT system is modeled using the entity-relationship diagram presented in figure 7.

Fig. 7. Entity relationship diagram for the CBT system

(d) Programming Tools for the Developed CBT System

    i.   Microsoft SQL Server 2008

    ii.   Macromedia Dreamweaver 8.0

    iii. Microsoft Visual Studio 2012

4 RESULT AND DISCUSSION
The CBT system is composed of six (6) different functional pages including the student login page, the admin login page, the question page, the result summary page, question upload and configuration page as well as the student result page.

4.1 The Student Login Page
This is the default page of the system. It is also known as the homepage of the system that automatically loads after the URL has been requested for by a web browser on the client system. It contains the login section for the student to provide his or her details which is used to authenticate the student to gain access to the system. This page is depicted in figure 8. The student logs-in with the matriculation number and password. The page also contains a link to the lecturer login section.
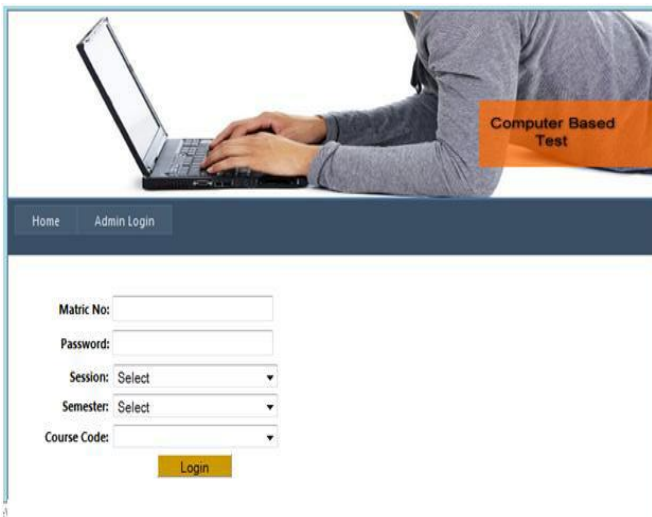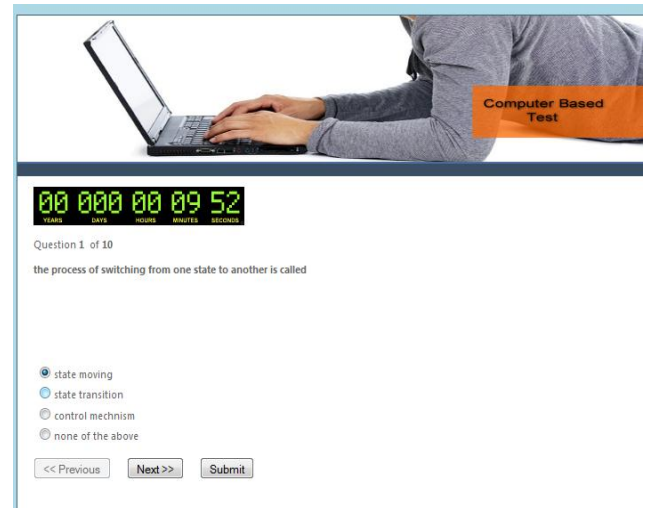
339

Fig. 8. Student Login Page

4.2 The Admin Login Page

As shown in figure 9, this page is used by the lecturer to login into the system in other to carry out operations like setting questions, viewing the result summary report to generate a complete list of student's grade after their examinations among other things. The lecturer always logs in with a pre-assigned and re-modified username and password.
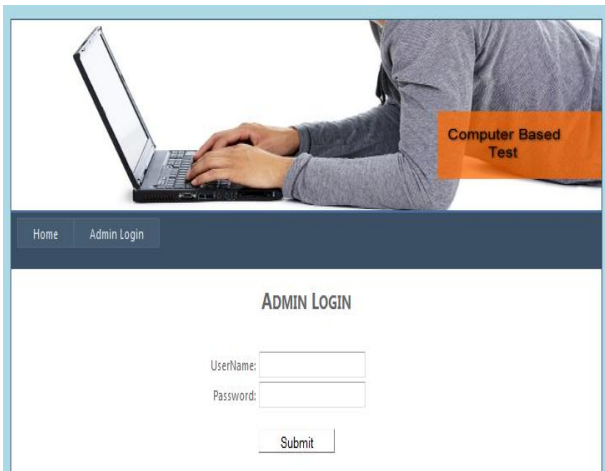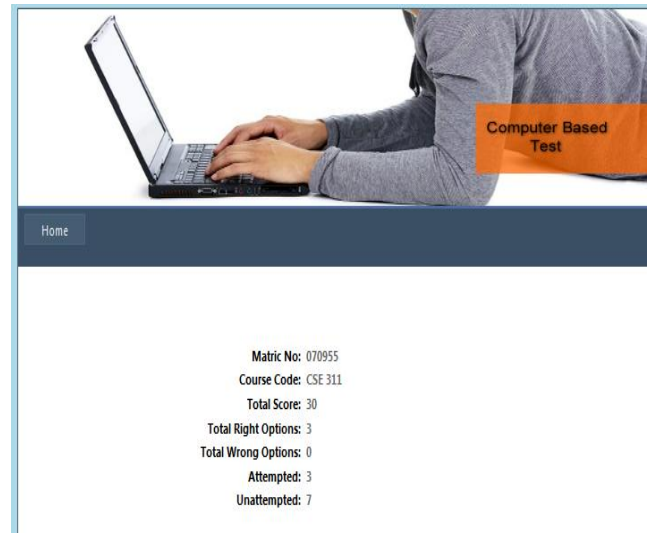

Fig. 9. Admin Login Page

4.3 The Question Page

This module is used to serve the questions of the examination to the student. The page is depicted in figure 10. The page upon load fetches questions from the database randomly and serves it to the student who can answer the questions by checking the radio button which corresponds to the correct answer in the student's option or present the answer in the required format required. The page also initiates a count-down timer which is used to manage the duration of the examination.

Fig. 10. Question Page

4.4 Student Result Page

The student result page is presented in figure 11. This module is used to display the result of the student in the concluded examination, the result is computed based on the number of options the student provided that matches the correct option specified by the lecturer or answered in a preferred format presented by the lecturer. The grade of the student is also displayed.

Fig. 11. Student Result Page

4.5 Question Upload and Configuration Page

This module provides a platform for the lecturer to input his or her question into the database, while inputting the question into the database, the lecturer also has to specify the answer to the question. This module is displayed in figure 12.
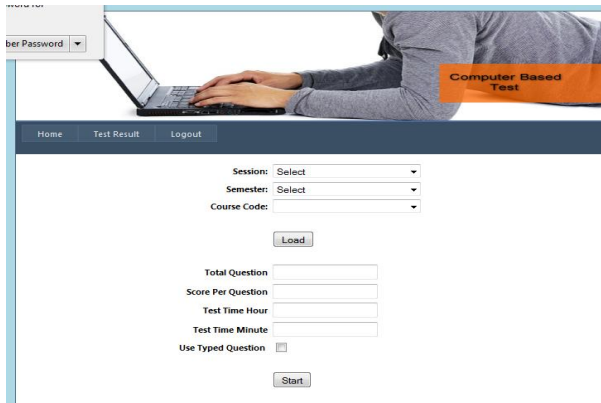
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Fig. 12. Question Upload and Configuration Page

4.6 Result Summary Page

This module, as shown in figure 13, is used to display the result of all students who have taken examination using the system based on the user's query.
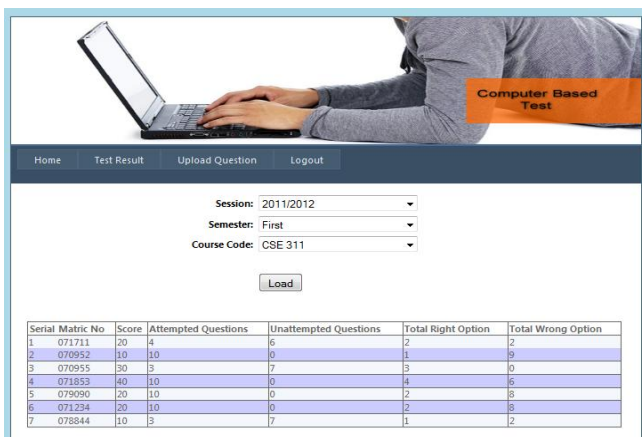

Fig. 13. The Result Summary Page

4.7 User Quality Assurance / Performance Scoring of the CBT System

The user quality assurance and performance scoring test was carried out using evaluation metrics including user friendliness (tool-tip text, soft guide notes, pop-up messages), user interface design, reliability, robustness, ease of use, flexibility (customizable features / controls to suit the user's needs) and scalability to incorporate new and advanced features. Performance assessment was carried out by 250 users of the CBT system and the average performance scoring is summarized in figure 14. The users comprise of software developers, students, lecturers and network engineers.
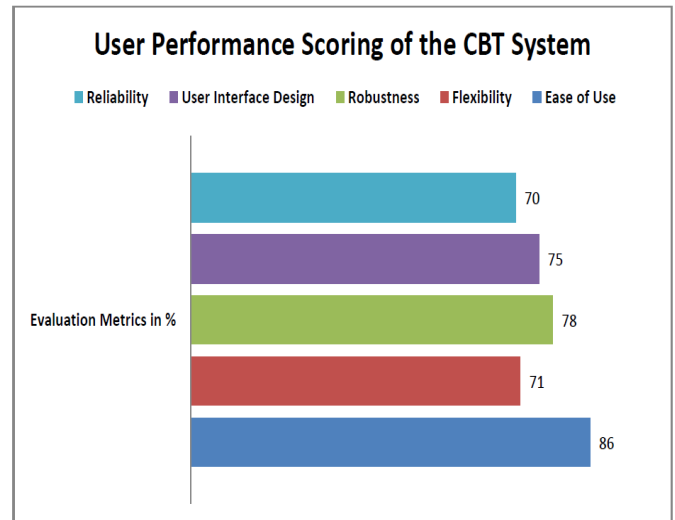

Fig. 14. User Performance Scoring of the CBT System

The software requirements for the CBT system include:

i. Operating system: Windows 2000/XP/VISTA/7

ii. Web browser: Internet Explorer 6+, Mozilla Firefox, Google Chrome.

iii. Microsoft SQL Server 2008

5 CONCLUSION

In this paper, a CBT system is developed and proposed for adoption in Nigerian Universities. The information system is an online examination system that delivers questions set by the lecturers 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. Challenges including examination malpractices, low capacity examination venues, inadequate invigilators, inadequate examination materials, omission of student's results and human error(s) during the marking / grading process will be automatically eliminated following the adoption of this *e*-examination system. The cost implication of conducting a mass-driven examination will become drastically and significantly reduced as there will be no need to print questions or answer booklets anymore. However, future research work should accommodate theory-based questions as opposed to only the multiple-choice and structured question formats that the CBT system currently accommodates. Also, provision for video-based *e*-assessment can be investigated.

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341

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