



## **Computer Based Testing (CBT) System for GST Exams in Adamawa State University, Mubi**

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### **Authors' contributions**

*This work was carried out in collaboration between both authors. Author NN initiates the need to have the GST exam automated, did the system analysis, and designed all the UML diagrams. Author AS designed the questionnaires and performed the data collection and analysis was also responsible for coding. The two authors were involved in debugging and review of relevant literatures. Both the authors read and approved the final manuscript.*

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### **ABSTRACT**

The examination is one of the most broadly used strategies for assessing learning and capacity of a student. Adamawa State University is engulfed in a lot of irregularities during examination and also delays of results after the examination. These and another manual method of processing results give room for errors during results compilation. The utilisation of Information and Communication Technology in directing examinations can enhance proficiency and decrease the delay of student's result after examination. A Computer Based Testing System (CBT) was designed and implemented to diminish the delay of student's examination result. The CBTS was designed using the Agile model of the Software Development Life Cycle (SDLC). Implementation was done utilising the open source technologies, like XAMPP server, MySQL, PHP, JavaScript, Cascading Style Sheet and Hypertext Markup Language. The CBT presents notice of student's outcome quickly in the wake of taking the examination, enable the student to retake the exam (where necessary), and furthermore give diverse kinds of questions. The utilisation of CBT system can enhance the productivity and gainfulness of scholarly establishments as it diminishes the cost of

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stationeries and work associated with conducting examination manually. This by implication can reduce the cost of buying examination materials (papers, printers, turners etc) and students can have their results immediately after the examination. The developed system proved to be efficient and can be enhanced by adding other forms of questions like diagrammatic question to make the test address more diverse areas.

*Keywords: Examination; CBT; online exam; student; general studies; malpractice; delays.*

## ABBREVIATIONS

*CBT : Computer-Based-Testing*

*GST : General Studies*

*ADSU : Adamawa State University - Mubi*

## 1. INTRODUCTION

General Studies usually coded as GST is a university based core course that equip students with education-oriented skills that cover a broad range of topics, thus prepare them for endless career paths. General Studies is a common nomenclature in most institutions of higher learning. By status, GST is compulsory for all registered students irrespective of course of study or programme of study at the university. In other words, all General Studies courses must be offered and passed by students to meet graduation requirement of the University.

As the name implies, general studies is "general" because it encompasses studies from a wide range of contents from various spheres of human endeavours. The course is tagged with various names in other institutions but it is generally refers to as GST in Adamawa State University, Mubi.

GST gives student basic preparation for many future careers. Graduates who acquired fundamental knowledge of GST can use the same experience to perform basic functions in various professional fields, including education, law, government, health care, social service, and private industry. Due to the ever increasing number of students offering GST courses and some observed examination irregularities like delays in processing results; there is a need to employ a method of assessment that can be used to conveniently examine a large number of students at the same time. Computer Based Test is a modern approach to testing and assessment. It is one of the modern breakthroughs of technology. Technology has significantly reshaped the method of evaluating students. For instance, Computer as a tool for technology is

used in multi-dimensional ways, though only very few organisations in Nigeria, including tertiary institutions, have gone beyond word processing and other routine tasks [1]. In many educational sectors, educational evaluation has moved towards the use of computer-based testing (CBT), which is known as tests or assessments that are administered by use of computer through technological devices linked to the intranet and in certain cases, internet.

Computer based Test simply refers to tests and assessments conducted through the use of organised systems on computers. Computer Based tests have the ability to automate a very time consuming task, marking and monitoring progress. Chalmers [2] sees Computer Based test as a test that can be used in a supervised or non-supervised environment and can allow students to check their progress through self-assessment. It can also be used for testing lower-order skills (such as knowledge, understanding and application); it can also be used for testing higher-order skills to improve the students' analysis, synthesis and evaluation skills with more complex application software.

### 1.1 Overview of CBT System

During the last few decades and especially from 1990 onwards computer-based testing (CBT) has become one of the most conspicuous ways of organising and delivering the tests. The reason behind this prominence of CBT over the paper-and-pencil based testing is its ease of administration, immediate display of results, improved item development, enhanced identification and authentication, and so forth. However, most of the organisations and institutions are still relying on the examinations where the examinees have face to face exams in an identified place under an administered situation. This may help the organisations to check the authenticity of the examinee by checking his identity using ID card and also ensuring that no cheating is going on during the exam. But due to the enormous advantages of

computer-based testing over the traditional paper-and-pencil based testing, most of the organisations are now moving towards CBT, Saleh et al. [3].

Kuyoro et al. [4] viewed CBT as an assessment platform in which a computer is an integral part of question papers' conveyance, response, marking of response or report of results from a test. The main goal of a computer based testing system is to provide all features that the examination system must have, with a user friendly interfaces that don't terrify its clients. Taylor [5], a Computer-Based Testing system could be conveyed on a remain solitary PC, inside a disengaged Local Area Network (LAN) or online using technologies such as the web, for example, web pages over the Internet. The two sorts of CBT system are:

1. Linear Test
2. Adaptive Test

## 1.2 CBT System in Nigerian Institutions

The computer based testing system can be used as an assessment tool in a long distance education or online education systems with a quite number of students. Successful execution of an examination targeted at assessment and evaluation is very critical, because of the problems arising from human errors and other technical difficulties which may lead to questioning of the examination and thus reliability and efficiency of the online and distance education systems [6].

National Open University of Nigeria (NOUN) is a distance learning institution in Nigeria which has many schools and academic centres within the country employs the use of online examination as their method of evaluating and assessing their students.

A research conducted by Osang [7] on 105 academic staff, revealed that 84 respondent recommended the use of CBT for conducting their examination in the university (NOUN) based on the fact that it is easy to use and administer by the users. Most importantly is it a fact that the examination result can be viewed immediately after the examination.

Many tertiary institutions are now using the CBT system for conducting Post-UTME examination for screening students into universities. So many universities in Nigeria are fully or partially

implementing the use of CBT system for evaluating their students [4]. However, some institutions like the National Open University of Nigeria (NOUN), has fully implemented the use of CBT system for assessing their students and it was employed through the internet, while other institutions employ through the intranet. Since 2015, the Joint Admission and Matriculation Board (JAMB) has been using the CBT system fully to conduct exams for admission into the tertiary institutions in Nigeria [4]. The use of ICT services can only be appreciated when compared with the manual method where students wait so long before getting their result.

## 2. LITERATURE REVIEW

A novel online examination system in light of a Browser/Server structure was designed by Zhenming et al. [8] to test the ability of students on basic computer skills using the Multi-Choice-Question (MCQ) type of question. The courses include Visual Basic programming, Operating system, Word, MS Office Packages, Internet and Email services. The system was a distributed communitarian system which depends on Distributed Component Object Model (DCOM) innovation. Web Information Server 4.0 (IIS) was utilised as the Web Server, Microsoft SQL Server 7.0 as Database Server and a browser as user interface. Cryptography, real-time monitoring system and data transmission encryption were utilized to ensure security of the system. The system can be enhanced through an arbitrary organisation of questions to decrease the level of examination malpractice.

Yuan-Lung et al. [9] developed an online examination system that isn't restricted by time and place which allows students to schedule time for examination based on their level of study. The system generates test questions randomly for each student, which reduces exam malpractice. The questions could likewise be in form of diagrams and animation other than MCQ questions, subsequently making the test addresses more different aspects that need to be examined. The system was categorized into three unit: The student unit, the instructor unit and the admin. Implementation was done using ASP.NET, internet information server (IIS) and Microsoft access as the database. The database was accessed using ODBC. Students can schedule their examination time based on their study progress. Test takers can check the test

result instantly after the test. With the ascent in cybercrimes, the security improvement of the online examination system ought to be looked into so as to guarantee that the exam questions are not altered or leaked preceding formal examination date.

Rashad et al. [10] built up an online examination administration system that is equipped for supporting a faculty in an institution, students and administration roles in the examination procedure. The system uses various types of questions, for example, yes/no question, multi choice question single answer, multi choice/multiple answer questions, fill-in the black question with a string. The system marks and gives out Examination result immediately. The system can be deployed through the Internet which is suitable for both local and remote examinations. The system could help, lecturers and instructors who will make new examinations or alter existing ones and the students that will participate in the examination. The system was designed using open source technologies like; AJAX, PHP, HTML and MYSQL as the database. Since the system will be used over the internet it will require a reliable security.

An online examination system that allow students to haphazardly choose a test paper or utilise a test question assigned by the instructor to test them keeping in mind the end goal to comprehend their learning level and change their learning progress was designed by Qiao-fang [11]. The system enables the lecturers to manage questions through questioning, including, erasing and altering the questions. It likewise guarantees that test questions are haphazardly generated based on specific requirements. A student can likewise haphazardly select a paper for an individual test. Implementation was done using client/Server model as its network application development model. Java Web technologies using the JSP Model 1 and JavaBean were utilised together with Tomcat as the JSP Engine and Web Server. JavaScript was used on the client-side scripting language while JSP was used as the server-side scripting language. The system enables the students to test their knowledge anytime they want to assess their level of understanding in a particular course. However, this work does not show us whether the system had a flexible timing feature that can logs off the student from the system when his time elapsed; this will help with evaluating how well the student has mastered a course.

A web-based online examination system designed by Adewale et al. [12], which gives out students' scores immediately upon submission of the examination. The Admin of the system has the privilege of adding, editing and deleting test questions. A client can enroll and login with his/her particular id. The system has two users (the admin area and the Student area). The system was designed using ASP. NET and VB.NET having DB2 as the back end (database). Windows 2000 Enterprise was used as the server interface while both of Windows 95/98/2000/NT could be used as the student interface. The system can generate a report (Exam result) showing who passed and those that failed the examination. The challenges of this system is that the lecturer can't enter the questions directly into the system and the questions are not randomised, Arachchi [13]

The CBT system developed by Fagbola et al. [14] was an online examination system that assesses students using multiple choice questions set by the lecturers and is capable of grading students accordingly. The system is expected to provide an effective solution for mass student evaluation and provides functionalities such as auto-submission of examination on the expiration of set time, auto-grading of students and examination result report generation. The Waterfall Model of software development Life cycle was adopted and the conceptual design (activity diagram, the use cases, the data flow diagram and the entity-relationship diagram) were presented. Macromedia Dreamweaver 8.0, Microsoft Visual Studio 2012 and Microsoft SQL Server 2008 were the tools used for the development of the CBT system. The system was implemented using C# (C Sharp) and SQL server. The CBT system was composed of six different functional pages which are the student login page, the admin login page, the result summary page, the question page, question upload and configuration page and the student result page. It was expected that the system would proffer solutions to challenges such as examination malpractices, low capacity examination venues, inadequate invigilators and inadequate examination materials. Performance assessment of the CBT system was carried out using 250 students and the statistics proved the system as highly flexible. This CBT system can be improved on through the implementation of essay-based questions. Integration of students' continuous assessment should also be included for it to be effective in a tertiary institution.

Alabi et al. [15] developed an online examination system which manages the entire examination process, i.e add, delete, update and refresh, execution and assessment, management of feedback from students, alongside guaranteeing utilization of analysis reports identified with the questions and examination created by an intelligent agent in the decision-making process. The system design incorporates Administration, Implementation, Finalization and Support layer. A Monitoring Agent was intended to help students through making reports. Analysis on this system at Sakarya University Turkey, demonstrated that the proposed intelligent agent support online examination system, it can detect problems that may emerge and enable the teachers to easily make decisions more effortlessly on such issues in a shorter time. The system utilises the IF THEN construct, it was recommended that the system should incorporate more intelligent features with the aim of solving more diverse issues Hedberg et al. [16]

Oyo et al.; P. Newhouse) [17,18] examined some of the challenges of the existing computer-based testing systems and came up with a new system that could be deployed on either internet or intranet. The proposed scheme was designed by a unified process using UML. Security and result integrity features were integrated in the system. The examiner should answer some questions on the first login and should update his authentication details. All authentications are logged automatically by the system in order to determine any illegal access. Also, an examinee could not have more than one active session running simultaneously.

### 3. MATERIALS AND METHODS

The CBTS developed in this work is based on the existing implementation infrastructures with an improvement in the systems adaptability to meet with the Nigerian structure of higher institutional examination systems. The Software Development Life Cycle (SDLC) for this system is the Agile Model. The CBTS presented was designed using; use case diagrams, entity-relationship diagram and data flow diagram. The design was based on the users and the system requirements of the CBTS.

#### 3.1 Research Methodology

Data was collected using stratified random sampling. Interview and questionnaire were administered to students and staff at all levels in the University as seen in Tables 1 and 2. Thirteen departments were selected for this study in ADSU; where eighteen (18) students (10 males, 8 females) were selected from each department for the interview and questionnaire purpose. Also six (6) lecturers were selected from each department for interview on their students' performance in the GST courses.

The departments that were selected randomly include; Computer science, Mathematics, Chemistry, Physics, Public Admin, Business Admin, Political Science, Agric. Econs & Ext., Animal Production, Biochemistry, Geography, Mass Communication and Accounting.

**Table 1. Students response**

S/N	Department	Students		
		Good/Accept (18)	Fair/Reject (18)	Indifference (18)
1	Mathematics	8	10	-
2	Computer Sci.	5	13	-
3	Biochemistry	9	9	-
4	Political Sci.	3	14	1
5	Business Admin	7	11	-
6	Public Admin	4	12	2
7	Agric Extension	4	14	-
8	Accounting	4	11	3
9	Mass Comm.	8	10	-
10	Chemistry	7	10	1
11	Geography	2	16	-
12	Physics	6	12	-
13	Animal Production	6	11	1
	<b>Total</b>	<b>73</b>	<b>153</b>	<b>8</b>

**Table 2. Lecturers responses**

<b>Lecturers</b>				
<b>S/N</b>	<b>Department</b>	<b>Good/Accept (6)</b>	<b>Fair/Reject (6)</b>	<b>Indifference (6)</b>
1	Mathematics	1	5	0
2	Computer Sci.	2	4	0
3	Biochemistry	1	4	1
4	Political Sci.	2	3	1
5	Business Admin	2	4	0
6	Public Admin	1	5	0
7	Agric Extension	3	3	0
8	Accounting	1	4	1
9	Mass Comm.	2	4	0
10	Chemistry	2	3	1
11	Geography	1	5	0
12	Physics	0	6	0
13	Animal Production	0	5	1
	<b>Total</b>	<b>18</b>	<b>55</b>	<b>5</b>

### 3.1.1 Analysis of the interview result

From the Tables 1 and 2, it was discovered that out of the 234 students interviewed, 73 students accepted that the manual method of examination (PPT) for GST courses is good enough. 153 students rejected the use of the manual method of conducting the examination, thus prefer the use of CBT system for the conduct of GST exams, while only 8 students show indifference to the interview. Also, from Table 2, 76 lecturers were interviewed, 18 prefer to continue using the existing manual method (PPT) while 55 saw the need for CBT system. Only five 5 lecturers did not respond to the questions.

It can, therefore, be concluded from Tables 1 and 2 above that most of the students and staff prefer the CBT system to the manual PPT or paper based methods of conducting GST examination in the University. This agrees with Omega [19].

### 3.2 Problem of the Existing System

The manual method of conducting the examination in Adamawa State University, Mubi is faced with challenges due to the ever-increasing number of students taking exams which include but not limited to exam malpractice, inaccuracy in marking, delay in marking results and omission of student's results, (Omega; PDF) [19,20].

However, much CBT system has been designed to curb with the above-mentioned problems but with certain limitations which includes:

- a. Some of the systems are standalone which makes it difficult to use over the internet or intranet.
- b. While some of the systems support only Multi-Choice-Questions (MCQ).
- c. And most importantly, the security of the system.

Hence, this research to design and implement a robust CBT system that can curb the existing problem and optimally meets the standard requirements in terms of speed, security, questions randomisation and cost.

### 3.2.1 Research question

Can the manual method (pen -on - paper) of GST examination be automated in Adamawa State University?

### 3.3 The Developed System

The CBT system developed in this paper is an online examination system which can be use over the internet or intranet. The system support MCQ and fill in the blank spaces type of question, it allows the students to retake examination (where necessary), view their result immediately upon submission with a flexible

timing function and presents the overall result statistically using pie chart.

### 3.3.1 Security of the system

1. The system allow students to login only when it is time for exam (the admin sets the time).
2. Login details of users is well encrypted using MD5 encryption method.
3. Data access is limited to each user except the admin who oversees the entire system.
4. To avoid leaking of exam questions, only the course lecturer is allowed to upload exam questions.
5. To help curb exam malpractice, the exam questions are randomized.

### 3.4 System Development

The CBT system was designed based on the requirements specifications. The conceptual design was carried out using; the data flow diagram together with the Entity-Relationship Diagram, system flow chart and the use case

diagrams. However, Fig. 1 is the flowchart diagram of the CBT system.

### 3.5 Development Tools

The CBT System was developed using WAMP Server, Hypertext Markup Language (HTML), JavaScript and Cascading Style Sheet (CSS), PHP and MySQL.

## 4. RESULTS 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 Implementation

The implementation was done on xampp server locally hosted on a computer and tested for consistency and correctness. The screen shots in the figures below shows few interfaces from the system.

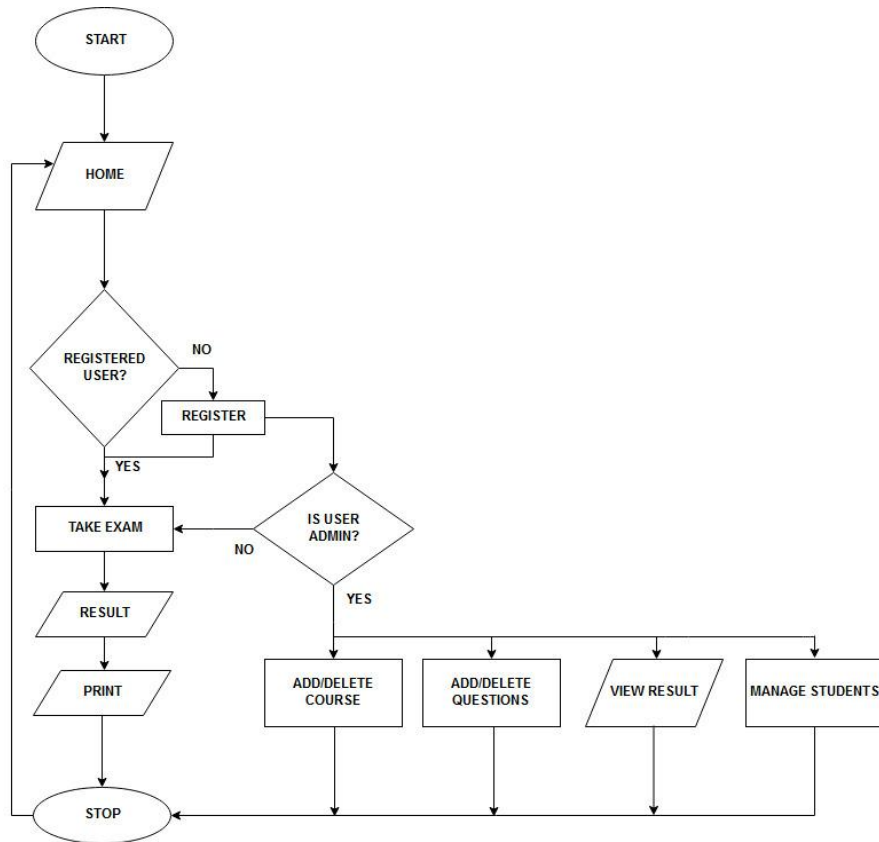


Fig. 1. Flowchart diagram

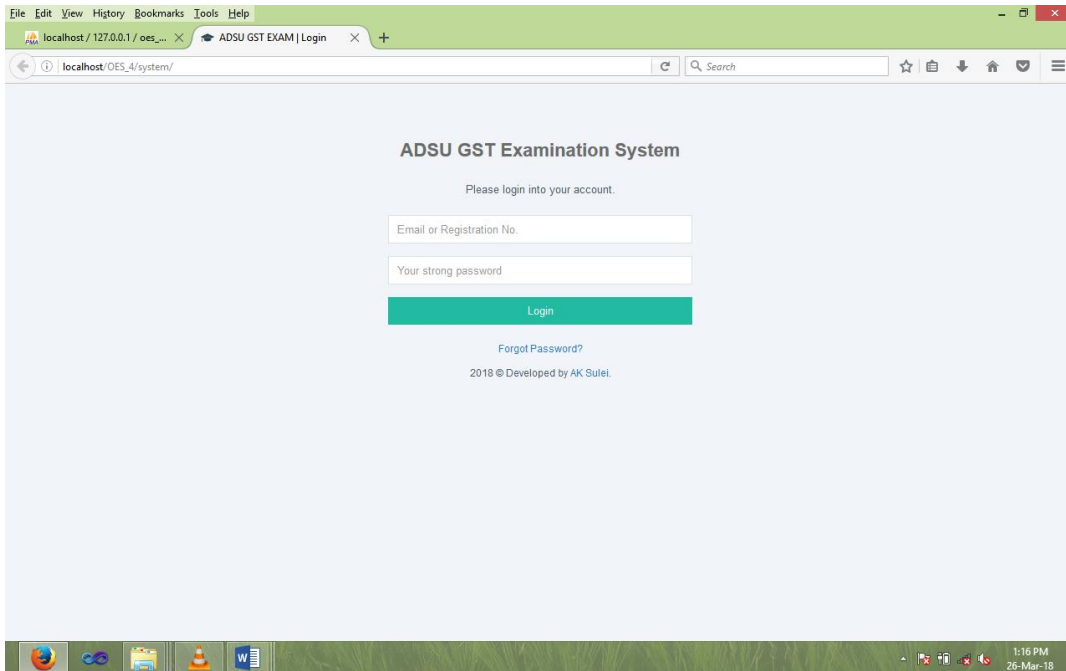


Fig. 2. Login page

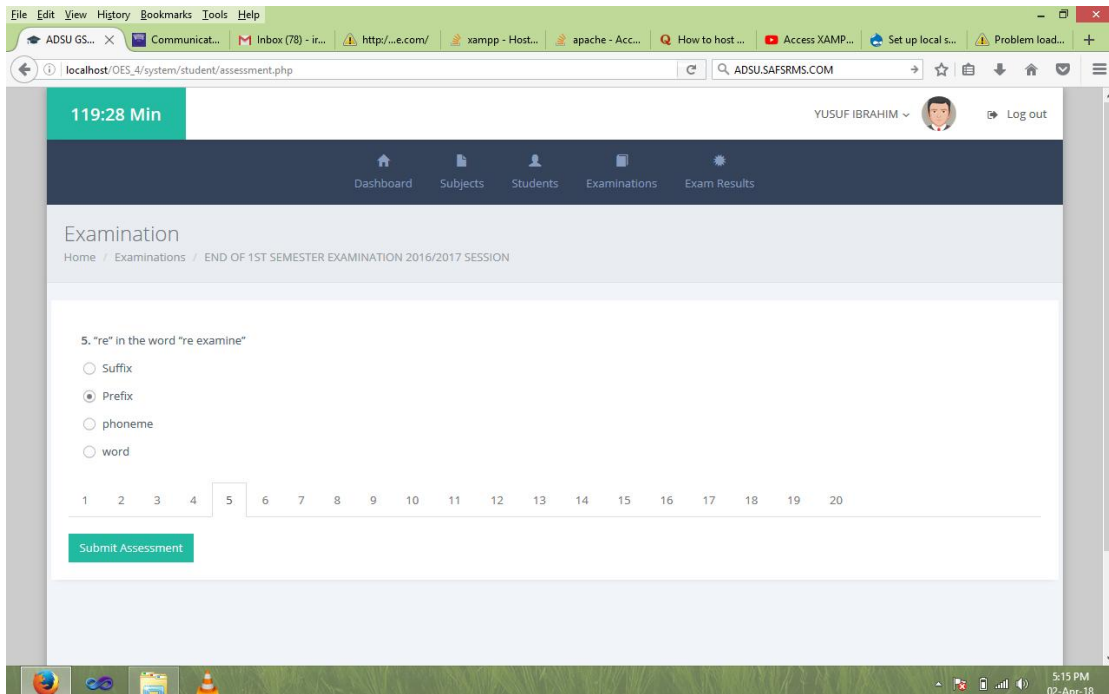


Fig. 3. Examination page

This page (Fig. 2 above) is used by the users of the system to login into the system with their login details in order to perform tasks on the system; it is also the homepage.

Fig. 3 above shows the examination process. Students use this section to take their examination; the page allows students to navigate through question numbers and



finally submit by clicking on the submit button. However, the system submit automatically when the exam time elapse.

can login to their dashboard later to view the result.

The students' result page is displayed immediately upon submission of the examination showing the score in percentage and remark. However, students

The course lecturers uses this section to upload or set examination question by choosing the question type such as MCQ or fill in the blank space e.t.c, and thus specify the correct answer and pass mark.

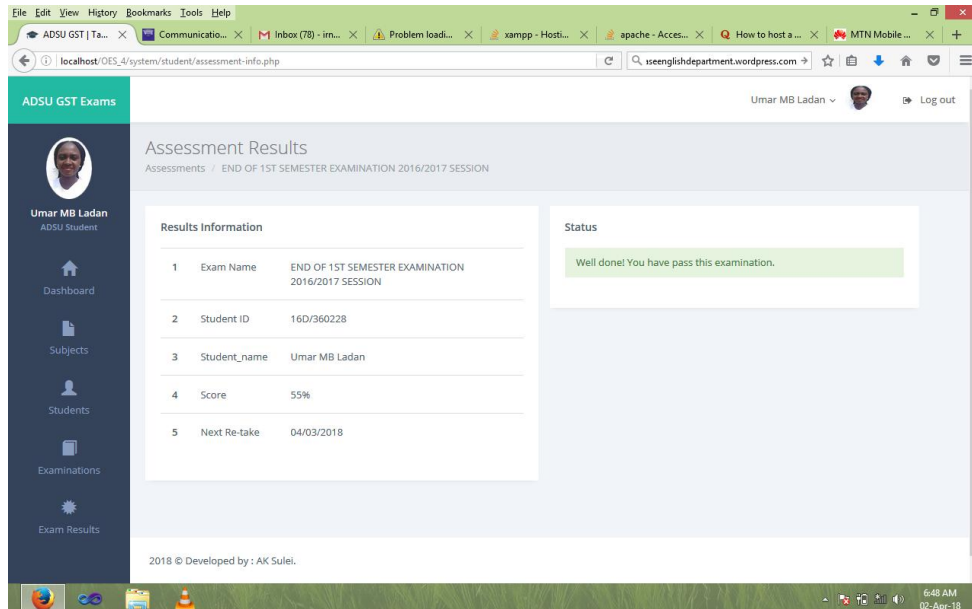


Fig. 4. Students' result page

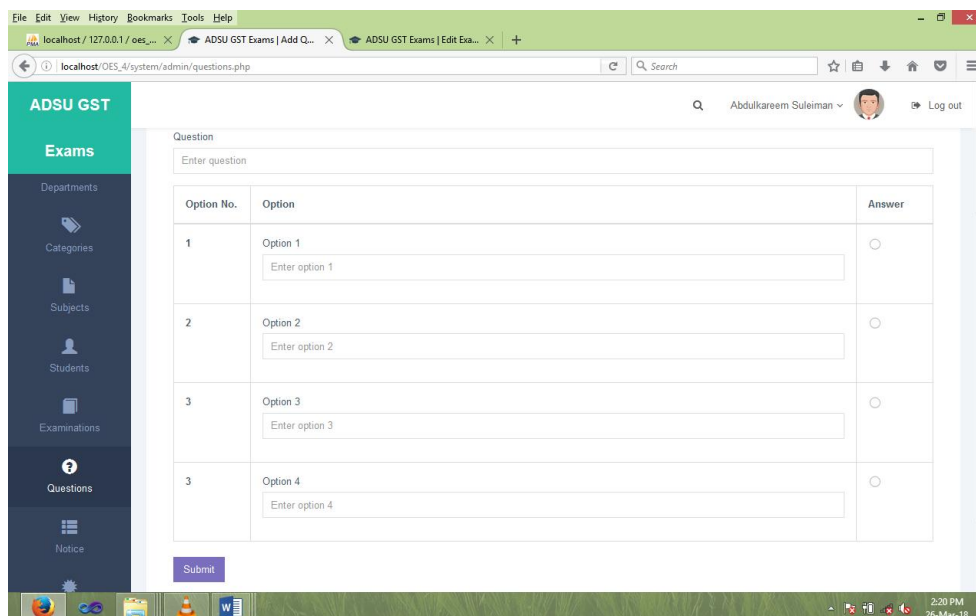


Fig. 5. Question upload page

The screenshot shows a web browser displaying the ADSU GST Exams Results page. The page title is "END OF 1ST SEMESTER EXAMINATION 2016/2017 SESSION Results". The user is logged in as Abdulkareem Suleiman. The page shows a table of results for five students. The table has columns for Student Name, Student ID, Exam Name, Score, Status, Date, RE Exam, and Action. The data is as follows:

Student Name	Student ID	Exam Name	Score	Status	Date	RE Exam	Action
ALIYU UMAAR	10/110007	END OF 1ST SEMESTER EXAMINATION 2016/2017 SESSION	75%	PASS	04/02/2018	04/03/2018	Select Action
Aminu Hamidu	13D/360116	END OF 1ST SEMESTER EXAMINATION 2016/2017 SESSION	20%	FAIL	04/02/2018	04/03/2018	Select Action
SANI MOHAMMED SHEIKH	15U/330035	END OF 1ST SEMESTER EXAMINATION 2016/2017 SESSION	65%	PASS	04/02/2018	04/03/2018	Select Action
Umar MB Ladan	16D/360228	END OF 1ST SEMESTER EXAMINATION 2016/2017 SESSION	55%	PASS	04/02/2018	04/03/2018	Select Action
YUSUF IBRAHIM	15D/360233	END OF 1ST SEMESTER EXAMINATION 2016/2017 SESSION	45%	PASS	04/02/2018	04/03/2018	Select Action

The page also includes a sidebar with navigation options like Dashboard, Departments, Categories, Subjects, and Students. At the bottom, it shows "Showing 1 to 5 of 5 entries" and navigation buttons for Previous and Next.

Fig. 6. Result summary page

## 5. CONCLUSION

However, in conclusion, findings shows that the CBT system has the possibility to do away with some of the problems that are linked with the manual methods of conducting examination such as omission of students result, delay in marking result, inadequate examination materials, human error (s) during the marking process, and eliminate some forms of examination malpractices. By adopting CBT system, the cost implication of conducting General Studies (GST) examination in the university will be cut down drastically as there will be no need print questions papers and answer booklets.

## 6. RECOMMENDATION

The researchers recommend that the system be adopted in Adamawa State University. The system is secured, many security features has been integrated. Staff can upload their questions during examination and students can see their results immediately after the examination.

## 7. FURTHER STUDIES

However, future research work should accommodate:

1. Other forms of question types such as diagrammatic questions to make the test questions more diverse.

2. Automatic delivering of the students' login details and results to their mobile phones or email address.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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