COMPUTER BASED TEST FOR THE CONDUCT OF EXAMINATION IN NIGERIAN UNIVERSITY BASED ON VOICE RECOGNITION

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ABSTRACT

In Nigeria today, the adoption of computer-based Test (CBT) over the years has become an acceptable and ideal method for assessing student's performance in the university system. However, since its introduction, candidates are only allowed to read questions from the computer screen and input answers via the mouse or keyboard without attending to the needs of the physically challenged who are vision impaired. Hence, this study proposed the design and implementation of a CBT with voice command. This study adopted the object oriented analysis and design methodology (OOADM). Python programming language and React.js, were used to implement the system, and supported with MangoDB database engine. The system is a web-based application based on behavior and states of objects. The voice mode is enabled with a click to read onscreen questions to the blind candidates, using the API.gTTS Google Text-to-Speech API with the aid of earpiece and system speaker.

1.   Introduction

A computer-based test (CBT) refers to any examination that is administered and answered using a computer or electronic device instead of traditional pen-and-paper methods. In CBT, the test questions are presented on a computer screen, and candidates select their answers either by clicking on the options presented or by typing in their responses. The entire process of test delivery, response recording, and scoring is managed electronically. CBT is commonly used in educational settings, professional certifications, and standardized testing programs due to its efficiency, scalability, and ability to provide instant feedback to test-takers [1, 2]. Computer-based testing (CBT) in Nigeria has evolved significantly over the past few decades, driven by advancements in technology and a growing need for efficient and scalable examination processes. The introduction of computer-based testing in Nigeria began in the late 1990s and early 2000s.

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Initial implementations faced challenges such as inadequate infrastructure (like reliable electricity and internet access), limited computer literacy among candidates, and concerns about the security and reliability of CBT systems. Despite these challenges, CBT gradually gained traction, especially in universities and professional certification exams.

The Joint Admissions and Matriculation Board (JAMB), responsible for university admissions in Nigeria, started conducting CBT for the Unified Tertiary Matriculation Examination (UTME) around 2013. This move aimed to curb examination malpractice and improve the efficiency of the examination process. Computer-based testing in Nigeria has evolved from early challenges to become a widely accepted and increasingly integral part of the educational (i.e. universities) and professional assessment landscape, driven by the benefits it offers in terms of efficiency, scalability, and improved test integrity. By the mid-2010s, CBT had become more widespread across various educational institutions, professional bodies, and government agencies in Nigeria. JAMB fully transitioned from paper-based tests to CBT for UTME, which is one of the largest examinations in Nigeria, taken by hundreds of thousands of students annually. Other organizations and sectors, including recruitment agencies, licensing bodies, and educational assessment services, also adopted CBT to streamline their examination processes. Testing agencies are taking advantage of it to provide high-quality services since agencies are currently using it to deliver services more effectively.

Practically speaking, applicants who choose computer-based exams will need a computer, a keyboard, and a mouse. CBT testing is conducted in-person at a testing centre that has been accredited, using a computer. Computer-based testing facilities are vetted and approved in a manner similar to that of paper testing facilities to guarantee that test-takers have the most equitable and positive testing experience. Establishing a new testing centre includes providing jurisdiction and test centre officials with training. Testing facilities are permitted to employ laptops or desktops as long as the necessary specifications are fulfilled. For many other test delivery programs, computer-based testing is the norm. Additionally, as technology develops, the majority of important evaluation programs are adopting it as their standard format [2, 3]. Since JAMB implemented CBT in the UTME, there have been numerous grievances and issues raised about it. The issues include: (1) candidates with physical disabilities might not be able to use the input devices as they would like; (2) candidates with vision impairments might find it challenging to read the questions on the computer screen; (3) there is not a submission status page to show which candidates have submitted; (4) timing inequity resulting from system lag; (5) candidates do not have a backup input device in case their keyboard and mouse break; and so on [2]. motivated by these limitations, this study decides to design a web-based voice recognition system in conducting examinations in the Nigerian University. The purpose of this study is to design and implement a voice-activated computer-based testing (CBT) system for the Nigerian universities, in order to alleviate the plight of the vision impaired candidates.

The rest of the paper is organized as follows: a review of related work is presented in section 2 while section 3 presents the materials and methods. Our results and discussion were presented in section 4. Section 5 discussed our conclusion of our work.

2.   LITERATURE REVIEW
The use of computer-based tests (CBTs) has grown over the past few years across a wide range of disciplines and objectives. The results indicate that CBTs offer advantages over paper-and-pen (pnp) versions in terms of efficiency (by cutting down on testing time) and effectiveness (by preserving test reliability). However, one of the validity evidences required in a CBT is that the variables (such as computer algorithms and research designs) still need to be well-designed.

Accordingly, efforts are still underway to further enhance the use of CBT in higher education, as many testing developers maintain that computerized testing will be able to offer prospective benefits [4]. Few studies have carried out research in this direction in the past, however, there is still need to improve on the existing works to address the physically challenged using adaptive technologies. Using voice command, the authors in [2] created a computer-based test system for the physically challenged that is intended to be used for both entrance and matriculation. The design of an enhanced computer-based examination in Nigeria tertiary institutions was proposed in [5]. The study used questionnaire survey to elicit respondent's opinion about the scalability, flexibility, reliability, ease of use, friendliness, user design interface, and robustness. The study opined that the use of adaptive technology which include the text-to-speech (read aloud) and face-ID authentication can help improved CBT. Shobayo *et al.,* in [6] investigated the perceived effectiveness of computer-based test mode among undergraduate students in southwestern Nigeria. The study showed that the use of CBT mode of examination in the university is effective and recommend its continuous provisions. E-examination system based on security and result integrity for Nigerian universities was proposed in [7]. Twenty students and five members of staff in six universities were interviewed using questionnaire. The new system used data encryption in order to protect the questions and a biometric finger print authentication to screen stakeholders. However, the system was not implemented. Similarly, Addah *et al.,* in [8] implemented a computer test for theory exams in tertiary institutions in Nigeria. However, the grading system is not automatic. Also, he authors in [9] carried out an evaluation of the JAMB computer based on test effectiveness in postsecondary schools in Nigeria. They opined that the challenge faced in the implementation of CBT is enormous and there are questions that needs to be addressed. In [10], the nature, structure and scope of computer based test for conducting general studies in university of Ilorin in Ibadan was examined. The study suggested that it is essential that the designer examines the purpose and aim of the learning to ensure that the assessment is appropriate to the skills, knowledge and attitude to be addressed. The design and development of an online CBT software for assessment and examination in the department of social science and technology education, university of Jos was proposed in [11]. The CBT software was developed as a web application using HTML, CSS, Angula 12, Java 11, Spring boot with Rest API and My SQL. The study recommends CBT for courses having large number of students to address malpractices and missing scripts issues. An enhanced computer based examination system with fingerprint authentication was designed by Akingbade and Eze in [12] using web-based application. The study suggested that biometric technique is still the most secure and safe means of authentication. However, the authors opined that there is still more secure identification and personal verification technologies to be introduced as the level of security is being compromised each day. Abubakar and Adebayo identified the opportunities and obstacles that could jeopardise the implementation of CBT in all exams and provided strategies for mitigating those risks [13]. The main sources of secondary data used were textbooks, scholarly publications, conference papers, and online resources, among others. According to the report, there are 10 major obstacles to CBT adoption in Nigeria, including power outages, poor ICT culture, policy, and implementation, security concerns, software, and economic factors. As a result, the study identifies many strategies to diffuse the situation, including public relations campaigns, web campaigns, post-test feedback, consistent power supplies, adoption of ICT policies, and instructional presentations on cognitive behavioral therapy [15]. Similarly, Alabi *et al.* in [1] designed a single-user-mode computer-based examination system, focusing 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. However, in Abah *et al.,* in [14] 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, caused by the absence of a networking system. Also, the system is not diverse enough as it does involve the theory based and diagrammatic questions. The reviewed works show that most works were stand-alone system, lacks voice-to-text or text-to-voice command recognition system, while others used questionnaire survey to elicit opinions about CBT usefulness and reliability, very few cater for the disabled candidates in addressing their needs. It is against this backdrop of the limited work successes recorded in the deployment of CBT based on vision impaired candidates that this paper leverage on a voice mode command to assist the vision impaired candidates to take their exams with the least minimum assistance from their friends and colleague.

3.   METHODOLOGY

This section discusses the methodology adopted in the design of our proposed CBT-based system. The hardware and software requirements for developing the system and proposed system architecture on which the system is based upon to achieve its goal are discussed.

3.1.   Hardware and Software Requirements

The following hardware and software tools are the minimum requirements needed for the development and implementation of the enhanced CBT with voice command capabilities. These features include a dual-core Intel Core i5 processor (or AMD Ryzen 5), an 8GB memory, 128GB solid state drive (SSD), an Ubuntu Linux LTS (Long Term Support) version operating System, modern web browser with Web Speech API support (e.g., Chrome, or Firefox), a high-speed internet connection for optimal performance, typescript in specifying the types of data being passed around within the code, with the ability to report errors when the types do not match. Others are Python programming language was used as a high-level, general-purpose programming language, with a design philosophy which emphasizes code readability with the use of significant indentation. Python was adopted in this study because it has been one of the most powerful, versatile programming languages, easy to learn and is widely used among developers. The Integrated Development Environment (IDE), using Visual Studio Code to run the Python programming language was adopted. The IDE is a software application interactive environment that provides comprehensive facilities for software development. IDE is optimized for building and debugging modern web and cloud applications. The MongoDB database, a flexible data model that enables the storage of unstructured data, and provides full indexing support, and replication with rich and intuitive APIs was adopted.

These general recommendations, and specific requirements may vary depending on the university's needs and the number of concurrent users. Universities with a larger user base or intensive use of features like video conferencing might need more powerful hardware that is beyond the scope of this study. Ubuntu Linux operating system, though a free open source software, was adopted because of its stability and security. It is a popular choice for educational institutions due to its cost-effectiveness and customizability. The Web Speech API is not mandatory but can enhance accessibility and user experience for note-taking or interacting with the system through voice commands.

3.2.   Proposed System Architecture

The system architecture shown in Figure 1 based on the three-tier client-server architecture presented in Figure 2 is adopted in this study. The design illustrates the interactions among the admin, teachers and students in a typical CBT system.
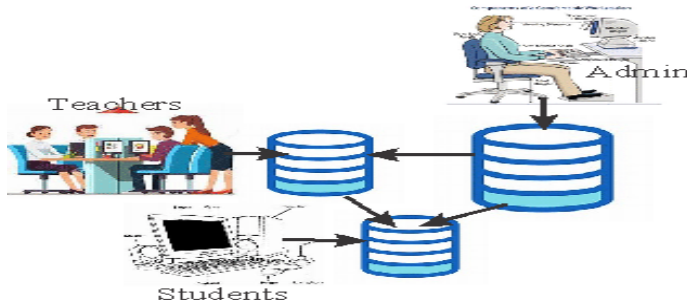
Figure 1. Users Interactions

From the Figure, the admin sets all privileges both to the teachers and students alike. The teachers set questions and allocate timing for exams, while the students complete privilege take exams. It describes the process flow, decisions, and outcomes of the design. The users of the CBT system comprise of and admin, the teachers and the students as depicted in the Figure 1. The conceptual design of a typical CBT system depicting the activity diagram, the data flow diagram and the use-case diagram, and the entity-relationships are described in our previous works in [5]. Each tier of the three-tier client-server architecture as shown in Figure 2 has a different role in the layered construction of distributed systems. The user interface and user interaction fall under the purview of the Presentation Tier. It functions as the application's front end, where users enter data and see the results. The management and storage of data falls under the purview of the Data Tier. It manages and performs all database functions, such as updates, retrieval, and management. The primary business logic is located in the Application Tier. In addition to processing user requests and interacting with the Data Tier to retrieve or store data, it also executes calculations and upholds business rules.
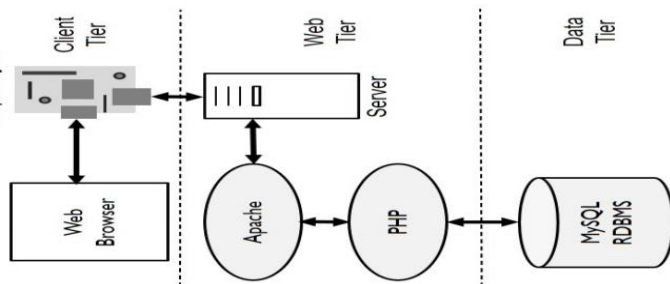

Figure 2. Three-tier client-server architecture [16]

4.   RESULTS AND DISCUSSION

The CBT system is composed of 5 main screens/components that are displayed conditionally which are the Splash Screen (Figure 3), Quiz Topics Screen, Quiz Details Screen, Questions Screen, and Result Screen. The front page enables students to take their exams option from React, JavaScript, Python, Gatsby, Angular, CSS or Kotlin courses. Figure 4 depicts the page redirecting privileges or user's roles to Admin, Students or Teachers to carry out their tasks. Also, the voice mode can either be activated or deactivated by clicking the button to toggle it on or off as depicted in Figure 5. While Figure 6 shows the start page of any quiz taken by the students, Figure 7 depicts the Quiz completion page. Figure 8 shows the scores students got at the end of taking their exams/quiz, and the total number of questions answered correctly. It also shows each score attached to each questions totaling the scores for the students and status of the performance as either pass or failed and time spent so far. Figure 9 depicts the total number of students that are registered and other details with regard to payment of school charges, email accounts, matriculation number and password details.
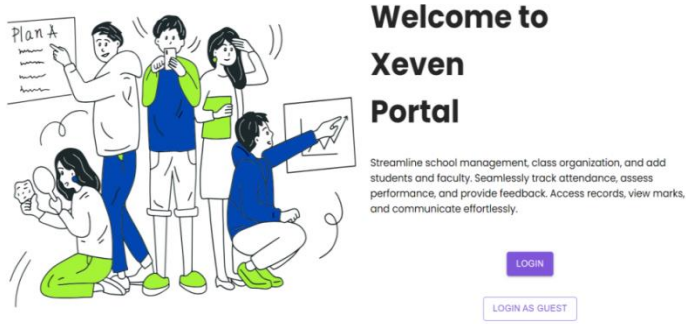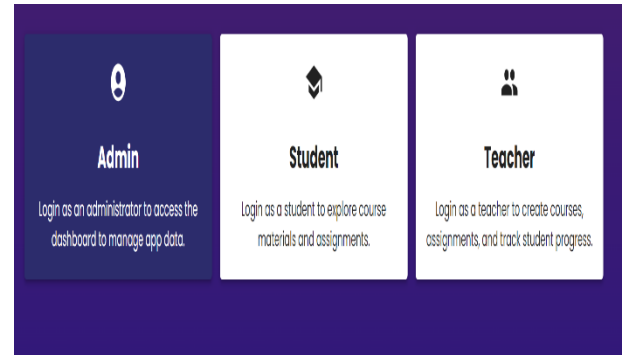
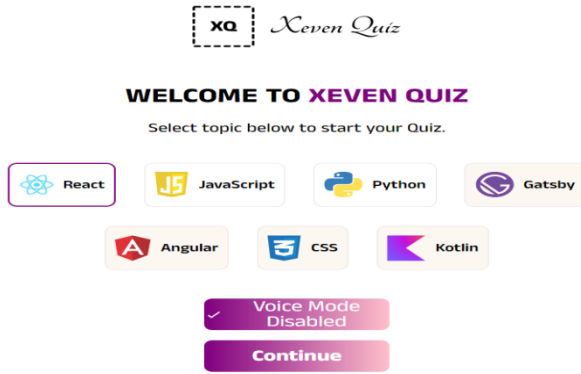**Figure 3. Splash Screen/Welcome Screen**

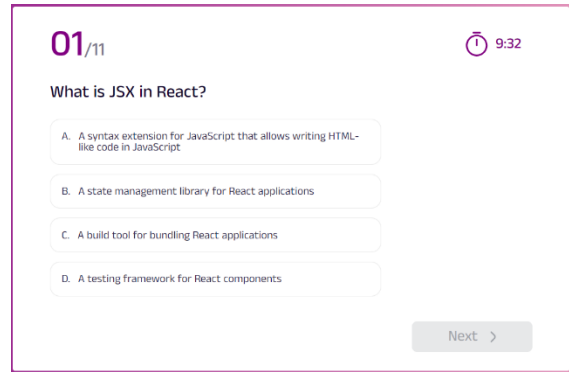

Figure 4. Choice Login Page
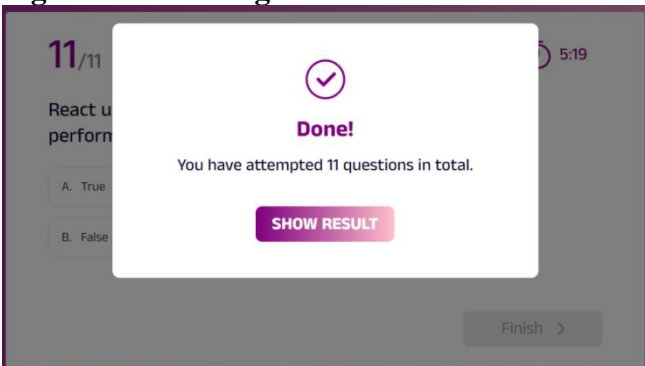

Figure 5. Front Page

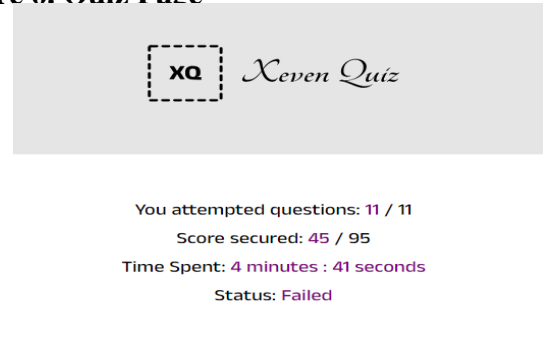**Figure 6. Quiz Page**

Figure 7. Quiz Completion Page

Figure 8. Result Page

ID	Name	Roll Number	Email	Password	Role	Has Paid School Fee
1	Chinedu Okeke	101	chineduokeke@example.com	password123	student	true
2	Ngozi Uche	102	ngouziuche@example.com	password123	student	false
3	Emeka Nwosu	103	emekanwosu@example.com	password123	student	true
4	Adetola Adebayo	104	adetolaadebayo@example.com	password123	student	true
5	Kelechi Eze	105	kelechieze@example.com	password123	student	false
6	Chioma Obi	106	chiomaobi@example.com	password123	student	true
7	Olumide Ayodele	107	olumideayodele@example.com	password123	student	false
8	Funke Adeola	108	funkeadeola@example.com	password123	student	true
9	Ifeanyi Nwachukwu	109	ifeanyinwachukwu@example.com	password123	student	true
10	Aisha Bello	110	aishabello@example.com	password123	student	false

Figure 9. Students Records

The CBT Management System is a web-based application built using the MERN stack including Mongo database, Express.js, React.js, and Node.js. It aims to streamline school management, class

organization, and facilitate communication between students, teachers, and administrators. Some of the features of the CBT system are: **User Roles:** The system supports three user roles: Admin, Teacher, and Student. Each role has specific functionalities and access levels. **Admin Dashboard:** Administrators can add new students and teachers, create classes and subjects, manage user accounts, and oversee system settings. **Attendance Tracking:** Teachers can easily take attendance for their classes, mark students as present or absent, and generate attendance reports. **Performance Assessment:** Teachers can assess students' performance by providing marks and feedback. Students can view their marks and track their progress over time. **Data Visualization:** Students can visualize their performance data through interactive charts and tables, helping them understand their academic performance at a glance. **Communication:** Users can communicate effortlessly through the system. Teachers can send messages to students and vice versa, promoting effective communication and collaboration.

CONCLUSION

This paper designed and implemented a Web-based CBT system with voice recognition for the physically challenged candidates. The adoption of this system can help to reduce the attendant problems faced in the University system which are impersonation, corruption cases, leakages of examination questions, further reduce the use of printing papers, and also the number of invigilators and so on. Most importantly, the blind candidates will have some level of relieve as to be able to take exams with limited assistance as the case is with existing systems. Also, the system has the tendency of increasing computer literacy among the key users and promote trust in the system. Future research may consider other challenges faced by students without limbs, hearing loss, security issues and others challenges that can inhibit the progress achieved by our proposed system.

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