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Development of a User-Centered Computer-Based Examination System with Automated and AI-Assisted Assessment

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Abstract

The growing reliance on digital technologies in higher education has increased the demand for efficient, secure, and scalable examination systems. Traditional paper-based examinations are often affected by challenges such as question leakage, delayed result processing, high administrative costs, and increased opportunities for examination malpractice. In response to these limitations, this study presents the design, implementation, and evaluation of a web-based Computer-Based Examination System (CBES) developed to enhance examination management and assessment processes, using Koladaisi University, Ibadan as a case study. The proposed system was developed following a user-centered approach, with requirements gathered through interviews and web-based questionnaires administered to students and lecturers. A three-tier architectural model was adopted to ensure modularity, scalability, and system security. The CBES supports secure user authentication, examination scheduling, randomized question delivery, time-controlled assessments, automated grading for objective questions, and AI-assisted evaluation of subjective responses. The system was implemented using widely adopted web technologies, including HTML, CSS, JavaScript, PHP, and MySQL. System testing and evaluation were conducted through unit testing, integration testing, and user acceptance testing under simulated real examination conditions. Performance results indicate high levels of usability and responsiveness, with most users rating the system as easy to use and satisfactory in overall performance. The findings demonstrate that the CBES significantly improves examination efficiency, accuracy, and reliability while reducing administrative workload and operational costs. This study confirms the practicality of computer-based examination systems as sustainable solutions for modern academic assessment and supports their broader adoption in higher education institutions.

Keywords: *Computer-Based Examination System; Web-Based Assessment; Academic Evaluation; Automated Grading; Higher Education; Digital Examination.*

1.0 Introduction

Today, the computer-based examination system is currently thought of as a rapidly developing examination technique due to its speed and accuracy. Computer-based examination management systems have improved the effectiveness and efficiency of the examination administration and grading process. Computer-based examination system, sometimes referred to as e-assessment or testing, is a test-administration technique in which the responses are either evaluated or recorded electronically, or both [5]. One of the main advantages of computer-based examination administration systems is the capacity to develop examinations specifically suited to the requirements of Information Technology and Computer Science classrooms. These systems make it simple for teachers to include a variety of question formats, including multiple-choice and subjective questions.

The online method of administering tests and examinations to students is crucial to the educational system in Nigeria which is in line with the newly approved blended method of teaching by the National Universities Commission (NUC) for the Core Curriculum for Minimum Academic Standard (CCMAS). Hence, Koladaisi University Ibadan, should also adopt the blended method of administering tests and examinations to students. Being a private University, the number of students in Koladaisi university keeps increasing and this necessitate need to adopt the blended approach and hence, reason for the computer-based examination system to ease the method of administering questions to students.

This project has been built to convert the current examination system at Koladaisi University into a digital system which requires lesser labour force and will be more accurate and less time-consuming as well. At present, Koladaisi University, Ibadan, adopts a pen and paper-based approach for administering examinations to her students, which is prone to leakage of questions, wastage of funds for examination stationeries, and results delay. Hence, this system was developed to ease examination script marking and grading system as well as saving cost, time, and also helps to reduce examination malpractice at Koladaisi University, Ibadan.

This research developed a computer-based examination system for Koladaisi University, Ibadan. The objectives of this research are to design and implement a computer-based examination system and to evaluate the system using performance and user satisfaction metrics. The study covered the design and implementation of a computer-based examination system using Koladaisi University, Ibadan as the case study. The system allows students to register and take the examinations, and also enables lecturers to input questions into the system and view and modify students' results.

The adoption of computer-based examination systems has become increasingly prevalent in educational institutions, offering several advantages over traditional paper-based examinations. However, the implementation of these systems is not without its challenges. Technological challenges include frequent hardware failures or slow response times, which can disrupt the examination process and cause significant inconvenience to the examinees. Software bugs or security vulnerabilities can also compromise the integrity of the examination.

[13] iterated that organizational challenges involve meeting the logistical and financial needs required for the implementation and upkeep of developed systems. Data privacy is another major concern, as managing and protecting the personal data of students and their examination results in compliance with data protection regulations is a complex but necessary task. [12] developed an electronic examination system using the client-server approach on an intranet environment to cater to questions presented in multiple-choice multiple answers and multiple-choice single answers. The performance of this approach was evaluated by implementing the application on different local host operating systems such as Linux and Windows using Xampp, Wamp, and Lamp.

[1] proposed a methodology classified into two main phases: the design of a question bank along with its database and the design of an Artificial Intelligence-based system for examination and its evaluation to improve e-learning. [7] developed and implemented an agile web-based system for planning and managing examinations in a university using a mixed-method approach that combined Agile Development, Rapid Application Development, and survey techniques.

[9] researched the transition from paper-based tests to computer-based national examinations using purposive sampling and evaluation models.

The study identified inconsistencies, leakage of questions, and result delays as major limitations of traditional examination systems.

[10] developed an online examination system for English grammar with time limitation features. [4] designed an adaptive online secure examination system using encrypted QR codes, though the study lacked discussion on system vulnerabilities. [14] developed a web-based examination system using Java web technologies to support question management and online testing. [8] proposed an online dynamic examination system with automated grading but noted its inability to grade subjective questions. [11] proposed a mock test and examination system incorporating biometric verification, though it supported only multiple-choice questions.

[3] evaluated e-examinations during COVID-19 using fingerprint matching and handwriting validation, identifying high cost as a limitation. [15] designed online examination applications for national examination preparation but did not address scalability challenges. [6] proposed the design and development of an online CBT software for assessment and examination in the Department of Science and Technology Education, University of Jos.

2.0 METHODOLOGY

In this section, the methodology employed for the development of the Computer-Based Examination System (CBES) is discussed. The methodology flowchart for the study is illustrated in Figure 1 and comprises the following stages:

i. Requirements Analysis and Data Collection
ii. System Design and Architecture
iii. System Implementation and Integration
iv. System Testing, Evaluation, and Validation.

2.1 Requirements Analysis and Data Collection

Data for the design and development of the Computer-Based Examination System (CBES) were collected using interviews and web-based questionnaires. To support this study, interviews were conducted with students and lecturers to identify their needs, expectations, and challenges with existing examination systems.

In addition, web-based questionnaires were administered to a larger group of users to gather data on user interface preferences, usability, accessibility, and overall system effectiveness as shown in Table 1. These responses provided diverse and reliable input that guided the system design decisions.

Further data were obtained through an analysis of existing computer-based examination systems. This analysis focused on identifying system objectives, strengths, limitations, and areas requiring improvement. By utilizing these data collection methods, the study ensured that the proposed CBES is user-centered, effective, and aligned with institutional examination requirements.

Table 1: Demographic Information Report from the data collected+

Question	Response Option	Results
Age	Under 18, 18-24 25-34, other	17.3% 61.5% 20.2% 1%
Gender	Male Female	68.3% 31.7%

2.2 System Design and Architecture

The next crucial stage in the methodology is the system design and architecture phase. This stage is essential to ensure that the Computer-Based Examination System (CBES) is well-structured, efficient, and capable of meeting user and institutional requirements. The design process focuses on defining how the system components interact and how data flows across the system.

The system architecture is based on a three-tier model, which separates responsibilities to improve scalability, maintainability, and security. The key design components include: Presentation Layer (Frontend), Business Logic Layer (Backend) and Data Access Layer. These design decisions are not merely structural choices but critical foundations that ensure the system operates reliably, securely, and efficiently. A well-defined architecture supports smooth examination delivery, accurate result processing, and real-time feedback. This structured design provides a solid framework for the subsequent implementation and testing phases, ensuring the CBES performs effectively in real academic examination environments.

2.3 System Implementation and Integration

System implementation and integration represent a crucial stage in the development of the Computer-Based Examination System (CBES). During this phase, the designed system architecture is translated into a functional application. The implementation focuses on developing the frontend, backend, database, and the seamless integration of all system components.

The frontend is implemented using HTML, CSS, Bootstrap, and JavaScript to provide an interactive and user-friendly interface for students, lecturers, and administrators. The backend is developed using PHP, which handles user authentication, examination logic, scoring, and communication with external services such as OpenAI for evaluating subjective responses. The database layer is implemented using MySQL to store user data, examination questions, responses, and results.

This integration process is critical to ensuring that all components work cohesively as a single system. Just as feature extraction in machine learning enables a model to identify relevant patterns, effective system integration ensures that examination data flows accurately between layers. This cohesive interaction enables secure examination delivery, reliable automated scoring, and timely feedback, thereby ensuring the overall efficiency and reliability of the CBES in real-world academic environments.

2.4 System Testing, Evaluation, and Validation

This phase was carried out to ensure that the system functions correctly, meets specified requirements, and performs reliably under real examination conditions. The testing process covered different system components, including user authentication, examination creation, examination delivery, automated scoring, and result generation. Both unit testing and integration testing were conducted to verify that individual modules and their interactions operated as expected.

The system was evaluated by simulating real examination scenarios involving students, lecturers, and administrators. Test cases were designed to assess system performance, response time, accuracy of automated grading for objective questions, and the reliability of OpenAI-based evaluation for subjective questions. Validation was performed by comparing system outputs with expected results to ensure correctness and consistency.

Through repeated testing cycles, identified errors and weaknesses were corrected until the system's performance stabilized. The evaluation outcomes and performance results of the CBES are presented in the subsequent chapter, demonstrating that the system is effective, reliable, and suitable for academic examination management.

3.0 Implementation

The implementation of the Computer-Based Examination System (CBES) involved several key stages, including requirements analysis, system design, system development, integration, testing, and validation. These stages ensured that the system was developed in line with the specified requirements and functioned effectively in a real academic environment.

3.1 System and Software Requirements

The software tools used in the implementation of this project include Visual Studio Code as the development environment, PHP for backend development, and MySQL for database management. The system was developed and deployed on a Windows operating system environment.

The technologies used for the frontend implementation include HTML, CSS, Bootstrap, and JavaScript, which were employed to design an interactive, responsive, and user-friendly interface. RESTful APIs were used to enable secure communication between the frontend and backend components of the system.

The hardware used in carrying out this project includes a personal computer with an Intel Core i3 processor or higher, a minimum of 2GB RAM, and a 64-bit operating system. These hardware specifications were sufficient to support system development, testing, and deployment of the CBES.

The CBES uses a client-server model where clients request services from a centralized server as shown in Figure1.

Client: Administrators, lecturers, and students access the system via a web browser, which sends HTTP requests to the server.

Server: Processes client requests, executes business logic, and interacts with the database, which stores examination data, user information, and responses.

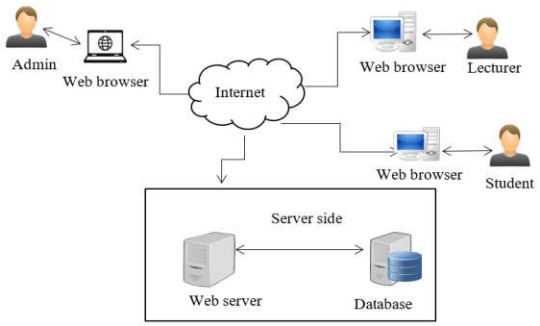

Figure 1: CBES Framework / Model

Figures 2, 3 and 4 below show the code snippet for html and php.

```php
<?php
function emptyinputSignin($admin , $pass){
    $result;
    if (empty($admin)|| empty($pass)) {
        $result= true;
        }
        else{
            $result = false;
        }
        return $result;
    }


    function invalidemail($email){
    $result;
    if (!filter_var($email,FILTER_VALIDATE_EMAIL)) {
        $result= true;
        }
        else{
            $result = false;
        }
        return $result;
    }
    function passwordmatch($Password, $repassword){
        $result;
        if ($Password !== $repassword) {
            $result= true;
            }
            else{
                $result = false;
            }
            return $result;
        }
    function passwordmatchlogin($conn, $admin,$pass){
        $sql = "SELECT * FROM admin WHERE username = ? ;";
        $stmt = mysqli_stmt_init($conn);
        if (!mysqli_stmt_prepare($stmt , $sql)) {
```

Figure 2

```
                <li><a href="block.php">Manage Account</a></li>

            </ul>
        </li>
        <li ><a href="course.php">Courses</a></li>
        <li ><a href="survey.php">Survey</a></li>
        <li ><a href="logout1.php">Log Out</a></li>
        ';
    }
    if($_SESSION['type'] == "student"){
        echo'
        <li ><a href="#top" class="active">Home</a></li>
        <li><a href="meetings.php">Exams</a></li>
        <li class="has-sub">
            <a href="javascript:void(0)">Pages</a>
            <ul class="sub-menu">

                <li><a href="studenthistory.php">exam history</a></li>
                <li><a href="profile.php">profile</a></li>
                <li><a href="mycourse.html">My courses</a></li>

            </ul>
        </li>
        <li ><a href="course.php">Courses</a></li>
        <li ><a href="survey.php">Survey</a></li>
        <li ><a href="logout1.php">Log Out</a></li>
        ';
    }
```

Figure 3

```
    }
            else {
        echo'
        <li ><a href="index.php" class="active">Home</a></li>
        <li><a href="login.php">Exams</a></li>
        <li class="has-sub">
            <a href="javascript:void(0)">Pages</a>
            <ul class="sub-menu">

                <li><a href="login.php">exam history</a></li>
```

```
    }
    else if ($month == 12){
      $m = 'DEC';
    }
    $quesid = $row['eid'];
    $link = "href="viewquestion.php?eid=".$quesid." "";

    echo'

    <br>
    <div class=" spec">

    <div class="col-lg-4">

    <div class="meeting-item ">
      <div class="thumb">
        <div class="price">
          <span>'.$code.'</span>
        </div>
      </div>
      <br>
      <div class="down-content">
        <div class="date">
          <h6>'.$m.' <span>'.$day.'</span></h6>
        </div>
        <a href=""><h4 class="h4-span">'.$title.'</h4></a>
        </br>
        </br>
        </br>

        <a class="a-btn" '.$link.'>view question</a>

      </div>
    </div>

  </div>

  </div>
```

Figure 4

3.2 Requirements Analysis

The requirements analysis phase involved identifying and documenting the functional and non-functional needs of the Computer-Based Examination System (CBES). This step was crucial to ensure that the system meets the expectations of all stakeholders, including students, lecturers, and administrators.

Functional Requirements:

- User Authentication: This system supports secure login and authentication for students, lecturers, and administrators.
- Examination Management: The system allows the creation of a variety of question formats such as multiple choice, true/false, and essay; scheduling examinations with timer; and assigning examinations to students.
- Examination Delivery: The system supports the secure delivery of examinations to students and the shuffling of questions to prevent cheating.

Non-Functional Requirements:

- Performance: The system loads the times of examinations and the user interface fast; it can handle a large number of users at once.
- Security: The system secures user authentication to prevent unauthorized access.
- Maintainability: The system has clear documentation for other developers to understand and modify the system.
- Usability: User-friendly interface with accessibility features to accommodate all users.

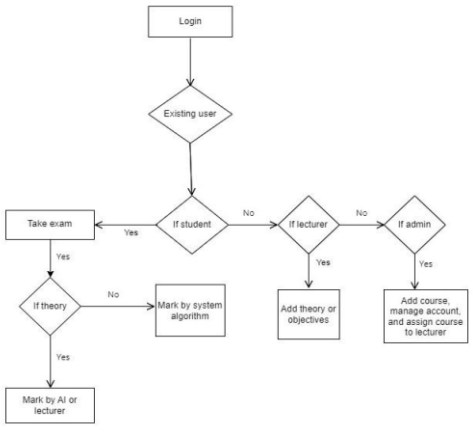

Figure 5: Process View for CBE System

3.4 System Design and Development

The system design phase focused on structuring the Computer-Based Examination System (CBES) to ensure efficiency, scalability, and usability. The design defines how the system components interact, how data flows through the system, and how user requirements are met. The CBES adopts a three-tier architecture consisting of:

Presentation Layer (Frontend): Interfaces with users, providing navigation, examination display, and accessibility. Implemented using HTML, CSS, Bootstrap, and JavaScript to ensure responsiveness and usability.

Business Logic Layer (Backend): Handles examination processing, user authentication, automated scoring, OpenAI integration for subjective question evaluation, and API communication. Developed using PHP with RESTful APIs to ensure secure data transfer.

Data Access Layer: Manages data storage and retrieval using MySQL. Ensures integrity and secure access to user data, examination questions, responses, and results.

This structured system design forms the foundation for the subsequent implementation and integration phase, ensuring that the CBES operates reliably, securely, and efficiently in a real-world academic environment.

3.5 Testing, Evaluation, and Validation

The CBES underwent rigorous testing to ensure reliability, accuracy, and performance:

Unit Testing: Checked individual modules for correct functionality.

Integration Testing: Verified that frontend, backend, and database components worked together smoothly.

User Acceptance Testing: Conducted with students and lecturers to validate usability, accessibility, and correctness of examination results.

Iterative testing and validation ensured that the system met all functional and non-functional requirements, providing a secure, efficient, and user-friendly platform for managing examinations.

4.0 Result

The performance evaluation of the Computer-Based Examination System (CBES) is critical for determining its effectiveness in delivering examinations, grading responses accurately, and providing instant feedback to students. This section describes the measures used to evaluate the system's performance and presents information about its capabilities.

The following subsection presents the performance evaluation results of the CBES based on user feedback and system testing:

Table 2: Performance Evaluation of the CBES

Metrics	CBES Performance
Ease of Use	80.5% rated as "Easy"
Responsiveness	86.2% rated as "Good"
System Speed	56.7% rated as "Quick"
Overall Satisfaction	65.2% rated as "Satisfied"
Recommendation	50.3% rated as "Likely to Recommend"

From the Table 2 above, it can be observed that the CBES received the highest ratings in responsiveness, with 86.2% of users indicating that the system responded promptly to their interactions. Ease of use was also highly rated, with 80.5% of respondents indicating that the system was intuitive and easy to navigate. System speed received a slightly lower rating at 56.7%, indicating that while the system generally performed efficiently, there may be room for optimization in handling large-scale examinations. Overall satisfaction and likelihood of recommendation were also positive, showing that users were generally pleased with the system and willing to suggest it to others.

These results highlight the CBES's capability to provide a reliable, user-friendly, and efficient platform for administering examinations. The system's performance ensures minimal disruption during examinations, accurate grading through automated and AI-assisted evaluation, and immediate feedback to students. The findings demonstrate the practical usefulness of the CBES in improving examination administration, enhancing academic assessment, and increasing user confidence in the integrity and fairness of the examination process.

5.0 Discussion of Results

The performance evaluation indicated that the Computer-Based Examination System (CBES) received high ratings in usability, functionality, and overall satisfaction compared to traditional examination methods. Despite these vital performance metrics, certain areas such as security measures and customer support were not fully optimized. This decision was primarily due to current limitations in system features, which could affect broader scalability and robust user management. Consequently, the CBES was still considered an effective tool for digital examination delivery. The system demonstrated promising results, achieving high levels of ease of use, responsiveness, speed, and overall satisfaction, which underscore its effectiveness in providing a seamless examination experience. This advancement significantly simplifies the examination process, making it both more efficient and reliable.

This study underscores the transformative potential of computer-based examination systems in improving examination administration and user experience. The findings highlight the critical role of advanced digital platforms in modernizing assessment methods and affirm their validity in educational practice. The integration of an automated examination tool with such usability and responsiveness represents a significant breakthrough in academic assessment. This innovation can significantly enhance educational outcomes by enabling timely, accurate, and efficient examination delivery, facilitating improved monitoring and results processing, and reducing the overall administrative burden on institutions.

However, the study has limitations. Key challenges include: Variability in user technical proficiency, practical applicability of advanced security and authentication features in real-world scenarios, and need for continuous optimization of system performance to handle increasing user loads.

Addressing these challenges methodically and pursuing further development could expand the potential applications of CBES technology in educational settings. Collaborative efforts among software developers, educators, and institutional administrators will be crucial in advancing the development and deployment of these systems. Such concerted efforts are paving the way for a new era in educational assessment characterized by efficiency, accessibility, and technological integration. Ultimately, the goal is to enhance learning and examination outcomes universally, ensuring that cutting-edge digital platforms like CBES realize their full potential and contribute to more effective academic administration.

Educators are encouraged to consider integrating CBES as complementary tools alongside conventional examination techniques. Institutional policymakers should actively support developing and integrating these technologies within academic systems, particularly in regions or institutions where traditional examination methods are inefficient or prone to errors. Additionally, staff and students should engage in training programs to ensure the effective implementation and utilization of these systems.

Future research should focus on expanding the scope of CBES functionalities to enable support for multiple examination formats, advanced analytics for educators, and adaptive testing features. While this study primarily focused on multiple-choice and subjective examinations, a more comprehensive approach that includes diverse assessment types could revolutionize automated assessment systems. These advancements would improve examination efficiency and extend these systems' applicability across different educational contexts and institutions. The capability to manage multiple assessment types could lead to developing comprehensive, adaptable, and scalable examination platforms that more effectively address pressing educational challenges.

Table 3

Question	Response Option	Results
Overall Satisfaction with the CBES	Very Satisfied Satisfied Neutral Dissatisfied Very dissatisfied	19.5% 65.2% 15.3% 0% 0%
Likelihood to Recommend the CBES to Others	Very Likely Likely Neutral Unlikely Very unlikely	36.4% 50.3% 10.4% 2.9% 0%

Conclusion

This study has demonstrated the significant potential of a computer-based examination system (CBES) in transforming traditional pen-and-paper examinations into a fully online and paperless mode. While conventional examination methods allow for human oversight, they are prone to errors, academic misconduct, and inefficiencies. The adoption of a CBES underscores the importance of automation, real-time result generation, and streamlined examination management in modern educational settings. The system's ability to deliver instant results for both objective and subjective questions highlight its efficacy in improving examination efficiency and reliability, thus offering a more accurate and convenient alternative to traditional examination methods.

The broader implications of this work suggest a transformative impact on academic administration, particularly in institutions like Koladaisi University, Ibadan, where resources and examination logistics can pose challenges. By reducing the dependency on physical materials, human invigilation, and manual grading, CBES can enhance fairness, minimize errors, and improve overall examination integrity. However, this study also acknowledges remaining challenges, including the need for enhanced automated grading accuracy, advanced security features, and broader adoption across academic programs. Future research and institutional support will be essential to optimize these systems, integrate features such as biometric authentication, and ensure equitable deployment of advanced examination technologies across higher education settings.

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