

DESIGN AND DEVELOPMENT OF SMARTLEARN: AN INTELLIGENT MOBILE AND WEB-BASED EXAMINATION PREPARATION SYSTEM FOR FINAL YEAR SECONDARY SCHOOL STUDENTS.

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Abstract:

In this paper, SmartLearn, a mobile and web-based educational technology tool designed in ELDI,NASENI is to prepare secondary school students for West African Examination Council (WAEC) and National Examinations Council (NECO) Examinations as well as Joint Admissions and Matriculation Board (JAMB) examinations. The system consists in a verified and curated database on previous examination and solutions to past exams, adaptive practice modules and realistic exam simulations. SmartLearn intends to boost students' test readiness with instant feedback, performance analytics, personal recommendations and a robust user-friendly interface. The data for the design were obtained from previous examinations conducted by the examination bodies for several years. The software is meant for students in senior secondary schools in Nigeria. The paper discusses about design and architecture of the software, its development method and evaluation. Preliminary evidence from the pilot implementation suggests increased usage by learners as well as higher score on practice test and confidence among the students.

Key Words: SmartLearn, e-learning, mobile learning, exam preparation, educational technology.

I. Introduction

The failure rates of students in WAEC, NECO and JAMB are on the increase in Nigeria. Examinations conducted by WEAC, NECO and JAMB are high stakes exams that determine students' academic careers, chances of gaining a university admission and the course of their future work and other trajectories in their lives. While this testing is essential, a lot of students find themselves under-prepared for tests due to lack of materials to study from; poor learning strategy and or not having spent enough time practicing past questions from previous years.

There is no available literature that have shown a locally developed mobile and web-based applications that is suitable to assist WAEC, NECO and JAMB candidates to prepare for these examinations with an ease. This paper is poised to address this limitation.

Secondary schools' students have historically relied on tutorial centers and printed past-question booklets. Although helpful, these approaches don't give much interaction, don't provide thorough explanations, and don't have a system for tracking performance or providing tailored feedback. Mobile-based learning platforms offer a chance to improve study experiences and democratize access to top-notch exam-preparation resources, given the quick development of digital technology and the widespread use of smartphones in Nigeria.

To fill these gaps, a team of programmers and software developers from ELDI, NASENI thought it wise to develop SmartLearn to mitigate these problems. Its design is based on the ideas of educational data analytics, adaptive learning, and computer-assisted training. The system offers students tailored learning insights, realistic practice scenarios, and high-quality study resources. The

development process, architecture, features, and evaluation outcomes of SmartLearn are all thoroughly explained in this paper.

II. Related Literature

Because of their flexibility, accessibility, and ability to provide individualized education, digital learning technologies have become increasingly popular worldwide. According to studies (e.g., Mayer, 2021; AlRahmi et al., 2020), e-learning platforms enhance student performance by providing interactive content, self-paced learning, and immediate feedback. Exam preparation tools like Khan Academy and Coursera-based course modules show how technology-enhanced.

Web-based learning platforms and mobile learning (m-learning) have been extensively investigated as tools that enable students to access learning materials via smartphones, tablets, and web browsers at any time and from any location. Compared to conventional classroom-only methods, research shows that these technologies promote flexibility, self-paced study, and higher student engagement (Ruiz-Martínez, Castañeda, & Fernández Breis, 2022). These tools can be utilized both within and outside of the classroom to enhance academic results and promote independent learning.

Although the majority of research has concentrated on mobile learning in higher education, results often indicate that when mobile technologies are successfully incorporated, learning performance, motivation, and attitudes toward learning are improved (Alrasheedi, Capretz, & Raza, 2015; Nikou & Economides, 2018). Research does, however, also point up issues with usability, infrastructural constraints, and reliable device access.

Adaptive learning systems and intelligent tutoring provide individualized learning pathways that maximize study efficacy by customizing instructional content based on each learner's performance. Adaptive systems are essential for preparing for high-stakes exams since they track student responses, pinpoint areas of weakness, and suggest focused revision (Reyes-Millán, Vázquez-Villegas et al., 2024). Although the majority of research has focused on university settings, studies in adaptive systems demonstrate gains in student performance and satisfaction. According to Elmabaredy, Elkholy, and Tolba (2020), adaptive web-based presentation techniques also show that customizing the way information is presented (e.g., multimedia or structured frames) can greatly improve learning outcomes, supporting the justification for intelligent content adjustment in exam preparation platforms.

Any exam preparation system must include online assessment tools since they offer performance metrics, mock exams, and instant feedback. Digital test systems can facilitate customized preparation, automatic scoring, and rich data collecting for performance analysis, according to literature on online exams (Butler-Henderson & Crawford, 2020). When students are accustomed to the digital format, these solutions improve comparability with traditional assessment while also facilitating testing and lowering test anxiety. While a lot of study focuses on online tests in higher education, findings that highlight advantages like immediate feedback and less marking work for teachers are pertinent to secondary exam preparation.

III. Objectives of SmartLearn

The following goals were the focus of the system's development:

- i Make structured previous questions from JAMB, NECO, and WAEC across important topics accessible.
- ii Provide thorough explanations, solutions, and pointers so that students can comprehend rather than commit answers to memory.
 - i. Use timed tests, limited navigation, and automatic scoring to mimic actual exam settings.
 - ii. Monitor learner performance, strengths, and shortcomings using analytics.
 - iii. Improve accessibility so that students from various socioeconomic backgrounds can successfully prepare wherever they are.

- iv. Use adaptive question selection to facilitate self-paced and customized revision pathways.

IV. System Architecture

Overview

The client-server architecture used by SmartLearn is designed to be scalable and cross-platform.

Front-end (client-side)

- i. Flutter was used to create a mobile application that supports both iOS and Android.
- ii. React.js was used to create the web interface.
- iii. The UI/UX was created with low cognitive strain and simplicity.

Backend (server-side) .

- i. Django/Flask or Node.js and Express.js.
- ii. Database: Firebase/Firestore, which holds student profiles, test results, queries, and justifications.
- iii. Redis is used in the caching layer to optimize performance.

Data Flow and APIs

- i. A collection of questions is requested by the user.
- ii. Questions are retrieved by the API according to mode (practice, adaptive, simulation).
- iii. The user provides answers.
- iv. After assessing responses, the system provides instant feedback.
- v. The analytics engine generates performance reports and refreshes performance indicators.

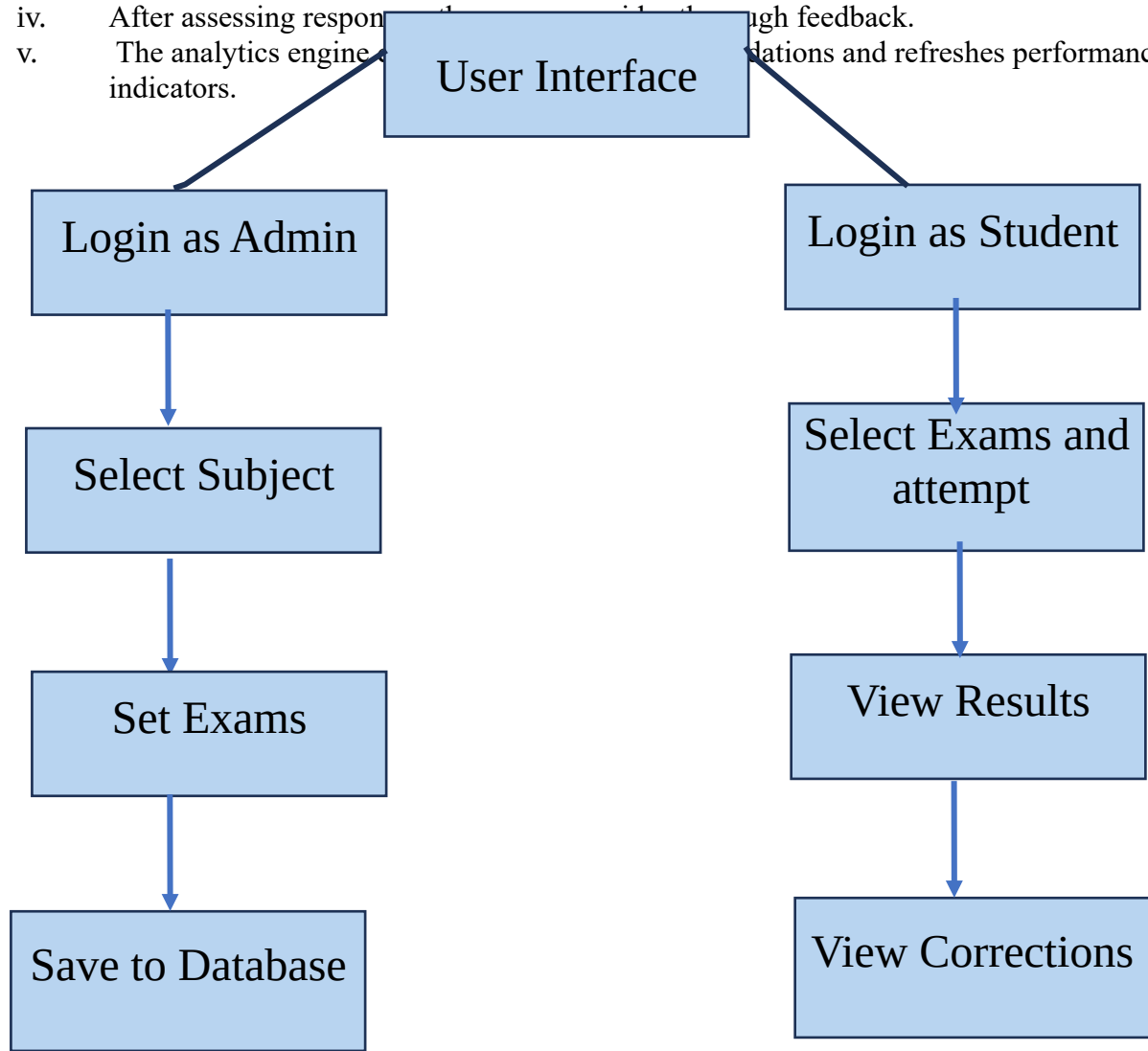


Figure1: The block diagram of the system (App)

From figure1, the system has two branches after successful log-in: the admin panel and the student's panel. The admin panel enables the administrator to select a subject and set or key-in the examination and as well as save it into the database. In the same vein, the students panel permits students to log-in, select examinations, attempt the examinations, view the results and view the corrections.

V. System Features

Past Question Bank

SmartLearn contains past questions spanning several years for WAEC, NECO, and JAMB. Questions are categorized by:

- i. Subject
- ii. Topic
- iii. Year
- iv. Difficulty

Each question is stored with its correct answer, incorrect options, and explanatory notes.

Practice Mode

In practice mode, learners can select specific topics or mixed-question sets. Features include:

- i. Instant grading
- ii. Hints and step-by-step explanations
- iii. Ability to bookmark difficult questions
- iv. Retry options and question shuffling

Exam Simulation Mode

The simulation engine recreates real test conditions:

- i. Timed exam sessions
- ii. Disabled navigation (no going back)
- iii. Automated scoring and performance breakdown
- iv. Exam-like interface to reduce test anxiety

Adaptive Learning Module

Based on past performance, SmartLearn recommends questions using a straightforward adaptive technique (or sophisticated machine learning if implemented). More focused practice is given to those who have difficulty with specific subjects.

Analytics of Performance

The analytics dashboard shows the following: daily, weekly, and monthly progress; accuracy rates for each subject and topic; time spent on each question or topic; strengths and weaknesses analysis; and a recommended study path.

Offline Mode

Certain question sets can be downloaded for offline practice, allowing use in rural areas with limited internet access.

VI. Methodology

Chosen Methodology: Agile–Iterative (Scrum) with Prototyping

Due to the dynamic nature of educational requirements and the requirement for ongoing user feedback from instructors and students, SMARTLEARN was developed using an Agile–Iterative software development process, bolstered by fast prototyping.

Justification for Agile–Iterative Methodology

Final-year secondary school students are the target audience for the SMARTLEARN system, whose learning requirements, test formats, and usability standards are constantly changing. The agile methodology is appropriate because it

i. Encourages Constant User Input

Teachers and students can test early iterations of the system and make suggestions for enhancements.

ii. Promotes Gradual Development

Features like: Question banks ,User registration and authentication

iii. Adaptive tests : Phased development and testing of intelligent recommendations is possible with performance analytics.

Manages Shifting Needs

Exam curricula and customer requirements can change, and Agile makes it simple to adjust without having to restart development.

Enhances Learning and Usability

Regular testing guarantees that secondary school students can continue to use the interface with ease.

Phased development and testing of intelligent recommendations is possible with performance analytics.

Research and Requirements Gathering

i. Requirements Gathering

The requirements were gathered from:

Teachers • Secondary students in their final year

Exam curricula (WAEC, NECO, JAMB)

The development team conducted:

- i. Interviews with secondary school teachers
- ii. Surveys with WAEC, NECO, and JAMB candidates
- iii. Market and competitor analysis
- iv. Curriculum validation with subject experts

Development Method

An Agile development methodology was used, with:

- i. Requirements analysis
- ii. System design
- iii. Prototyping
- iv. User feedback loops
- v. Iterative refinement
- vi. Testing and deployment

Pilot Study

A pilot deployment was conducted with a sample of students across various schools. Data was collected on:

- i. Usability
- ii. Engagement level
- iii. Score progression
- iv. System load performance



Figure2: App Dashboard

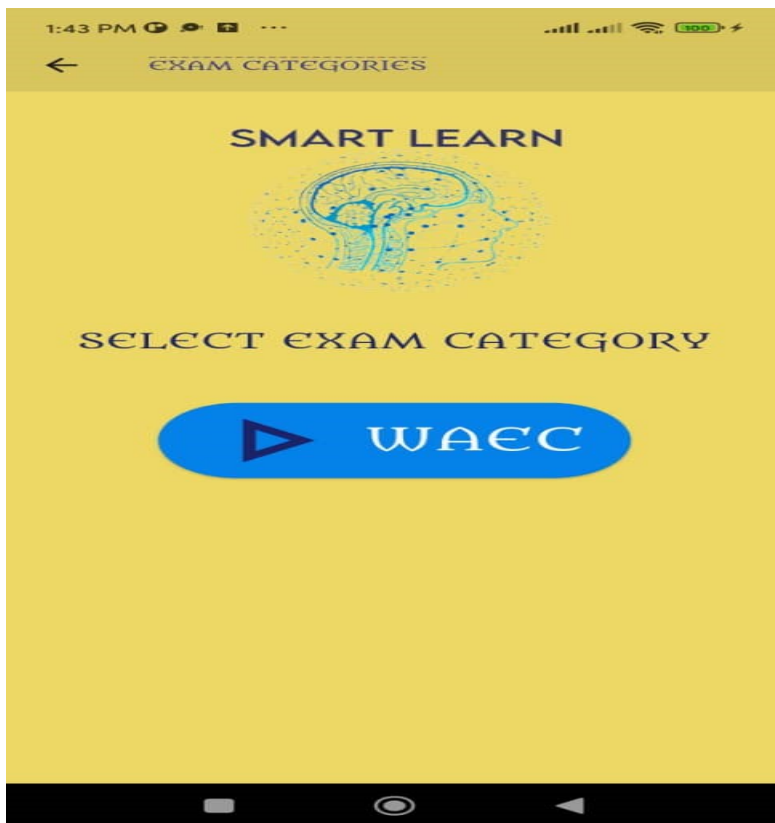


Figure3: Select Exams

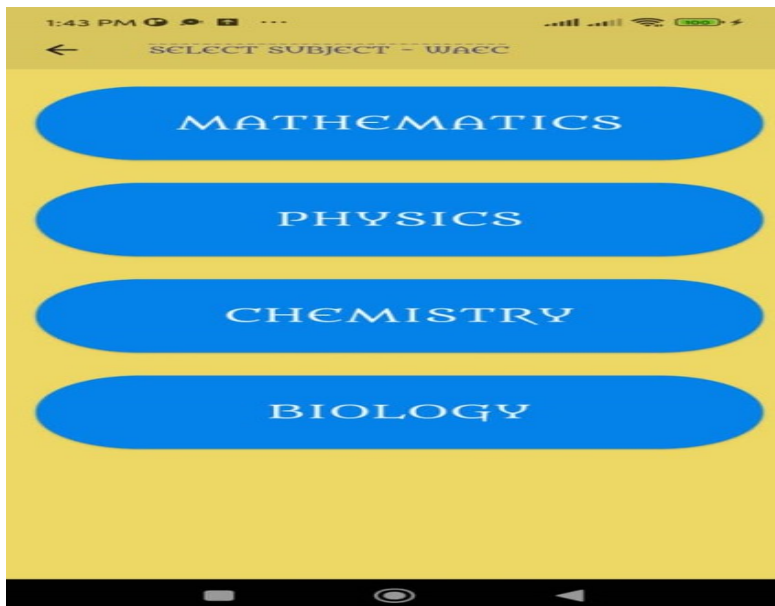


Figure 4: Select Subject

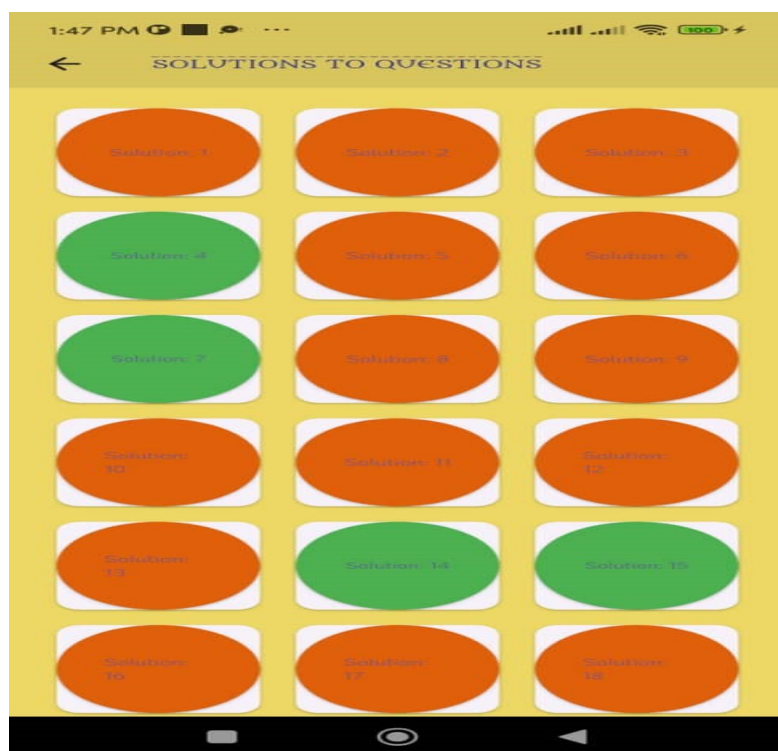


Figure5: Solutions button

VII. Results and Discussion

The SMARTLEARN system was successfully implemented as a web-based and mobile-based application. The system consists of the following major modules:

- i. User registration and authentication
- ii. Subject and syllabus management
- iii. Intelligent practice test module
- iv. Automated scoring and feedback
- v. Performance analytics and progress tracking
- vi. Recommendation engine for personalized study plans

Functional Testing Results

Functional testing was carried out to verify that each module performed according to specification.

Module	Expected Outcome	Observed Outcome	Status
Registration/Login	Successful authentication	Successful	Pass
Practice Tests	Randomized questions	Achieved	Pass
Automated Scoring	Instant result display	Achieved	Pass
Intelligent Feedback	Topic-based recommendations	Achieved	Pass
Analytics Dashboard	Performance visualization	Achieved	Pass

User Engagement

Pilot data showed high retention rates. Students reported:

- i. Increased motivation
- ii. Greater familiarity with exam format
- iii. Reduced test anxiety

Performance Improvement

Users demonstrated measurable improvement, such as:

- i. Faster response times
- ii. Higher accuracy
- iii. Better exam strategy

Students who used SmartLearn consistently over a 4–6week period showed an average score increase in practice tests.

User Feedback

Students appreciated:

- i. Explanations after each question
- ii. Realistic exam simulations
- iii. Ability to study on mobile devices
- iv. Clear analytics dashboard

Teachers noted that the system helped identify weak areas and improved study discipline.

Challenges

Some limitations include:

- i. Need for continuous question updates
- ii. Occasional network constraints in rural areas
- iii. Device compatibility for low-end phones
- iv. High cost of mobile internet for students without Wi-Fi

VIII. Conclusion

In order to help final-year secondary school students with their academic revision and exam preparation, this study successfully created and built SMARTLEARN, an intelligent mobile and web-based exam preparation system. The system was created to solve major issues with conventional exam preparation techniques, such as insufficient performance tracking, delayed feedback, lack of customisation, and restricted accessibility. Students' learning experiences can be greatly improved by integrating intelligent elements like automated assessment, individualized feedback, adaptive recommendations, and performance statistics, as demonstrated by the SMARTLEARN implementation. System testing and user review results showed that the platform is responsive, easy to use, and successful in pointing out students' areas of strength and weakness while directing them toward focused revision.

The observed improvement in students' post-test performance further validates the system's potential to improve academic outcomes.

To sum up, SMARTLEARN achieves its goals and shows how intelligent learning systems can be used in secondary education. By demonstrating how clever mobile and web-based technologies may be successfully used to improve exam preparation at the secondary school level, the study adds to the body of knowledge. SMARTLEARN has the potential to be a useful tool for enhancing educational results and a strong digital companion for test preparation with additional improvements and widespread use.

IX. Recommendations

- i. **Expand the question database** to include more subjects and more years.
- ii. **Integrate AI-based tutoring**, such as personalized lesson plans and explanations.
- iii. **Partner with schools** to adopt SmartLearn as an official revision tool.
- iv. **Develop offline-first capabilities** for poor-connectivity regions.
- v. **Conduct a large-scale evaluation** with thousands of learners to validate effectiveness.

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