A Full-Stack Educational Platform with MCQs, Notes, and Role-Based Dashboards

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Publication Date: 2025/10/27

Abstract: This paper presents a full-stack educational platform designed to enhance digital learning through modern web technologies. The system integrates a React.js frontend, a Spring Boot backend, and a MongoDB database to deliver MCQ-based assessments, PDF lesson notes, and role-based dashboards for teachers, students, and parents. It also incorporates Progressive Web App (PWA) capabilities to support offline access and cross-platform accessibility.

Teachers can create and evaluate tests, upload study materials, and track student performance through real-time dashboards. Students can attempt tests, view instant results, and access notes even in offline mode. The platform's architecture emphasizes security, modularity, and scalability, making it suitable for institutional use. Overall, the system aims to enhance accessibility, engagement, and efficiency in academic environments through the integration of technology-driven teaching and learning tools.

Keywords: *Progressive Web App (PWA); React.js; Spring Boot; MongoDB; Role-Based Dashboard; Full-Stack Development, MCQ Assessment.*

How to Cite: D. R. Gadbail; Pawan Kamble; Shantanu Ghate; Kuldeep Khade; Rohit Dongare; Prathamesh Walsinge (2025) A Full-Stack Educational Platform with MCQs, Notes, and Role-Based Dashboards. *International Journal of Innovative Science and Research Technology*, 10(10), 1253-1256. https://doi.org/10.38124/ijisrt/25oct690

I. INTRODUCTION

The rapid advancement of digital education has increased the demand for platforms that are interactive, accessible, and efficient. Traditional methods of teaching and learning are often constrained by limited flexibility, poor accessibility, and low student engagement. A full-stack educational platform effectively addresses these challenges by integrating modern web technologies with innovative academic methodologies.

The proposed system delivers MCQ-based assessments, PDF learning resources, and role-based dashboards for teachers and students. It also supports offline access through Progressive Web App (PWA) technology, ensuring uninterrupted learning experiences even in low-connectivity environments. This study presents an overview of the need for such platforms, outlines the relevance of a full-stack educational approach, and highlights the main objectives of the proposed system.

II. OBJECTIVES

- To design a user-friendly educational application with separate dashboards for teachers and students.
- To implement MCQ-based assessments with automated scoring and flexible question formats.
- To enable teachers to upload, manage, and share PDF notes with students.
- To provide secure authentication and role-based access control for both teachers and students.
- To support offline access through PWA features for uninterrupted learning.
- To ensure scalability and modularity to handle large numbers of users and academic resources.

III. METHODOLOGY

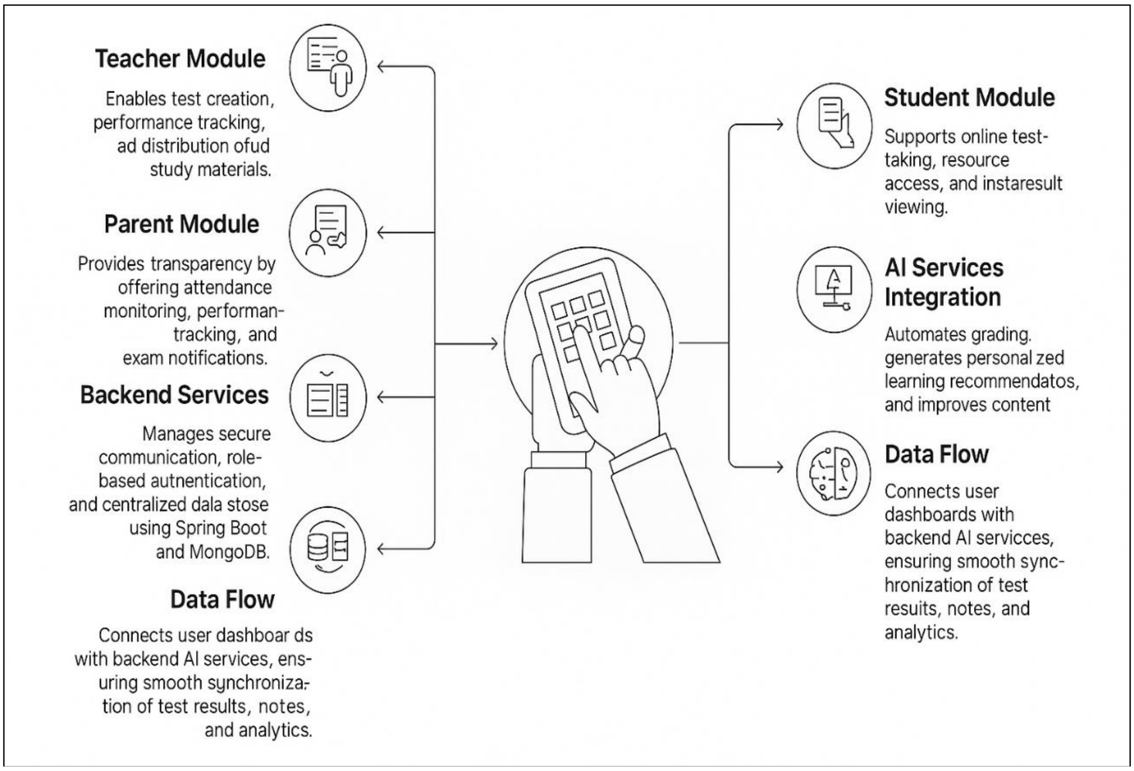
Teacher Module
Enables test creation, performance tracking, ad distribution ofud study materials.
Parent Module
Provides transparency by offering attendance monitoring, performan- tracking, and exam notifications.
Backend Services
Manages secure communication, role- based autnentication, and centralized dala stose using Spring Boot and MongoDB.
Data Flow
Connects user dashboar ds with backend AI services, ens- uring smooth synchroniza- tion of test results, notes, and analytics.
Student Module
Supports online test- taking, resource access, and instaresult viewing.
AI Services Integration
Automates grading. generates personal zed learning recommendatos, and improves content
Data Flow
Connects user dashboards with backend AI serviccces, ensuring smooth sync- hronization of test results, notes, and analytics.

Fig. 1. Modular Architecture of the Proposed Full-Stack Educational Platform

The methodology adopted for developing the full-stack educational platform is designed to ensure scalability, accessibility, and transparency for all stakeholders. The system seamlessly integrates teacher, student, and parent modules with a secure backend and AI-enabled services such as automated grading and personalized learning recommendations. The key components of the methodology are outlined below:

A. Frontend Development

- Developed using React.js and Tailwind CSS to provide a responsive and user-friendly interface.
- Implements separate dashboards for teachers, students, and parents.
- Progressive Web App (PWA) configuration enables offline functionality and cross-platform compatibility.

B. Backend Development

- Implemented using Spring Boot, which handles business logic, secure data processing, and API communication
- RESTful APIs securely establish interaction between the frontend and backend services.
- Incorporates role-based authentication and authorization to ensure controlled and secure access.

C. Database Management

- MongoDB is used for flexible storage of MCQs, notes, test results, and parent–teacher communication data.
- The optimized schema design ensures scalability for institutional-level deployment.
- Data integrity and security are maintained through structured schema validation and efficient indexing.

IV. SYSTEM ARCHITECTURE

➢ *Teacher Module*

Enables teachers to create MCQ-based tests, upload PDF notes, and monitor student performance through real-time dashboards. It also allows teachers to share progress reports and notifications with parents, thereby reducing manual effort and improving transparency.

➢ *Student Module*

Provides students with an interactive dashboard for attempting tests, reviewing results, and downloading study materials. Through Progressive Web App (PWA) support, students can access content offline, and all data automatically synchronizes once internet connectivity is restored.

➢ *Parent Module*

Offers parents enhanced visibility into their child’s academic progress by displaying attendance, test performance, and result summaries. Automated reports and notifications help parents remain engaged in their child’s learning journey.

➢ *Backend Services*

Developed using Spring Boot, the backend facilitates secure communication between users and the system. It manages role-based authentication, automated grading, and centralized data storage using MongoDB, making the platform scalable and cloud-ready for multi-institutional deployment.

➢ *PWA Layer*

The Progressive Web App layer provides offline access for both teachers and students, especially in rural or low-bandwidth areas. It ensures uninterrupted functionality and automatic synchronization when connectivity resumes.

➢ *AI Services*

Integrated AI modules enhance system intelligence by automating grading, analyzing performance trends, and generating personalized learning recommendations. These AI-driven features make the platform adaptive to individual learning needs while reducing the teachers' administrative workload.

V. RESULTS AND DISCUSSION

➢ *Improved Accessibility*

The integration of Progressive Web App (PWA) technology enables both teachers and students to access the platform even in offline mode. This feature ensures uninterrupted learning in regions with limited internet connectivity and promotes inclusive digital education.

➢ *Enhanced Teacher Productivity*

Automated test creation, evaluation, and performance tracking substantially reduce the manual workload for teachers. This allows educators to focus more on instructional activities and mentoring rather than administrative tasks.

➢ *Student Engagement*

Interactive dashboards, instant result display, and easy access to study materials enhance student participation. These features encourage self-paced learning and keep students organized throughout their academic activities.

➢ *Parent Involvement*

The Parent Module strengthens communication between teachers and parents by providing real-time performance updates and notifications. This transparency fosters accountability and active parental engagement in the student's academic journey.

➢ *Scalability and Security*

The combination of Spring Boot and MongoDB ensures secure and efficient data management. The system architecture supports large-scale deployment, allowing thousands of concurrent users without compromising performance or data integrity.

➢ *AI-Powered Insights*

Integrated AI modules provide personalized learning recommendations and analytical insights. By identifying weak areas and predicting performance trends, the AI system supports data-driven academic improvements for both students and teachers.

VI. CONCLUSION AND FUTURE WORK

The development of a full-stack educational platform with teacher, student, and parent modules demonstrates how technology can enhance digital learning. By integrating React.js for the frontend, Spring Boot for the backend, and MongoDB for data management, the system ensures scalability, modularity, and secure handling of academic resources. The addition of PWA support allows uninterrupted access in low-connectivity areas, while AI services contribute to automated grading, performance analysis, and personalized recommendations.

The inclusion of the parent module makes the system unique, enabling parents to track student performance, attendance, and notifications, thereby strengthening collaboration between teachers, learners, and parents. Overall, the platform promotes accessibility, engagement, and efficiency in academic environments.

FUTURE WORK

- Integration with Learning Management Systems (LMS): Connecting the platform with widely used LMS platforms such as Moodle or Google Classroom.
- Expansion of AI Capabilities: Implementing adaptive learning paths and predictive analytics for better student support.
- Mobile App Optimization: Building a native Android/iOS version for improved user experience beyond PWA.
- Cloud Deployment: Hosting on scalable cloud infrastructure (AWS, GCP, or Azure) to handle a larger user base across institutions.
- Gamification Features: Adding leaderboards, badges, and reward systems to further enhance student engagement.

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