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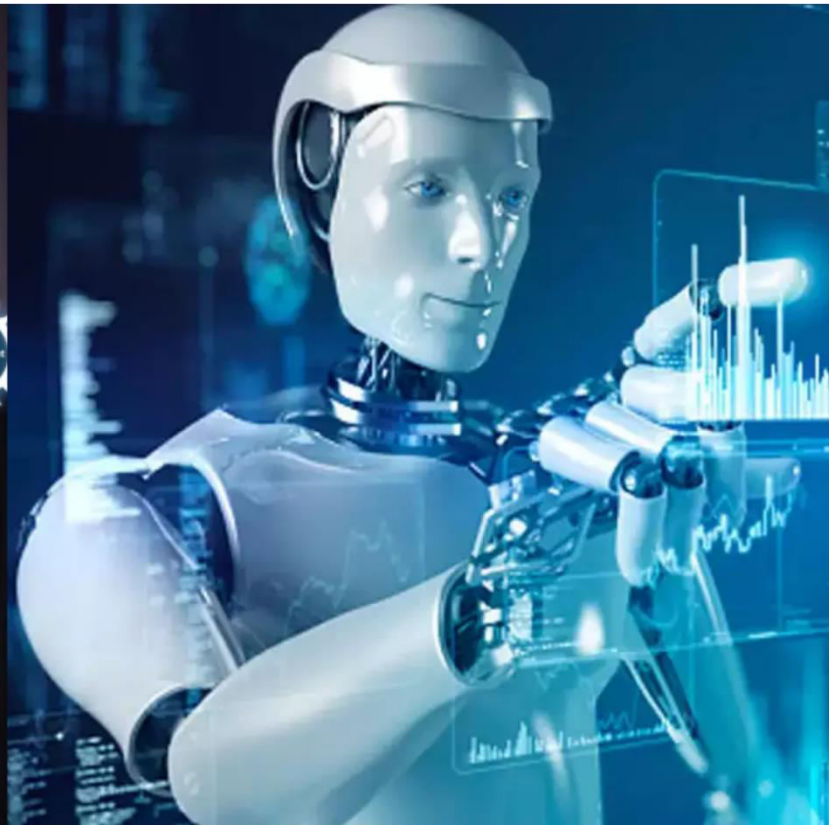

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# A Role-based Learning Management System

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**ABSTRACT**: In today's digital era, Learning Management Systems (LMS) play a vital role in enhancing education delivery and engagement. However, most LMS platforms follow open or payment-based enrollment processes that lack personalized control. This paper presents a role-based LMS that simplifies course enrollment through a request-approval mechanism, allowing instructors to manage student access effectively. The proposed system is developed using modern technologies like Node.js, Next.js, MySQL, and Sequelize ORM. It enables students to apply for courses and instructors to approve or reject requests, ensuring secure and role-specific access. The application also features responsive dashboards tailored to the user's role—Student, Instructor, or Admin. The system was designed as an academic project and tested for authentication, role-based navigation, and dynamic content management. Results show that the platform offers a flexible, secure, and scalable solution for academic institutions.

## I. INTRODUCTION

The transformation of education through digital technologies has led to the widespread adoption of Learning Management Systems (LMS) in schools, universities, and corporate training environments. These systems provide centralized platforms for managing courses, users, and academic workflows. However, many traditional LMS platforms offer either unrestricted course access or paid enrollment models, which can compromise learning quality and restrict control for educators.

To address this limitation, we developed a Role-Based Learning Management System that allows students to apply for courses instead of directly enrolling or purchasing them. Instructors can then approve or reject enrollment requests, enabling a more curated and effective learning environment. This ensures that course participants are genuinely interested and aligned with the course objectives.

The system is built using a modern technology stack that includes Node.js for the backend API, Next.js for the frontend, MySQL as the database, and Sequelize as the ORM for database interactions. The LMS provides secure authentication using JSON Web Tokens (JWT) and supports three user roles: Student, Instructor, and Admin. Each role has specific privileges and access to different parts of the system through dedicated dashboards.

This paper outlines the development process, system design, features, and testing of the LMS. The primary goal is to create a secure, scalable, and role-oriented LMS that simplifies course management and improves student-instructor interaction.

## II. LITERATURE SURVEY

The demand for robust Learning Management Systems has steadily increased due to the shift toward online education and remote learning. Various LMS platforms have emerged, each with its strengths and limitations in terms of usability, scalability, and access control.

Moodle is one of the most popular open-source LMS platforms. It offers a wide range of features such as course creation, content management, and quizzes. However, its steep learning curve and complex administration often require technical expertise for customization and maintenance, which may not be suitable for smaller institutions or beginner users.

Google Classroom provides seamless integration with Google tools and is widely used in academic settings. While it's user-friendly, it lacks granular control over course access, especially for instructors who wish to manually review enrollment.

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Udemy and Coursera are large-scale learning platforms that focus on paid course enrollment. These platforms often rely on open-access or pay-to-enroll models, which may not always allow instructors to control who accesses their courses.

Research by Patel et al. (2020) highlights the benefits of implementing Role-Based Access Control (RBAC) in web applications. RBAC ensures that users can only access functions and data based on their assigned roles, improving both security and user experience. This principle is essential in educational platforms where students, instructors, and administrators interact with different components of the system.

Recent advancements in JavaScript frameworks, particularly React and Next.js, have enabled the development of responsive, dynamic, and SEO-friendly web applications. These technologies are increasingly being adopted in educational tools due to their fast rendering and modular component architecture.

This review reveals a gap in the current LMS market—most platforms either lack role-specific control or depend on payment-based access. Hence, there is a need for a customizable, role-driven LMS that enables instructors to manage student participation effectively without monetary barriers. The proposed system aims to fill this gap by integrating modern technologies with a request-based course enrollment workflow.

## III. METHODOLOGY

The proposed Learning Management System was developed using a full-stack web development approach. The system was designed to enable secure, role-based user interaction, dynamic content rendering, and a controlled course enrollment process. The methodology adopted for the development of the system is divided into the following stages:

A. Requirement Analysis
The initial phase involved identifying the core requirements of the LMS. This included defining user roles (Student, Instructor, Admin), course management features, authentication mechanisms, and enrollment workflows. Feedback from academic peers and mentors helped prioritize functionality that ensures ease of use and administrative control.

B. System Architecture Design
The LMS follows a modular MVC (Model-View-Controller) architecture:

Frontend: Built using Next.js, which supports server-side rendering and efficient routing. Tailwind CSS was used to design a clean, responsive UI.

Backend: Developed using Node.js with Express.js to manage API requests, user sessions, and business logic.

Database: MySQL was used to store user data, course details, and request statuses. Sequelize ORM facilitated smooth interaction between backend APIs and the database.

Authentication: JWT (JSON Web Token) was used to securely manage user login and protect API routes. Middleware functions were implemented to verify roles and restrict access accordingly.

C. Implementation of Features
Role-Based Access: Upon registration, users are assigned a role. After login, they are redirected to dashboards based on their role.

Course Management: Instructors can create, update, and delete courses through their dashboard.

Enrollment Requests: Students can view available courses and apply to join them. These requests are stored and displayed in the instructor's dashboard for approval or rejection.

Dashboards: Separate dashboards were implemented for students (view approved/applied courses), instructors (view courses and requests), and admin (monitor users and platform stats).

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D. Testing and Iteration
Each module was tested independently using Postman for backend routes and browser-based debugging tools for frontend logic. Test cases were created to validate login, request submission, role-based redirection, and error handling.

E. Tools and Technologies Used
The system was implemented using a modern full-stack approach. The **frontend** was built using **Next.js**, a React-based framework, combined with **Tailwind CSS** for styling and responsive UI design. The **backend** utilized **Node.js** and **Express.js** to handle API routing and business logic. For data storage and management, **MySQL** was chosen as the relational database, with **Sequelize ORM** used to simplify database operations. Secure **authentication** was achieved using **JSON Web Tokens (JWT)** and **bcrypt.js** for password hashing. The platform was thoroughly tested using tools like **Postman** for API verification and browser-based developer tools to ensure frontend performance and behavior.

## IV. EXPERIMENTAL RESULTS

The proposed Role-Based Learning Management System was tested across multiple user roles to evaluate its functionality, reliability, and responsiveness. The system was implemented locally and tested using **Postman**, **browser tools**, and **manual UI testing** for validation of both backend and frontend components.

### A. Testing Environment

- **Frontend:** Next.js (React-based), Tailwind CSS
- **Backend:** Node.js with Express.js
- **Database:** MySQL
- **ORM:** Sequelize
- **Tools Used:** Postman, VS Code, Browser Developer Tools

### B. Key Functional Areas Tested

1. **Authentication & Role Verification**
   Each user (Student, Instructor, Admin) was able to register, log in, and was redirected to the correct dashboard based on their role using JWT-based authentication.
2. **Course Creation & Management**
   Instructors could create, update, and delete courses from their dashboard, with data stored and fetched through protected API routes.
3. **Enrollment Request Workflow**
   Students could apply for courses. Instructors could approve or reject these requests. Only approved students could access course content.
4. **Dashboard Routing & UI Behavior**
   Each role was shown only the UI and options permitted to them. Navigation was tested for protected routes and incorrect role access.

### C. Sample Test Cases

| Test ID | Scenario | Expected Output | Status |
|---|---|---|---|
| TC01 | Register user with valid data | Account created and redirected | Pass |
| TC02 | Login with wrong credentials | Error message shown | Pass |
| TC03 | Instructor creates a course | Course saved and listed | Pass |
| TC04 | Student applies for a course | Request marked as “Pending” | Pass |
| TC05 | Instructor approves student request | Status updated to “Approved” | Pass |
| TC06 | Unauthorized user accesses instructor route | Access Denied (403 or 401) | Pass |

### D. UI and Performance Observations

- Navigation was smooth and responsive.
- API responses were fast and accurate.
- Modal forms for course creation and login were validated and handled gracefully.
- Data updates reflected immediately without full-page reloads.

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## V. CONCLUSION

The role-based Learning Management System presented in this paper addresses the limitations of traditional LMS platforms by enabling controlled, instructor-managed course access. Through secure authentication, role-specific dashboards, and a user-friendly interface, the system provides a reliable platform for academic institutions and learners.
The course request workflow introduces a more personalized learning experience, allowing instructors to review and manage student enrollments rather than relying on open or payment-based access models. Additionally, the use of modern web technologies like Node.js, Next.js, MySQL, and Sequelize ensures the application is scalable, secure, and responsive across devices.

While the system achieved all core functionality, it is still open to further enhancement. Future development could include integration of:

- Real-time notifications for request status
- Assignment uploads and submissions
- Feedback and grading modules
- Admin analytics and monitoring dashboard
- Deployment on cloud platforms for wider accessibility

This project demonstrates that a lightweight, modular LMS with role-based control can provide a more efficient and secure learning environment for both students and instructors.

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