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AI-Powered E-Learning Platform Using MERN Stack

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ABSTRACT -

The transition from traditional classroom instruction to digital education platforms has become a defining trend in modern pedagogy. E-learning systems are increasingly being augmented with Artificial Intelligence (AI) to provide enhanced user engagement, real-time assistance, and personalized learning experiences. This paper presents the development of a comprehensive AI-powered Learning Management System (LMS) utilizing the MERN stack MongoDB, Express.js, React.js, and Node.js. The platform is designed to serve multiple roles, offering dedicated access for administrators, instructors, and students. Key functionalities include course creation and management, multimedia content delivery, live interactions, and user progress tracking. One of the core contributions of this system is its integration of AI components to enrich the learning experience. A rule-based course recommendation system dynamically suggests relevant courses to users based on their prior learning history, interest areas, and job-aligned progression paths. Additionally, a natural language processing (NLP)-based chatbot has been incorporated to resolve user queries instantly, mimicking a conversational assistant to reduce the burden on instructors and enhance student engagement. The platform also features analytical tools to evaluate individual learner performance, enabling targeted feedback and interventions. With a focus on scalability, accessibility, and user experience, this LMS stands as a modular, adaptive, and interactive solution for educational institutions. It not only addresses common challenges like learner isolation, content discoverability, and limited feedback but also supports inclusive and lifelong learning. The system demonstrates how emerging web technologies coupled with AI can redefine digital education by creating personalized and efficient learning environments for diverse user groups.

Keywords: E-learning platform, online education, video courses, notes download, FAQ chatbot, role-based access, interactive learning.

INTRODUCTION

The evolution of education from traditional classroom settings to digital platforms has significantly reshaped the learning landscape, making education more accessible, flexible, and scalable. Despite this transformation, many existing e-learning systems encounter limitations such as inadequate personalization, inefficient query resolution, and a lack of engaging interactive features. These shortcomings often contribute to decreased learner motivation, reduced academic performance, and increased dropout rates. To address these challenges, this project proposes an AI-powered Learning Management System (LMS) developed using the MERN stack—comprising MongoDB, Express.js, React.js, and Node.js. The system is designed to enhance the online learning experience by integrating artificial intelligence (AI) technologies that enable personalized course recommendations, an intelligent chatbot for real-time student support, and analytics tools to monitor and improve academic performance. Furthermore, the platform implements role-based access control to ensure seamless functionality for different user types: administrators, instructors, and students. Key features include the ability to upload and view video lectures, download study materials, engage in live discussions, and navigate through an intuitive user interface. By combining modern web development technologies with AI-driven personalization and interactivity, the proposed LMS addresses existing e-learning gaps and delivers a comprehensive, adaptive, and secure digital education solution suitable for diverse academic environments.

LITERATURE SURVEY

The paper outlines the design of the "Celestial Learning System," an eLearning platform that addresses security concerns in online education, particularly focusing on secure content sharing and performance analysis. The platform features a user-friendly interface built with React and Material UI, enhancing the learning experience for both authors and students while ensuring accessibility across various devices. Key functionalities include live sessions, a discussion forum, performance analytics, and a chat portal, promoting interaction and engagement among users. Security measures are implemented to prevent unauthorized screen recording and content leakage, including a standalone Python application for detection and Android restrictions on screenshots. The proposed system aims to improve upon existing platforms like Udemy and Coursera by providing a secure, interactive, and effective online learning environment, with plans for future expansion into mobile applications and integration with ERP systems.[1]

The paper discusses the evolution of e-learning, tracing its development from Computer-Assisted Instruction (CAI) to contemporary online learning systems, highlighting the significance of technology in education. It categorizes e-learning studies into three main dimensions: people, technology, and services, emphasizing the interplay between these elements and their impact on learning outcomes. The authors present a theoretical framework for e-learning that includes pedagogical models, instructional strategies, and learning technologies, aiming to connect theoretical concepts with practical applications in educational settings. The study identifies key stakeholders in e-learning systems, such as students, educational institutions, employers, and technology providers, and explores their interactions and roles within the e-learning ecosystem. The paper calls for further research to assess the effectiveness of e-learning systems and to better understand the implications of technology on collaborative learning and educational practices.[2]

PROPOSED SYSTEM

The proposed system is a web-based AI-powered Learning Management System (LMS) developed using the MERN stack, designed to enhance online education through personalized learning paths and real-time support. The system architecture is modular and incorporates various cloud-based services to ensure seamless deployment and functionality.
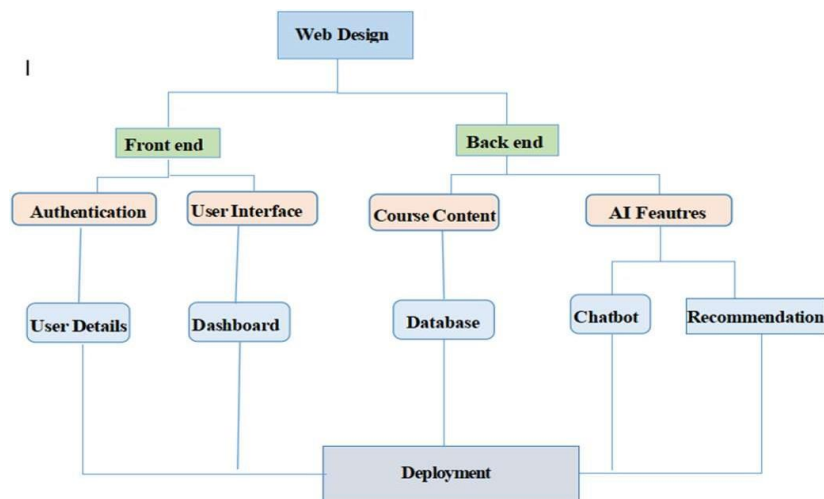

Fig. 1: System Architecture

A. User Roles and Access Control:

The platform provides three roles:

- **Admin**: Manages content, users, and platform settings.
- **Instructor**: Uploads video lectures, manages course enrolments.
- **Student**: Enrols in courses, watches content, interacts with the AI chatbot. Role-based permissions and authentication are handled using Clerk.

B. Course Recommendation System:

A rule-based engine suggests the next course based on:

- Previously completed courses
- Predefined progression paths (e.g., Frontend → Backend → DevOps)
- Implemented using Node.js APIs and MongoDB to store course logic and user data.

C. AI Chatbot Integration:

An AI-powered chatbot is integrated into the frontend to:

- Answer common questions
- Help with navigation
- Provide basic academic support
- Implemented with basic NLP techniques, embedded in React frontend, and backed by API calls.

D. Content Delivery:

Instructors upload video lectures. Students can:

- Stream content
- Participate in basic discussions
  No PDFs, quizzes, or interactive assessments are included.

E.   Deployment and Setup:
- MongoDB Atlas: Cloud database
- Clerk: Authentication and webhooks
- Cloudinary: Media storage (video uploads)
- Stripe: Payment integration
- Vercel: Deployment of both backend and frontend
- Environment variables configured for cloud services.
  The backend is started and deployed first, followed by the frontend.

RESULT

The developed AI-powered Learning Management System (LMS) Edemy demonstrates robust functionality across various modules, successfully delivering a seamless digital learning experience. Below are the key results with corresponding interface outputs:

Step 1: After logging in, users are directed to the dashboard based on their assigned roles (Admin, Instructor, or Student).
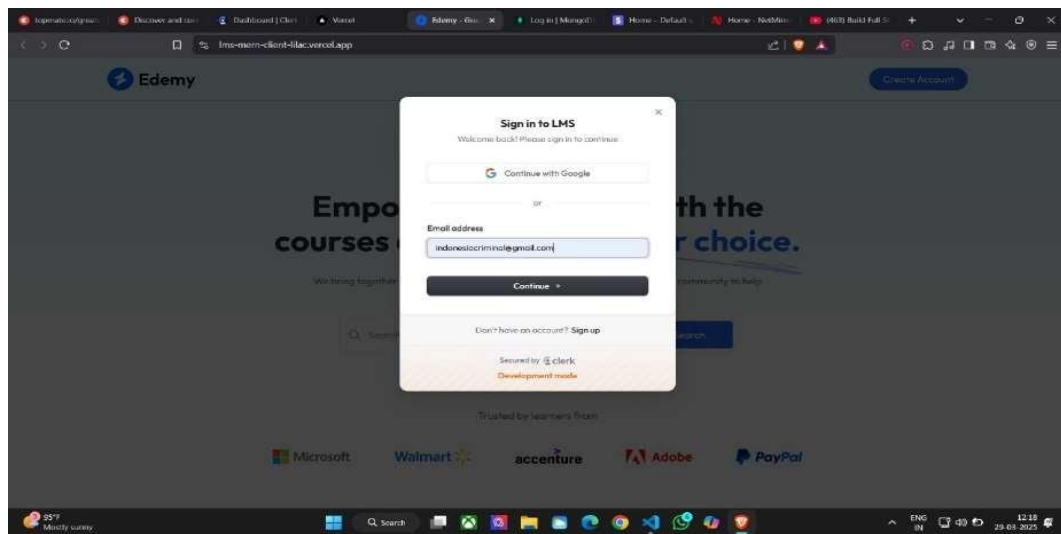

Fig. 2: Login page

Step 2: After login into the page you can see the Edemy platform's homepage, featuring a course search and promotional content.
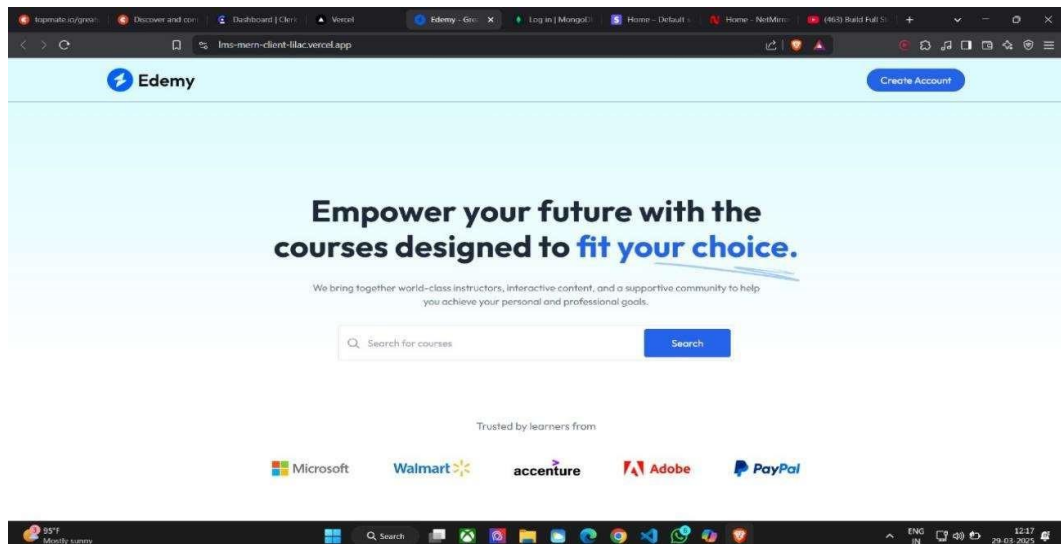

Fig. 3: Home Page

Step 3: Later you can see the Course List page, displaying available courses with titles, descriptions, and pricing within the Edemy learning platform.
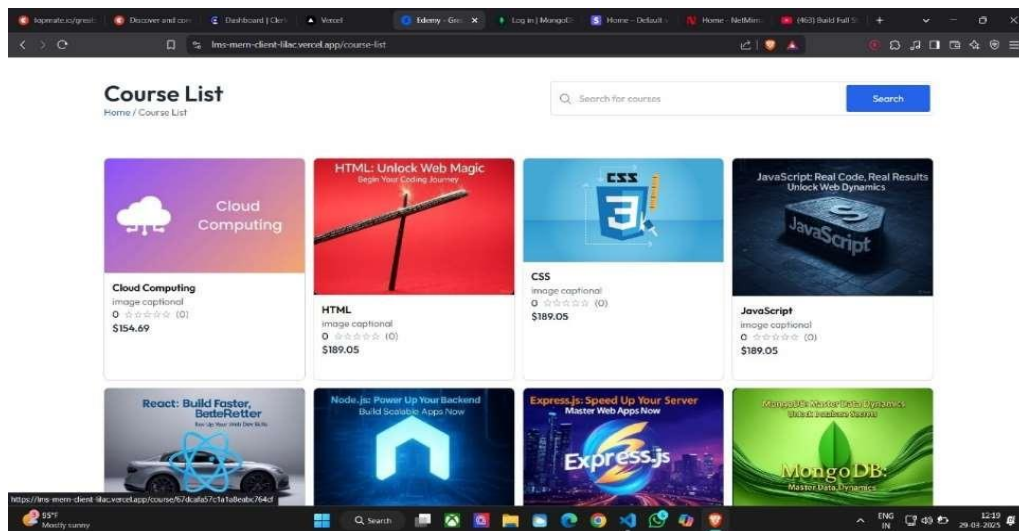
Fig.4: Course List Page

Step 4: After see the course list you can see the detailed course information, structure, pricing, and enrollment options.
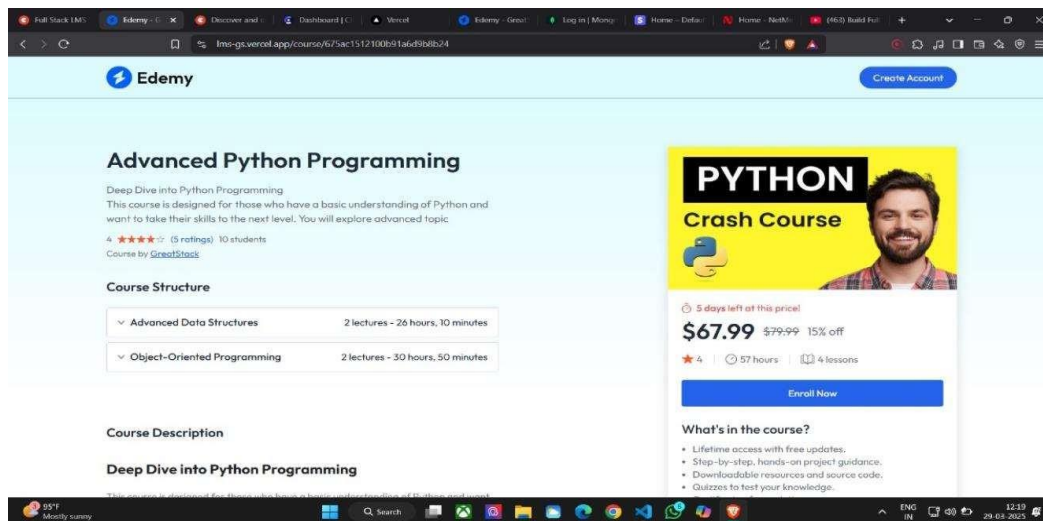

Fig.5: Course Enrollment Page

Step 5: If we want to enroll the course you can pay the amount by using Cash App Pay interface being utilized within the Stripe checkout flow for a transaction of a specific amount on what seems to be the Edemy platform.
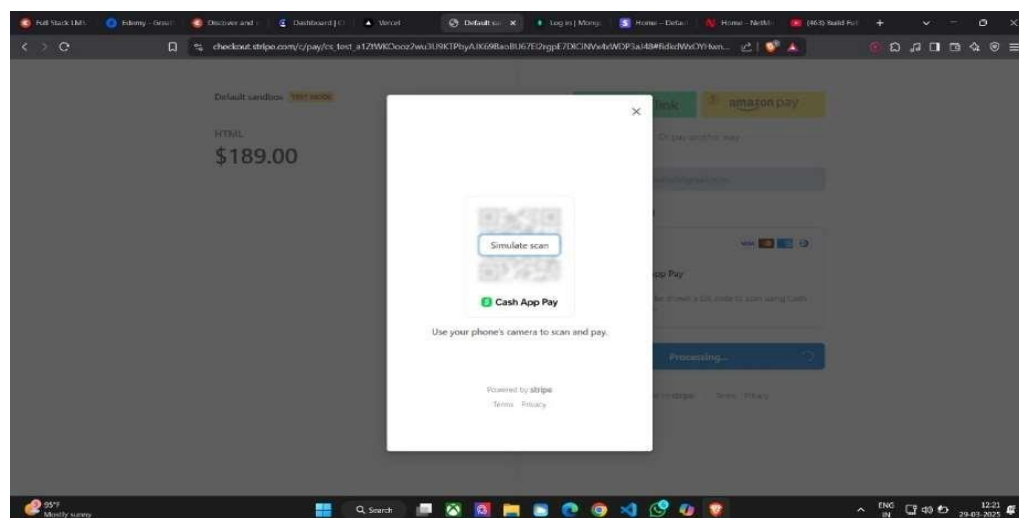

Fig. 6: Online Payment Page

Step 6: The integrated AI Chatbot allows students to interact in real-time, ask questions, and get instant responses related to courses, navigation, and platform usage. It enhances the learning experience by simulating a virtual assistant.
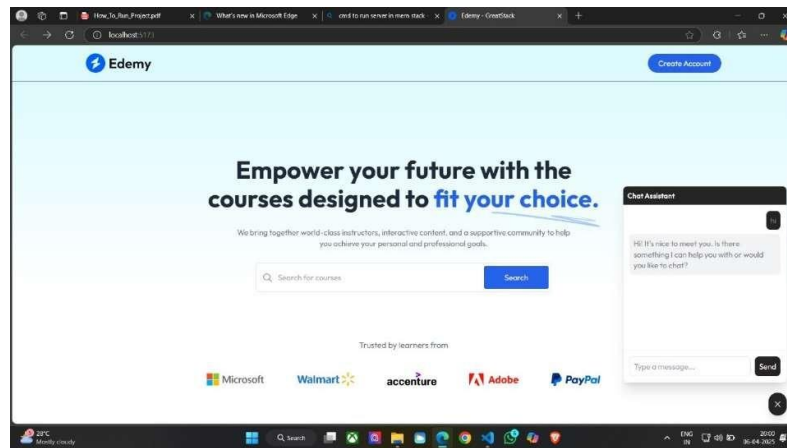
Fig. 7: Chatbot Assistant

CONCLUSION :

The integration of AI-driven features such as a rule-based recommendation engine and an interactive chatbot within the MERN stack LMS represents a significant advancement in modern e-learning platforms. This unified system delivers a personalized, user-friendly solution that enhances learner engagement and accessibility, especially in digital-first environments where scalable, efficient education delivery is critical. Furthermore, deploying the platform with cloud services like Clerk, Cloudinary, and Stripe has enabled a seamless and interactive user experience, effectively addressing limitations found in traditional LMS platforms and supporting the future of intelligent online education.

LIMITATIONS

The system currently uses a rule-based recommendation approach, which may not adapt well to evolving learner behaviour without manual updates. The chatbot operates on basic NLP, limiting its understanding of complex queries. Additionally, the platform lacks performance analytics and interactive assessments due to resource and time constraints.

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