

AI-Assisted E-Learning Platform

Sana Batool

Department of Information Technology, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, Pakistan

*Correspondence: sanabatool6699@gmail.com

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The integration of artificial intelligence into e-learning systems has the potential to enhance learner engagement, accessibility, and operational efficiency; however, many existing platforms still lack real-time support and adaptive interaction. This paper presents an AI-Assisted E-Learning Platform that incorporates an intelligent assistant to provide continuous academic and technical support. The primary objective of the proposed system is to improve learner interaction through natural language-based assistance and voice-enabled functionality while simultaneously reducing administrative and instructional workload. The intelligent assistant facilitates instant query resolution, voice-based interaction for learning activities, and personalized guidance throughout user interaction. Experimental evaluation conducted in a controlled testing environment indicates improved learner accessibility, system usability, and administrative efficiency, along with secure access control mechanisms. The results suggest that integrating AI-driven assistance within e-learning environments can enhance the effectiveness and responsiveness of learning systems.

Keywords: E-learning, Learning Management System (LMS), Artificial Intelligence, Adaptive Learning, NLP Chatbot, Voice Interaction, Secure Learning Systems.



Introduction:

Advancements in Information Technology (IT) have significantly transformed the education sector through the development of sophisticated e-learning platforms that enable remote access to educational resources and facilitate knowledge sharing across geographical boundaries. These platforms enhance access to quality education while supporting flexible, learner-centered instructional models [1][2]. The integration of Information and Communication Technologies (ICT) has further enabled distance learning, digital collaboration, and scalable academic support services, establishing e-learning as a fundamental component of modern education systems [2].

With the rapid evolution of Artificial Intelligence (AI), contemporary e-learning environments are shifting from static content delivery toward adaptive, interactive, and intelligent learning systems. AI-driven educational technologies demonstrate significant potential for improving learner engagement. Furthermore, these systems enhance personalization and overall academic outcomes [1][3]. In particular, Natural Language Processing (NLP)-based systems facilitate intelligent interaction, automated assistance, and context-aware learning support, thereby enhancing the overall learning experience [4].

Traditional Learning Management Systems (LMS) are widely adopted in higher education and corporate training. However, many platforms rely on rigid course structures, manual intervention, and static interfaces. These limitations restrict personalization, reduce learner engagement, and impose significant administrative workload on instructors [3][4]. These limitations underscore the need for intelligent automation and adaptive learning mechanisms capable of providing real-time interaction and personalized support.

AI-powered chatbots have emerged as effective tools for providing instant academic and technical assistance, guiding learners through course content, and automating routine administrative tasks. Prior studies have demonstrated that intelligent chatbots can significantly enhance learner satisfaction and engagement by offering personalized and real-time support [5]. Additionally, adaptive learning frameworks leveraging machine learning techniques have been shown to improve academic performance prediction and facilitate personalized content delivery [6]. However, many existing systems lack seamless integration of intelligent assistance with comprehensive multi-role dashboards.

Recent research also highlights the importance of voice-enabled interaction in e-learning platforms to promote accessibility and inclusivity. Voice-based intelligent assistants enable learners to navigate systems, access learning resources, and receive guidance using natural language, thereby improving usability for diverse learner populations [7][8]. Nevertheless, practical implementations that combine text- and voice-based intelligent assistants within secure LMS environments remain limited.

Security and privacy are critical considerations in modern e-learning systems, as these platforms handle sensitive user data, including personal information, academic records, and assessment results. Robust security mechanisms, such as secure authentication and role-based access control, are essential to maintain data confidentiality, ensure system integrity, and comply with relevant regulations [9][10].

In response to these challenges, this paper presents an AI-Assisted E-Learning Platform designed to address the limitations of conventional LMS solutions. Unlike existing approaches that focus on individual intelligent components, the proposed system integrates an NLP-based chatbot, voice-enabled assistance, secure role-based dashboards, modular course management, and real-time progress tracking within a scalable web-based architecture. By combining Laravel-based backend services with Python-based AI modules, the platform provides a secure, intelligent, and user-centric learning environment.

Experimental evaluation demonstrates that the proposed system enhances, accessibility, and administrative efficiency while maintaining robust security mechanisms, thereby offering a comprehensive and practical solution for intelligent digital education.

The remainder of this paper is organized as follows: Section II presents the literature review, Section III describes the proposed methodology and system architecture, Section IV discusses the implementation and experimental results, and Section V concludes the paper with directions for future research.

Literature Review:

E-learning has become a fundamental component of modern education, enabling flexible and remote learning through digital technologies such as computers, mobile devices, and web-based platforms. Learning involves the acquisition of knowledge and skills through instruction, experience, and practice, requiring active cognitive engagement. The widespread adoption of Information and Communication Technologies (ICT) has accelerated the globalization of education by facilitating access to learning resources beyond geographical boundaries. However, disparities in ICT infrastructure and accessibility continue to constrain educational opportunities, particularly in developing regions.

Evolution of E-Learning Platforms:

Early e-learning systems primarily focused on content delivery and basic course management functionalities. As technology evolved, Learning Management Systems (LMS) were introduced to support course administration, assessment management, and learner tracking. Studies in [2] emphasize that modern LMS platforms play a critical role in higher education by supporting blended and fully online learning models. Despite these advancements, many traditional LMS platforms remain static, offering limited personalization and minimal real-time learner support.

Recent studies underscore that scalable web-based architectures are essential to accommodate the growing number of users and the dynamic content requirements of modern e-learning platforms. [11] demonstrate that modular and scalable system designs are necessary to ensure performance, reliability, and extensibility in AI-powered educational platforms.

Artificial Intelligence in E-Learning:

Artificial Intelligence has emerged as a transformative technology in the education sector, enabling intelligent automation, adaptive learning, and personalized content delivery. [1] provide a comprehensive review of AI applications in education, highlighting improvements in learner engagement, academic performance, and instructional efficiency. AI-driven systems can analyze learner behavior and performance data to generate personalized learning paths and adaptive recommendations.

Natural Language Processing (NLP) has received particular attention for enabling intelligent human-computer interaction in e-learning environments. [12] demonstrate that NLP-based intelligent tutoring systems enhance contextual understanding and learner interaction, resulting in improved learning outcomes. These systems allow learners to communicate using natural language rather than rigid system commands.

AI Chatbots and Intelligent Assistants:

AI-powered chatbots have been widely investigated as effective tools for providing real-time academic and technical support in online education. [3] present a systematic review demonstrating that intelligent chatbots reduce instructor workload, enhance learner satisfaction, and improve system responsiveness. Similarly, [5] report that chatbot-based assistance significantly increases learner engagement by offering instant and personalized support.

[13] further demonstrate that the integration of chatbots within student support systems enhances navigation, query resolution, and overall user experience. However, most

existing chatbot implementations function as standalone components and lack comprehensive integration with LMS dashboards and learning workflows.

Predictive Analytics, Gamification, and Engagement:

Machine learning techniques have been increasingly applied to predict learner performance and identify at-risk students. [6] show that predictive analytics can improve academic outcomes by enabling early interventions and personalized support strategies. Additionally, gamification has emerged as an effective strategy for enhancing engagement in digital education. [14] demonstrate that reward-based mechanisms, leaderboards, and adaptive learning paths significantly improve learner motivation and retention.

Despite these advancements, many LMS platforms implement predictive analytics and gamification features independently, without integrating them into a unified intelligent learning environment.

Voice-Based Interaction and Accessibility:

Voice-enabled intelligent assistants have received growing attention for improving accessibility and usability in e-learning platforms. [7] show that voice-based interaction enhances learner autonomy and supports users with diverse learning needs. Similarly, [8] highlight that voice interaction improves accessibility in AI-driven learning systems by enabling natural and intuitive system navigation.

However, practical implementations that combine both text-based NLP chatbots and voice assistants within secure LMS platforms remain limited, particularly in real-world educational settings.

Security and Trust in AI-Enabled LMS:

Security and privacy are critical concerns in AI-enabled e-learning platforms due to the handling of sensitive user data, including personal information, academic records, and assessment results. [9] emphasize the importance of role-based access control (RBAC) in securing LMS platforms and preventing unauthorized access. More recently, blockchain-based certification mechanisms have been proposed to enhance data integrity, transparency, and trust in digital learning environments [14].

[15] argue that future AI-enabled LMS platforms must balance personalization, scalability, and security to ensure long-term adoption and reliability.

Research Gap and Motivation:

Although prior research has extensively explored AI chatbots, adaptive learning, predictive analytics, gamification, and voice-based interaction independently, limited work has focused on integrating these technologies within a unified, secure, and scalable e-learning platform. Existing studies on intelligent chatbots, predictive analytics, gamification strategies, and voice-enabled learning systems serve as foundational works that highlight the potential of AI in education but lack holistic system integration. Most current LMS platforms provide these capabilities in isolation, without seamless coordination between intelligent assistance, real-time dashboards, progress tracking, and role-based access control.

To address this gap, the proposed AI-Assisted E-Learning Platform integrates NLP-based chatbot support, voice assistance, real-time analytics dashboards, progress tracking, and secure multi-role access within a single scalable LMS architecture. This holistic approach aims to enhance learner engagement, accessibility, administrative efficiency, and overall system intelligence.

The identified gaps directly inform the design choices presented in the following methodology section, where a unified AI-assisted LMS architecture is proposed to address limitations in personalization, accessibility, and secure system integration.

Methodology:

The overall development lifecycle of the proposed AI-Assisted LMS is illustrated in Figure 1, highlighting the sequential phases from problem identification and requirement

analysis to implementation and experimental evaluation. The system performance was evaluated using chatbot response accuracy, task completion rate, and user interaction metrics collected during experimental testing.

Research and Development Workflow

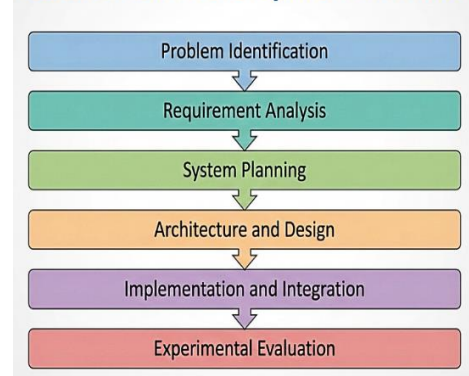


Figure 1. Research and development workflow of the proposed AI-Assisted LMS, including problem identification, requirement analysis, system design, implementation, and experimental evaluation.

System Architecture:

The system follows a modular, multi-layer architecture consisting of:

Frontend Layer: HTML, CSS, Bootstrap, and JavaScript-based interactive interface with role-specific layouts.

Backend Layer (Laravel): Handles authentication, APIs, user roles, course creation, document uploads, progress calculations, and assessments.

AI Module (Flask + Python + spaCy): The AI module is responsible for intelligent interaction, intent detection, and semantic query processing within the LMS environment.

NLP chatbot

Intent recognition

Voice command processing

Communication with the LMS via APIs

Database Layer (MySQL): Stores user accounts, courses, modules, documents, quizzes, progress, and analytics.

System Design:

The proposed AI-Assisted E-Learning Platform adopts a modular and scalable architecture comprising an Admin Module, Trainer Module, Student Module, and an AI-powered Intelligent Assistant. The backend is implemented using the Laravel framework to ensure security, scalability, and maintainability. It incorporates an API Gateway to manage secure requests and responses between the core system and external AI services, while the AI modules themselves are developed using Python and Flask. The integrated system architecture and data flow between the frontend, backend, AI module, and database layers are illustrated in Figure 2.

Admin: The Admin Module provides a secure interface for managing users, courses, and system configurations. Administrators can monitor platform performance through analytical reports, while Role-Based Access Control (RBAC) restricts sensitive operations to authorized users, ensuring data integrity and system security.

Trainer: The Trainer Module enables instructors to upload and organize multimedia content into structured lessons. Integrated analytics provide real-time insights into learner progress and engagement, reducing administrative overhead and supporting effective instructional management.

Student: The Student Module delivers a personalized and interactive learning experience. Learners can browse and enroll in courses, access learning materials, and track progress through personalized dashboards. Feedback and rating features support continuous course improvement.

The platform also integrates voice assistance, allowing learners to navigate the system, access resources, download documents, and receive instant guidance using voice commands, thereby enhancing accessibility and usability.

AI Chatbot and Voice Assistant:

The AI-powered chatbot provides continuous academic and technical support using Natural Language Processing (NLP). The integrated voice assistant utilizes Speech-to-Text (STT) and Text-to-Speech (TTS) technologies to support verbal interaction for queries, navigation, and learning tasks, significantly improving learner autonomy and accessibility. The AI engine employs spaCy's transformer-based Named Entity Recognition (NER) and intent classification techniques. Cosine Similarity is applied to vectorized user inputs to match queries with the internal knowledge base, ensuring low-latency response without reliance on external APIs.

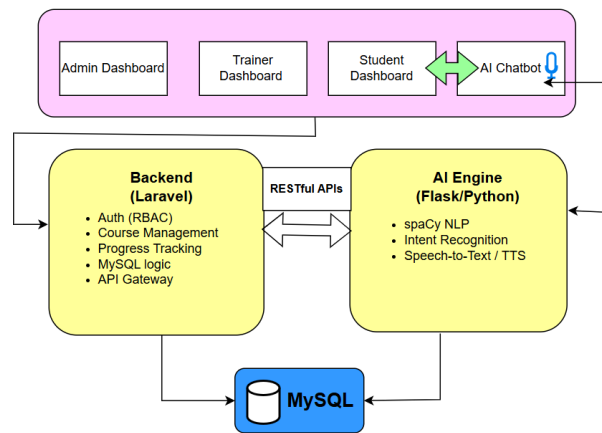


Figure 2. Integrated System Architecture illustrating the request-response data flow between the multi-role Frontend, the Laravel Backend (API Gateway), and the Python-Flask AI Engine.

Major Features:

- AI Chatbot (NLP-based)
- Voice Assistant for navigation and user interaction
- Modular course creation
- Role-based dashboards
- Automated quiz evaluation
- Document/video upload and viewing
- Automatic course progress calculation
- Secure authentication and authorization

Results and Discussion:

The system was evaluated through structured functional validation and scenario-based performance testing conducted under controlled experimental conditions. The evaluation framework focused on system stability, response latency, authentication security, workflow completion accuracy, and AI response effectiveness.

System Implementation Overview:

The proposed AI-Assisted E-Learning Platform was implemented as a modular, web-based system employing a hybrid architecture. The backend was developed using the Laravel framework to ensure scalability, secure authentication, role-based access control, and RESTful

API communication with AI services. The frontend layer was developed using HTML, CSS, JavaScript, Bootstrap, and React to ensure a responsive and device-independent user interface.

AI functionalities were implemented using a Python-based Flask server integrated with the spaCy NLP library for intent recognition and contextual query processing, enabling rule-based and predefined response generation. A MySQL database was employed to store user profiles, course data, enrollment records, learning progress metrics, and chatbot interaction logs. The implementation demonstrates the technical feasibility of integrating modern web technologies with AI-driven services to deliver a scalable and intelligent learning environment.

Dashboard Evaluation:

The Admin Dashboard functioned as the core management and analytics module. Role-Based Access Control was rigorously tested, with all unauthorized access attempts successfully prevented. Administrative operations, including course and user management, were performed efficiently, with average response times below five seconds. Real-time analytics, including enrollment trends and learner feedback, enabled informed, data-driven administrative decision-making. The interface and analytics visualization of the Admin Dashboard are presented in Figure 3.

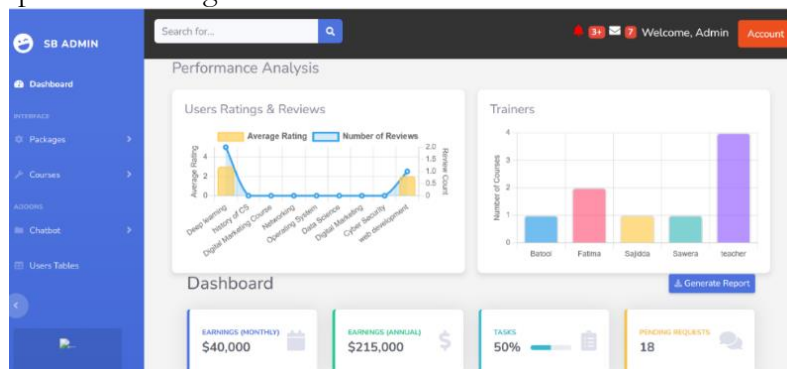


Figure 3. Admin Dashboard displaying real-time enrollment trends, course statistics, and learner feedback analytics.

The Trainer Dashboard enabled instructors to create, upload, and manage multimedia course content, including structured modules and learning resources. The system provides an organized course management interface allowing trainers to add, edit, and configure course components efficiently. Modular course structuring enhances content organization and improves instructional clarity. The Trainer Dashboard and course configuration interface are illustrated in Figure 4.

The course creation form includes fields for Course Name, Package (dropdown menu), Trainer, Duration, Description, and Course Image (file upload). Below these is a 'Modules' section with a list of modules, currently showing 'Module 1'.

Figure 4. Course creation and module configuration interface within the Trainer Dashboard.

The Student Dashboard facilitated personalized learning through intuitive navigation, dynamic progress indicators, and achievement tracking. The interface, including real-time progress visualization, is presented in Figure 5. Functional validation and interface testing demonstrated efficient navigation flow and structured learner progress monitoring within the

system. Additionally, students were able to submit course feedback, thereby supporting continuous quality improvement. The integrated voice assistant interface for natural language queries and the voice-enabled assignment submission functionality are illustrated in Figures 6 and 7.

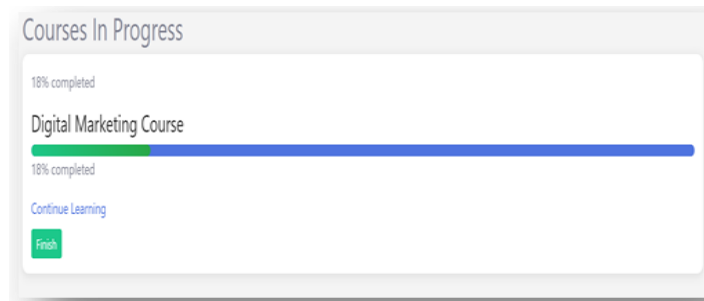


Figure 5. User Dashboard – Student Dashboard displaying real-time progress tracking and course completion indicators.

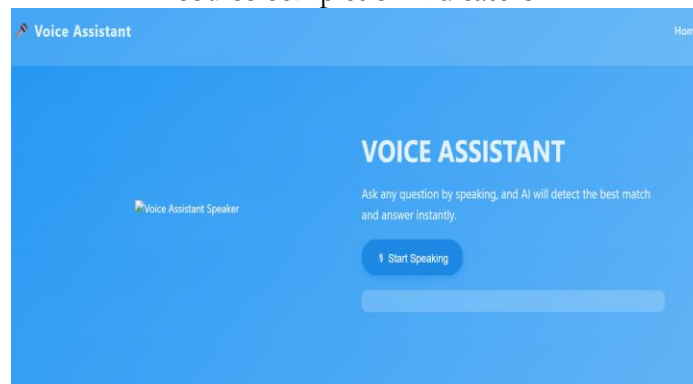


Figure 6. User Dashboard – Voice assistant interface demonstrating natural language query handling.

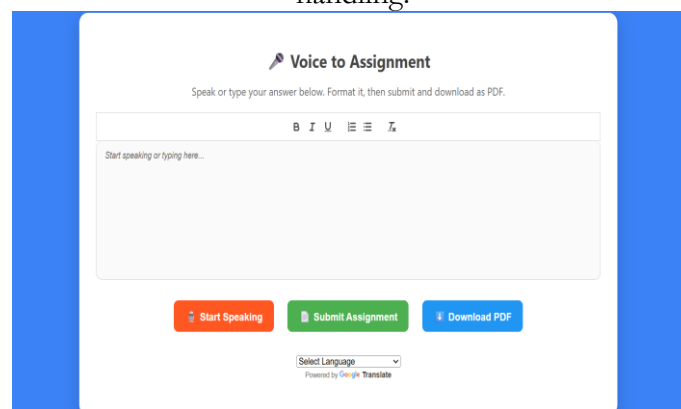


Figure 7. User Dashboard – Voice-enabled assignment submission interface within the student dashboard.

AI Chatbot Integration and System Impact:

An AI-powered chatbot was integrated to provide real-time academic and technical assistance. During controlled testing with predefined query scenarios, the chatbot successfully addressed approximately 85% of common student queries related to enrollment, navigation, and course progress. Personalized responses and targeted course recommendations, including direct links to relevant courses, reduced reliance on instructor-mediated support and enhanced system accessibility. A sample chatbot interaction demonstrating contextual query handling is presented in Figure 8.

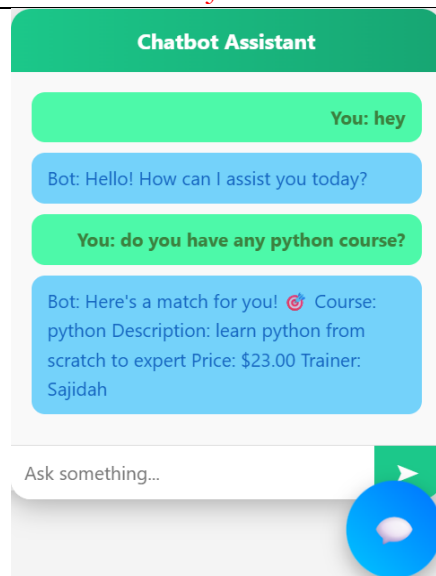


Figure 8. Chatbot Interface with sample conversation.

Overall, the integration of intelligent dashboards and AI-driven assistance addresses several limitations observed in existing AI-enabled learning management systems. Representative industry platforms such as Docebo, 360Learning, and EdApp provide AI-supported learning analytics and automation; however, they typically emphasize modular AI features rather than tightly integrated contextual NLP assistance, voice interaction, and unified multi-role dashboard management within a single architecture. Performance evaluation was conducted using structured, scenario-based testing under controlled conditions. Concurrent request simulations assessed API response latency, authentication robustness, and workflow execution stability. The system maintained an average API response time below three seconds during concurrent access simulations, with no authentication failures or data inconsistencies observed across repeated validation cycles.

In addition to latency measurement, workflow completion accuracy was evaluated using predefined administrative, instructional, and learner interaction scenarios across all system modules. All core functionalities operated without system crashes or transactional inconsistencies, confirming architectural stability and integration reliability. While large-scale user-centered statistical evaluation remains part of future work, the current study focuses on architectural feasibility, integration validation, and controlled performance assessment to establish the technical robustness of the proposed AI-assisted learning platform. Table I presents a qualitative comparison between the proposed system and representative AI-enabled LMS platforms, highlighting the enhanced accessibility, learner support, and system integration achieved by the proposed approach.

Table 1. Qualitative comparison of AI capabilities, system integration, and role-based functionality between representative AI-enabled LMS platforms and the proposed AI-Assisted system.

Feature	Existing AI-Enabled LMS (Docebo, 360Learning, EdApp)	Proposed AI-Assisted E-Learning Platform
AI-Based Learner Support	Text-based chatbots with limited course-context awareness	NLP-based chatbot with contextual + course-specific support
Voice Interaction	Limited or not supported	Integrated voice assistant for navigation and assistance
Role-Based Dashboards	Partial (mainly admin & learner)	Full multi-role dashboards (Admin, Trainer, Student)

Course Progress Tracking	Basic completion metrics	Real-time progress %, resume learning, mandatory quiz completion
System Integration	Modular but externally configured	Fully integrated AI-assisted LMS within a unified architecture

Conclusion and Future Work:

This research successfully addressed the limitations of real-time support in traditional LMS by implementing a unique dual-framework architecture. By bridging a secure Laravel backend with a high-performance Flask AI engine, the system achieves a level of integrated voice and text assistance beyond that of standalone components. The proposed framework incorporates dedicated Admin, Trainer, and Student dashboards to ensure structured management, modular content delivery, and personalized learner interaction.

A significant contribution of this work is the integration of an AI-powered chatbot and voice assistant using Flask and spaCy NLP. The intelligent assistant delivers real-time academic and technical support, enables voice-based interaction for assignments and navigation, and provides direct access to learning resources. This dual text- and voice-based interaction enhances accessibility, learner autonomy, and overall engagement.

Structured functional validation and scenario-based performance testing confirmed system stability, authentication robustness, workflow completion accuracy, and an average API response latency below three seconds. The integrated chatbot successfully handled approximately 85% of predefined academic and navigation-related queries under controlled testing conditions. Compared with conventional LMS platforms that deploy AI components independently, the proposed system offers a more unified integration of contextual NLP assistance, voice interaction, and secure role-based management within a single architecture. The novelty of this work lies in the seamless architectural integration of AI-driven conversational support, voice-enabled interaction, and secure multi-role LMS management within a unified and scalable framework rather than deploying these components as independent modules.

Future enhancements will focus on integrating advanced transformer-based language models, such as BERT or GPT, to improve conversational intelligence and contextual understanding. Additional directions include incorporating gamification features, applying AI-driven analytics to predict learner performance and dropout risks, developing mobile applications for wider accessibility, and exploring blockchain-based certification to enhance credential security. Integration with external learning platforms while maintaining intelligent in-system support also represents a promising research direction.

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