iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.81269

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

AI-Powered Adaptive Learning Platform Management

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Abstract: ***The increasing diversity in learner abilities and the limitations of conventional one-size-fits-all teaching approaches present a significant challenge in modern education systems. Students often struggle due to the lack of personalized learning paths, resulting in reduced engagement and inefficient knowledge acquisition. To address this problem, this paper proposes an AI-powered Adaptive Learning Platform that delivers personalized and data-driven educational experiences.***
The proposed system utilizes an initial diagnostic assessment to evaluate learner proficiency and categorize students into appropriate learning levels. Based on this classification, the platform generates customized learning paths and dynamically adapts content delivery according to student performance. The system integrates modules for learning content management, engagement tracking, progress monitoring, and secure assessment to ensure continuous evaluation and improvement. Additionally, advanced AI techniques such as LLaMA-based code summarization combined with Retrieval-Augmented Generation (RAG), along with rule-based bug detection, are incorporated to enhance programming skill development. Collaborative learning is further supported through task management tools and a SkillSwap module that enables monitored peer-to-peer interaction.
Experimental observations indicate that the proposed system improves learning efficiency, increases student engagement, and enhances overall academic performance. In conclusion, the platform offers a scalable, intelligent, and adaptive solution that effectively addresses the limitations of traditional education systems while supporting personalized and collaborative learning environments.
Keywords: Adaptive Learning System, Artificial Intelligence in Education, Personalized Learning, Student Performance Analysis, Retrieval-Augmented Generation (RAG), Large Language Model (Llama).

I. INTRODUCTION

Artificial Intelligence in education has evolved significantly to enable more efficient, adaptive, and personalized learning experiences. Traditional classroom teaching generally follows a uniform instructional model in which all students are taught the same content at the same pace, regardless of their individual understanding levels. However, in real educational environments, learners differ in their cognitive abilities, learning speed, and comprehension styles. This variation has led to the development of adaptive learning systems that use data-driven techniques to analyze student performance and provide customized learning content, making education more flexible, interactive, and learner-centred.

The problem exists because conventional education systems are not designed to dynamically adapt to individual learner needs. In many cases, students struggle to understand complex concepts when teaching is delivered at a fixed pace, leading to gaps in knowledge and reduced engagement. Additionally, educators face difficulties in continuously tracking the performance of each student in large classrooms and providing personalized feedback. The lack of real-time adaptability, limited personalization, and minimal use of intelligent technologies further reduce the effectiveness of traditional learning systems, creating a need for automated and adaptive educational solutions. The purpose of this project is to design and develop an AI-powered Adaptive Learning Platform that provides personalized and intelligent educational support. The system evaluates students through an initial assessment and classifies them into appropriate proficiency levels, enabling the generation of customized learning paths based on individual needs. It also includes modules for engagement tracking, progress monitoring, secure assessments, and interactive learning support to enhance the overall learning experience. In addition, advanced AI techniques such as Llama-based code summarization integrated with Retrieval-Augmented Generation (RAG) and rule-based bug detection are incorporated to improve programming skill development. Overall, the project aims to create a scalable, intelligent, and adaptive learning system that enhances student engagement, improves learning efficiency, and modernises the education process.

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II. LITERATURE SURVEY AND RELATED WORK

In recent years, advancements in artificial intelligence (AI) and data analytics have significantly transformed the field of education by enabling personalized and adaptive learning systems. The integration of machine learning, natural language processing (NLP), and learning analytics has created new opportunities for delivering customized educational experiences based on individual learner needs. These technologies allow systems to analyze student performance, behavior, and engagement patterns, thereby improving learning efficiency and academic outcomes.

Kuldeep Vayadande et al. [1] contributed to intelligent educational systems by developing a web-based platform that integrates modern web technologies with AI services to enhance user interaction and system responsiveness. Their work demonstrated how real-time processing and user-friendly interfaces can improve accessibility and usability in AI-driven applications. This approach laid the foundation for integrating AI with web-based educational platforms for better user engagement.

Expanding on adaptive learning concepts, Sachith Seneviratne et al. [2] explored the use of large-scale AI models and data-driven analysis to evaluate system performance and adaptability in complex environments. Their research highlighted the importance of handling large datasets and improving system accuracy, while also identifying limitations such as scalability issues and contextual inconsistencies in automated systems.

To enhance data understanding and contextual mapping, Manavkumar Patel et al. [3] proposed hybrid approaches combining statistical techniques with intelligent learning models. Their work improved the system's ability to interpret user inputs and deliver more accurate and context-aware outputs. This research emphasized the role of semantic understanding and adaptability in AI-based systems. Similarly, Himanshu Kothari et al. [4] developed an interactive web-based system that focused on improving user experience, simplicity, and accessibility through structured design and efficient backend integration. Their model highlighted the importance of responsive interfaces and user-centric design in modern applications.

Collectively, these studies demonstrate the evolution of AI-driven systems from basic automation to intelligent, data-driven platforms capable of personalisation and real-time interaction. However, many existing systems still lack integrated features such as adaptive learning mechanisms, engagement tracking, and AI-assisted academic support. Building upon these advancements, the proposed AI-Powered Adaptive Learning Platform Management system introduces a comprehensive solution that combines pre-assessment-based classification, personalized learning paths, real-time analytics, and AI-driven support tools. This approach provides a scalable, interactive, and student-centred learning environment aimed at improving academic performance and overall learning experience.

III. PROPOSED SYSTEM

The proposed system is an AI-powered Adaptive Learning Platform designed to deliver a personalized and intelligent learning experience using artificial intelligence and web technologies. The system begins with a pre-assessment module that evaluates student knowledge and classifies learners into proficiency levels using a rule-based approach. Based on this classification, customized learning paths and study materials are provided to match individual learning needs, improving understanding and retention.

The platform includes a content management system that allows faculty to upload and organize academic resources efficiently. An engagement tracking module monitors student activity such as login frequency, time spent on learning materials, and interaction behavior, which is displayed through a progress dashboard for performance analysis. A secure assessment module is also integrated to ensure fair and structured evaluations. To enhance technical learning, the system incorporates AI-based tools including Llama-based code summarization with Retrieval-Augmented Generation (RAG) for simplifying complex code, along with rule-based bug detection for error identification. Additionally, a task management feature helps students organize academic activities, while the SkillSwap module enables collaborative learning and peer-to-peer knowledge sharing under instructor supervision.

Overall, the proposed system provides a scalable, efficient, and data-driven solution that enhances personalized learning, improves engagement, and supports academic development through intelligent automation.

IV. SYSTEM ARCHITECTURE

The AI-Powered Adaptive Learning Platform is designed using a multi-layered architecture to ensure efficient functionality and scalability. The system consists of user, presentation, application, data, and AI layers that work together to deliver a personalized learning experience. Users interact with the platform through a responsive interface, while the backend processes requests and manages core functionalities such as assessment, content delivery, and progress tracking. The data layer stores all academic and user-related information securely, and the AI layer enhances the system by providing intelligent features such as adaptive learning, code analysis, and performance insights. This structured architecture enables smooth data flow, effective decision-making, and

improved learning outcomes.

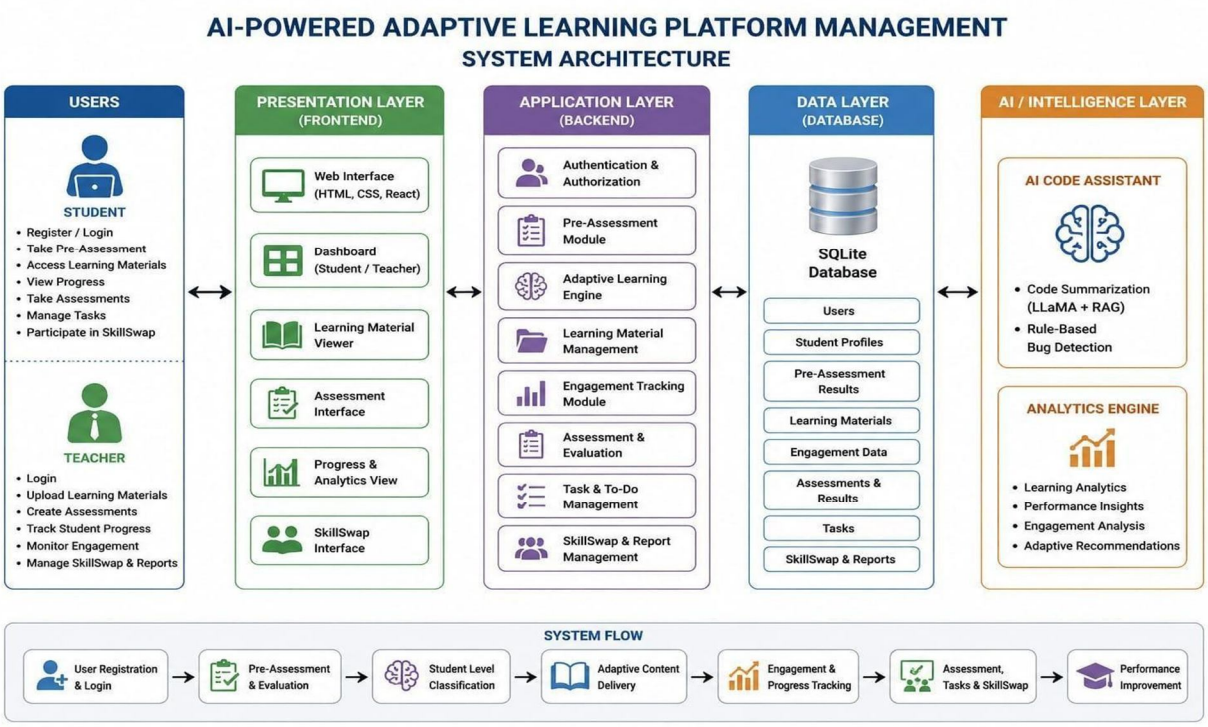

Fig 1: System Architecture

V. IMPLEMENTATION

The AI-Powered Adaptive Learning Platform is implemented using a structured and modular approach to ensure smooth execution of system functionalities. The implementation follows the logical flow of the application, starting from user access to performance evaluation and collaborative learning. The system is divided into four major modules as described below.

A. Authentication and User Management Module

This module is responsible for handling secure access to the platform. It manages user registration, login, and role-based authentication for students and instructors.

Students can create accounts and access their personalized dashboards, while teachers are provided with additional privileges such as uploading learning resources and managing assessments. The module ensures data security through proper validation and controlled access mechanisms, forming the entry point of the system.

B. Pre-Assessment and Classification Module

This module evaluates the learner's initial knowledge level through a structured assessment process. Students are required to complete a pre-assessment quiz after logging into the system.

Based on their performance, a rule-based classification approach is applied to categorize users into different proficiency levels. This classification plays a crucial role in determining the type of learning content delivered to each user, ensuring that the platform adapts to individual learning capabilities.

C. Adaptive Learning and Content Delivery Module

This module acts as the core component of the platform by providing personalized learning experiences. Based on the classification results, the system delivers customized study materials and structured learning paths.

Teachers can upload and manage resources such as notes and documents, which are organized and made accessible to students according to their learning level. The module also integrates AI-based support, including code summarization and error detection, to assist learners in understanding complex programming concepts. This ensures effective knowledge transfer and improved

comprehension.

D. Engagement Tracking, Evaluation, and Collaboration Module

This module focuses on monitoring student activity, evaluating performance, and encouraging collaborative learning. It tracks parameters such as login frequency, time spent on learning materials, and interaction behavior.

The collected data is processed to generate insights that are displayed through a progress dashboard. A secure assessment system is used to conduct tests and record results. Additionally, task management features help students organize assignments and deadlines efficiently.

The module also includes a collaborative learning component, where students can participate in peer interactions. Teachers can monitor these interactions, review reports, and ensure a safe and productive learning environment.

VI. RESULTS AND DISCUSSION

The proposed AI-Powered Adaptive Learning Platform was successfully developed and evaluated to measure its effectiveness in delivering personalized education and improving student performance.

The system integrates adaptive learning, AI-based assistance, and engagement tracking to provide a comprehensive learning environment. The primary objective was to enhance learning efficiency, simplify complex concepts, and support data-driven decision-making in education.

A. Analysis of Results

The system demonstrated significant improvement in learning outcomes by delivering customized content based on individual student performance.

The pre-assessment and classification mechanism effectively categorized learners, allowing the system to assign appropriate study materials. This resulted in better understanding and reduced learning difficulty among users.

The integration of AI-based features, such as code summarization and rule-based bug detection, played a key role in improving programming skills. Students were able to interpret complex code more easily and identify errors with minimal assistance, promoting independent learning.

The engagement tracking module provided valuable insights into user activity, including time spent on learning materials, frequency of access, and interaction behavior. These insights helped in monitoring student progress and identifying areas that required improvement. The progress dashboard enabled both students and instructors to evaluate performance in a clear and structured manner.

B. System Performance Comparison

A comparative analysis between the existing learning systems and the proposed platform was conducted based on key performance metrics such as accuracy, efficiency, and usability.

1) Accuracy: The proposed system achieved higher accuracy in delivering relevant learning content due to its adaptive learning mechanism and AI-based analysis.

2) Efficiency: The platform reduced manual effort by automating content delivery, evaluation, and feedback processes, resulting in faster and more effective learning.

3) Usability: The user-friendly interface and structured workflow improved accessibility and ease of use for both students and instructors.

The graphical comparison indicates that the proposed system consistently outperforms traditional systems across all performance parameters, demonstrating its effectiveness in providing a personalized and intelligent learning experience.

C. Overall Outcome

The results confirm that the AI-Powered Adaptive Learning Platform enhances student engagement, improves comprehension, and supports efficient academic management. The system operates reliably with smooth data handling and interactive features. Although minor delays may occur during high data processing, the overall performance remains stable and effective. The platform proves to be a scalable solution for modern, technology-driven education.

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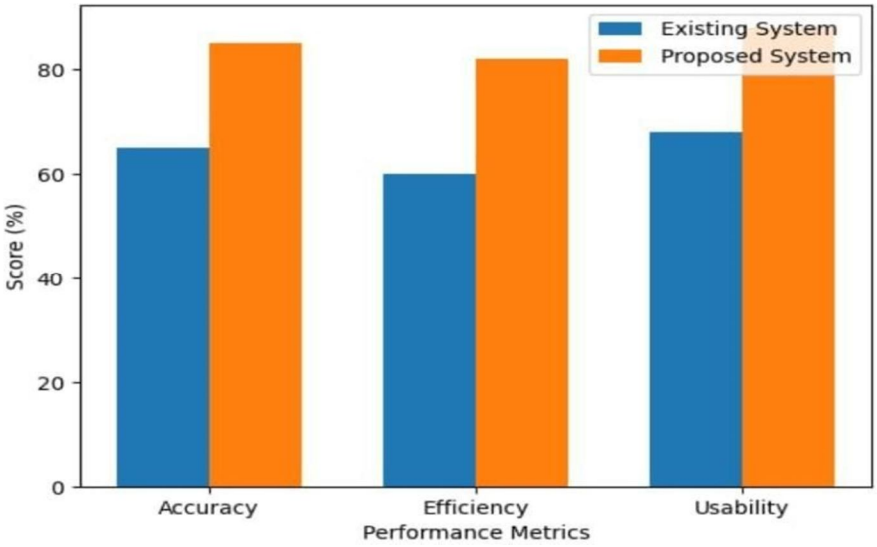

Fig 2: System Performance Comparison (Code Summarization, Debugging, Skillswap)

VII. CONCLUSION

This paper presented an AI-Based Adaptive Learning Platform designed to improve the effectiveness of digital education through personalization and intelligent support. The system successfully integrates assessment, adaptive content delivery, engagement monitoring, and collaborative learning within a unified platform. By evaluating student performance through a pre-assessment process, the platform is able to provide tailored learning paths that suit individual capabilities, thereby enhancing understanding and retention. The inclusion of artificial intelligence techniques, such as automated code summarization and error detection, further strengthens the learning process by simplifying complex programming concepts. Additional features like progress tracking, task management, and secure assessments contribute to a structured and efficient learning environment.

The overall implementation demonstrates that combining adaptive learning strategies with AI technologies can significantly improve student engagement and academic performance. The system offers a scalable and flexible solution that can be extended to various educational domains. This work highlights the potential of intelligent learning platforms in shaping the future of modern education.

VIII. FUTURE WORK

The proposed AI-Based Adaptive Learning Platform can be further enhanced by incorporating advanced technologies and additional features to improve its functionality and user experience. One potential improvement is the integration of more sophisticated machine learning models that can continuously learn from user behavior and provide more accurate and dynamic content recommendations.

The development of a mobile application can increase accessibility and allow users to engage with the platform anytime and anywhere. Real-time collaboration features, such as live discussions and interactive group learning sessions, can further strengthen peer-to-peer interaction and knowledge sharing.

Future enhancements may also include multilingual support to make the system accessible to a wider audience and voice-based assistance to improve usability. The integration of predictive analytics can help identify at-risk students and provide early intervention strategies. Additionally, automated quiz generation and intelligent feedback systems can further enhance the learning process.

By implementing these improvements, the platform can evolve into a more comprehensive, efficient, and globally accessible educational solution.

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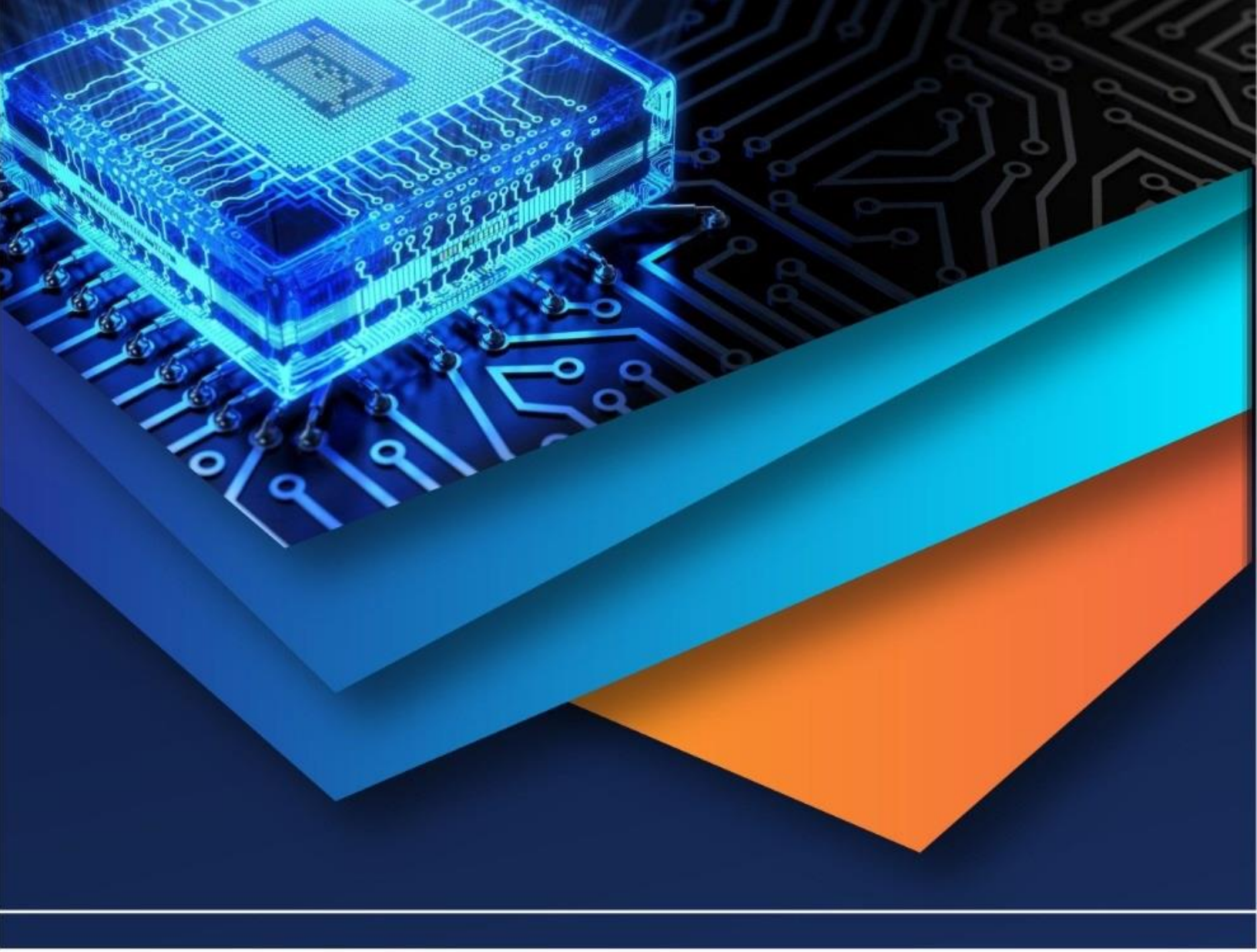

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