

An AI-Based Framework for Personalized Educational Content Generation and Adaptive Assessment

Farendrakumar Ghodichor¹, Tejas Kumbhar², Tushar Jadhav³, Ramkrushna More⁴, Bhagavat Mhaske⁵

^{1,2,3,4,5}Department of AI & DS, Dr. D. Y. Patil College of Engineering & Innovation, Pune, India

Peer Review Information	Abstract
Type: Article Received: 26 March 2026 Revised: 10 April 2026 Accepted: 24 May 2026 Published: 15 June 2026	The swift development of digital learning has required the replacement of the immobile teaching repositories with dynamic adaptive learning spaces. Although artificial intelligence has already started infiltrating the educational industry, the current systems often fail to be able to offer holistic personalization that considers not only the intellectual capacity but also the unique psychological profiles of specific learners. The paper suggests a holistic design of a personalized learning and assessment platform powered by AI that integrates Large Language Models (LLMs) with the elements of automated behavioral profiling and tools that enable accessibility to all. The proposed platform will also be capable of changing pedagogical strategies and content presentation on the fly to maximize student engagement by using natural language processing to understand student personality traits and learning styles. Moreover, the platform incorporates safe, decentralized data management mechanisms to safeguard confidential psychological and academic information. By carefully examining the modular structure of the system, the theoretical basis, and the hypothetical assessment plan, the paper will provide a strong base of the next generation educational technologies that can be effective, secure, and ethically responsible at the same time. Keywords: Artificial Intelligence; Personalized Learning; Natural Language Processing; Large Language Models (LLMs); Adaptive Learning; Educational Technology; Behavioral Profiling; Data Security.

How to Cite This Article

Ghodichor, F., Kumbhar, T., Jadhav, T., More, R., & Mhaske, B. (2026). An AI-based framework for personalized educational content generation and adaptive assessment. *Multidisciplinary Journal of Research in Engineering and Technology*, 13(2s), 28-32.

Introduction

Artificial Intelligence (AI) integration into education has transformed the interaction process between learners and digital learning systems and materials. The present-day AI- based systems allow the automatic creation of content, smart tutoring, and personalized learning process, which facilitates easier and more efficient education. Although these developments exist, a good number of the current e-learning systems continue to use the one-way delivery of content and do not have the ability to accommodate the needs of the individual learners.

Conventional online learning systems tend to deliver the same content to everyone and neglect the variation in learning speed, which is already known, and cognitive capacity. This makes the engagement to be less, learning to be ineffective and knowledge retention challenging. Moreover, students often have to deal with such difficulties as information overload, the absence of structured learning resources, and insufficient assistance with doubts in real-time.

Recent researches emphasize that the interest in AI-driven applications that can produce personalized learning materials, such as notes, summaries, quizzes, and recommendations is increasing. Nonetheless, most of the solutions available are not comprehensive and the user has to switch between a variety of platforms to perform various learning activities. Also, the usage of advanced AI tools may presuppose technical proficiency, including timely engineering, which puts a handicap on a number of students.

The other significant problem is the digital divide, in which the students living in resource-limited or rural areas are unable to access and utilize more sophisticated educational technologies. This gap limits the advantages of AI in education and the need to create simplified, combined, and easy-to-use learning systems.

Related Work

The conventional e-learning systems have been mainly based on the concept of delivering content as it is in its form to the learners irrespective of their needs. Although these systems are accessible, they do not consider differences in learning speed, background knowledge and cognitive capabilities, which in turn result in diminished engagement and poor knowledge retention [1]. Recent innovations in Artificial Intelligence and Machine Learning have supported the creation of customized learning systems that change content depending on the user behavior and performance. Recommendation systems, clustering, and knowledge tracing techniques are popular methods to study the interactions of learners and deliver personalized educational materials to enhance the general efficiency of learning [2], [3].

Educational content generation has also undergone a further revolution in the form of generative AI models, especially transformer-based models, which allow automatic creation of summaries, notes, quizzes, and question-answer pairs. Such models decrease reliance on the manual content preparation and offer structured and concise study materials to the learners. Nevertheless, the solutions that are available tend to work as standalone applications and do not integrate with adaptive learning environments [4]. Adaptive assessment systems also have been drawing a lot of attention as they vary the difficulty of questions dynamically depending on how the learners respond. Studies indicate that such systems can improve the learning experience by keeping the level of challenge at the optimum and keep the learner constantly updated with what he has learned. These systems often utilize methods such as Item Response Theory (IRT) and AI-based methods of difficulty prediction [5].

Moreover, AI-powered chatbots and intelligent tutoring systems are becoming more and more widespread in the educational environment to deliver interactive learning experiences and real-time support. Such systems enhance student interaction through immediate feedback and customized instructions, yet most of them are still incomprehensive of context and cannot be smoothly incorporated into the learning material [6].

Nevertheless, even with such improvements, modern learning platforms are still disjointed, and users have to follow through the various tools of generating content, assessing it, and resolving doubts. This brings up the necessity of a single AI- based system that would combine the personalized content creation with adaptive assessment and real-time support into one integrated system.

Methodology

The suggested system is based on a multi-stage pipeline that incorporates the generation of customized content, the modelling of the learner, adapting assessment, and the creation of feedback. The framework applies Artificial Intelligence methods including Natural Language Processing (NLP), machine learning and recommendation systems to dynamically customize learning material and assessment plans in response to individual learner profiles.

System Architecture

The entire architecture will be constructed so that it will be scalable, adaptable, and capable of responding in real- time. The system is composed of four major interconnected layers:

Frontend Architecture

- The frontend interface will be created with the help of the latest web frameworks like Streamlit or React that will create an interactive and friendly learning experience. It facilitates several ways of interaction, such as:
- Individual Learning Dashboard: Shows recommended content, performance metrics, and performance analytics.
- Content Generation Interface: This interface enables a user to enter topics and create summaries, notes, quizzes and flashcards.
- Adaptive Assessment Module: It offers dynamic quizzes with real time feedback and adjustment of difficulty.
- Interactive charts based on the libraries such as Plotly or Chart.js are incorporated to show the performance of the learners, trends of the accuracy and the topic- based performance.

Core Processing Pipeline

The fundamental processing unit is in charge of all AI- based calculations and will include several sub- elements:

- Content Generation Engine: This is an engine that uses NLP and transformer-based models to produce educational content (summaries, key points, pairs of questions and answers).
- Recommendation System: This uses content-based filtering and clustering algorithms to provide useful learning resources according to user preferences and past interactions.
- Learner Modeling Unit: Monitors user behavior, learning trends, and performance indicators to create a dynamic learner model.
- To ensure efficiency, the system uses optimized batches of data and imposes size and generation length constraints on the input to preclude excess computation.

Data Architecture

- Proponents: The system stores both structured and unstructured data to facilitate personalization and flexibility:
- User Data: Learning history, quiz performance, preferences and patterns of engagement.
- Content Repository: Holds educational resources, notes produced, and evaluation objects.
- Adaptive assessment logic: This is facilitated by a mapping system of knowledge level, in which questions are grouped according to their difficulty level and matched to certain learning objectives. A scoring system is used to test the responses of the learners and to update the level of proficiency.

Performance Optimization

- To provide real-time performance and scalability, a number of optimization strategies are used:
- Dynamic Difficulty Adjustment: Reduces unnecessary recalculations by adjusting the difficulty levels periodically.
- Effective Data Processing: Relies on caching and compact data structures to minimize latency.
- Model Optimization: API-based inference or lightweight AI models are employed to trade off speed and accuracy.
- Background processes generate content and update data asynchronously to enhance responsiveness.

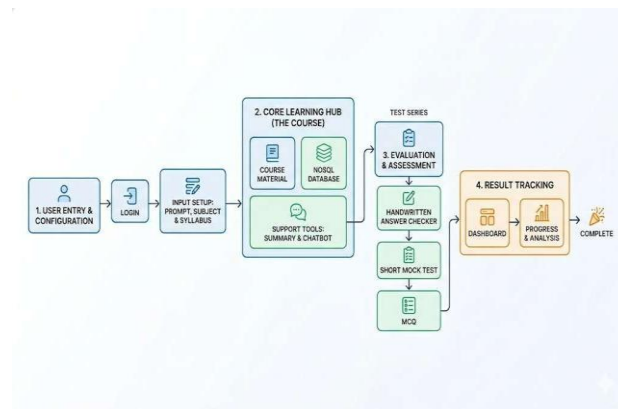


Fig. 1. AI-Driven Personalized Education and Evaluation Model

Results And Discussion

The suggested system shows efficient functionality in creating custom educational materials and offering adaptive testing regarding the behavior of individual learners. The combination of AI-powered modules allows providing dynamic content, providing feedback in real-time, and enhancing the learning process.

Content Generation and Quality Evaluation

The system is able to create structured learning content, such as summaries, notes, quizzes, flashcards, based on the subject of user input.

Content that is generated is contextually relevant and is short, which saves time spent on preparing it manually. Assessment of the generated outputs indicates that learners get topic-centered and simplified explanations that enhance their understanding and learning.

Personalized Recommendation Performance

The recommendation module is very effective in proposing learning resources depending on the preference of the user, history of interaction, and performance. With the help of content-based filtering and similarity measures, the system makes sure that the learners are shown the relevant materials. The visualization dashboards allow visualizing proficiency by topic, which allows users to know weak areas and concentrate their learning on them.

Real-Time Feedback and Interaction

Real-time doubt resolution and interactive learning is possible through the integration of an AI-based chatbot. The system will give feedback immediately on the quiz answers, indicate errors and propose remedial learning materials. Its lightweight processing pipeline provides quick response times, which make the interaction without apparent delays possible.

Discussion and Limitations

Despite the fact that the system has the ability to show high personalization and adaptive learning, there are limitations. The quality of the generated content is based on the underlying AI models and sometimes does not have a deep contextual insight on very specialized matters. Moreover, adaptive assessment accuracy is dependent on enough user interaction data, and this could be scarce in the case of new users (cold-start problem).

Moreover, the system mainly uses textual and interaction-based inputs that might not be very effective in capturing complex cognitive or emotional learning issues. The improvements could be made in the future with multimodal learning inputs (e.g., voice, video) and more sophisticated learner modeling methods to enhance the accuracy of personalization.

Conclusion

The current paper proposed an AI-based system of generating personalized educational content and adaptive assessment. The proposed framework is based on the latest methods of Artificial Intelligence, such as Natural Language Processing, machine learning, and recommendation systems, which will allow improving the digital learning experience.

The proposed system, unlike the traditional e-learning systems, which are based on the delivery of fixed content, dynamically generates individualized learning material which could be in the form of summaries, notes, quizzes, and flashcards depending on the preference and performance of the learners. Moreover, the adaptive assessment can be integrated to allow real-time difficulty adjustment of questions, and this will guarantee optimum learning curve to the users.

The framework also has smart recommendation systems and real-time feedback, which is chatbot, thus making the system interactive, scalable, and user-centric. In general, the offered solution enhances the engagement of learners, minimizes the time spent on the preparation of the material, and offers a single platform of personalized learning, which will allow developing the next generation of intelligent learning systems.

Future Scope

Although the suggested framework proves to have a far greater improvement in individualized learning and adaptive assessment, the opportunities of future improvement are also present. The existing system is mostly centered on the text-based content production and evaluation though the positive side of development in the future can be projected and the framework that the system should be based on can be extended to multimodal learning where video, audio, and interactive simulations can be used to create a more engaging learning experience.

Accurate personalization and dynamic decision-making can also be enhanced by the integration of highly effective deep learning models, including large language models and adaptive systems based on reinforcement learning. Also, emotional aware learning system with facial recognition or sentiment analysis can be added to be able to comprehend the engagement of learners and their cognitive states better.

The structure has a great possibility of also being applied in large learning settings like the colleges, online education, and corporate training systems. The digital divide can be addressed by conducting future research aimed at enhancing the scalability, multilingual support, and accessibility of these technologies to learners with different backgrounds.

Also, the system can further be expanded to incorporate predictive analytics on early detection of at-risk students, as well as individual intervention strategies. Real-time collaboration and decision-making will be improved with integration with Learning Management Systems (LMS) and cloud-based infrastructures. The innovations will help to create a smarter, more inclusive and adaptive education ecosystem.

References

1. Hariyanto, H., Kristianingsih, F. X. D., & Maharani, R. (2025). Artificial intelligence in adaptive education: A systematic review of techniques for personalized learning. *Discover Education*, 4.
2. AI-Powered Personalized Learning and Assessment Platform. (2025). *International Journal of Research in Technology and Innovation (IJRTI)*.
3. Halkiopoulos, C., & Gkintoni, E. (2024). Leveraging AI in e-learning: Personalized learning and adaptive assessment through cognitive neuropsychology—A systematic analysis. *Electronics*, 13(18).
4. Sajja, R., Reddy, V. K., & Kumar, A. (2023). Artificial intelligence-enabled intelligent assistant for personalized and adaptive learning in higher education. *arXiv preprint arXiv:2309.10892*.
5. Mittal, U., Sai, S., Chamola, V., & Sangwan, D. (2024). A comprehensive review on generative AI for education. *IEEE*.
6. Comprehensive Framework for AI-Based Personalized Learning Systems. (2024).
7. Adaptive Learning Systems Using Artificial Intelligence Techniques. (2024).
8. Review of AI Applications in Personalized Education and Learning Analytics. (2023).