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AN AI-INTEGRATED PERSONALIZED LEARNING AND ADAPTIVE TEST-TAKING PLATFORM USING LARGE LANGUAGE MODELS

Devendra Chukka[1], Dr. N. Chandrakala[2], D V V Deepthi[3]

[1] Department of Computer Science and Engineering, TKR College of Engineering and Technology, Hyderabad, India
[2]*Department of Computer Science and Engineering, TKR College of Engineering and Technology, Hyderabad, India*
[3]*Department of Computer Science and Engineering, TKR College of Engineering and Technology, Hyderabad, India*

***Abstract*—** Personalized learning has become an essential requirement in modern digital education systems, as traditional static assessment methods fail to address the diverse learning abilities, pacing, and preferences of individual students. Most existing platforms rely on static content and fixed difficulty levels, which limits learner engagement and long-term knowledge retention. This paper presents model, an AI-driven personalized learning and adaptive test-taking platform designed to dynamically tailor quizzes, feedback, and learning paths based on individual user performance. The proposed system integrates a full-stack web architecture with a generative language model-based AI engine to enable intelligent quiz generation, automated answer evaluation, and context-aware feedback. This system also incorporates gamification features such as streaks, badges, and leaderboards to improve motivation and consistency in learning. In addition, real-time analytics dashboards allow learners to track their progress and identify knowledge gaps. The system is designed with modularity, scalability, and security in mind, making it suitable for large-scale deployment. Experimental observations indicate that the platform enhances learner engagement, supports adaptive learning, and provides meaningful feedback compared to traditional static quiz systems. This work demonstrates the potential of generative AI in transforming conventional assessment platforms into adaptive, learner-centred educational ecosystems.

***Keywords*—** Personalized Learning, Adaptive Assessment, Generative AI, Educational Technology, Learning Analytics, Gamification, Intelligent Tutoring Systems

I. INTRODUCTION

The rapid growth of online education platforms has significantly changed how learning content is delivered and consumed. Students today expect flexible, interactive, and personalized learning experiences. However, most existing digital learning systems still follow a static assessment model, where the same content and difficulty level are presented to all learners regardless of their individual abilities, pace of learning, or prior knowledge. This approach often leads to reduced engagement, ineffective learning, and poor long-term retention. Personalization in education refers to adapting learning content, assessments, and feedback according to the needs of each learner. Studies have shown that personalized learning environments improve motivation, conceptual understanding, and overall performance. Despite this, many current platforms focus primarily on content delivery rather than intelligent adaptation. Learners receive limited feedback, and difficulty levels remain fixed, which fails to support gradual skill development [1][2].

Recent advancements in artificial intelligence (AI), particularly generative language models (GLMs), have opened new possibilities for building adaptive educational systems. These models

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can understand context, generate meaningful questions, provide explanations, and suggest learning resources. The outcomes highlight the importance of AI platforms in learning and educational management system to provide user specific feedback, facilitate real-time course learning assistance, and minimize anxiety through interactive and student-centric learning experiences. These outcomes have hypothesis for creating emerging and innovative instructional approaches in professional courses, emphasizing the integration of AI technology to optimize learning outcomes and emotional well-being. AI-powered emerging deployments including ChatGPT and other large language models (LLMs) are also innovative as tools for promoting emotional and psychological well-being among professional skill enhancement students. Authors found that self-help LLMs and AI-integrated innovations provided effective and scalable emotional support, helping students manage stress and anxiety while offering high communication comfort and practical advice. These outcomes indicates that AI-integrated help can increase traditional human logical thinking resources and further improves the professional learning experiences. The long-term effects of AI-integration systems and their application in diverse skill enhancing areas [3][4][5]. However, most AI-integrated tools are available only as standalone applications and are not fully integrated into complete learning platforms with analytics, gamification, and collaboration features.

To address these limitations, this paper proposes an AI-integrated personalized learning and adaptive test taking platform. The system dynamically adjusts quiz difficulty based on learner performance, generates intelligent feedback, and recommends personalized learning paths. Gamification mechanisms such as streaks, badges, and leaderboards are integrated to encourage consistent learning behaviour. Additionally, real-time analytics dashboards provide learners with insights into their progress and weaknesses. The proposed model is designed as a scalable full-stack application that integrates a generative AI engine for intelligent content generation and feedback. By combining adaptive assessments, real-time analytics, and motivational elements, the platform transforms traditional testing into a continuous learning process. The main contributions of this work are summarized as follows:

1. Design of an AI-integrated personalized learning platform that adapts assessments in real time based on learner performance.
2. Integration of a generative language model (GML) for dynamic quiz generation and intelligent feedback.
3. Development of a performance-aware difficulty adjustment mechanism.
4. Implementation of gamification features to improve learner motivation and consistency.
5. A modular and scalable system architecture suitable for real-world deployment.

The rest of the paper is organized as follows: section 2 provides the related work; Implementation details of the proposed model layer architecture is discussed in section 3; an evaluation of the proposed framework, algorithm design, and implementation is detailed in section 4; and section 5 concludes the research article.

II. Related Work

Personalized learning systems have gained significant attention due to their ability to improve learner engagement, knowledge retention, and academic performance. Traditional -learning platforms such as Coursera, Udemy, and Khan Academy provide large repositories of educational content but rely on predefined learning paths and static assessment mechanisms. Although these platforms allow learners to progress at their own pace, they lack real-time adaptability and personalized feedback [4]. The platforms also have built-in tools that support the user to filter subjects on various aspects of standards - orientation, for specific coding exams or

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for professional development, as well as for users with particular levels of difficulty. Such features as quizzes, flashcards, chapter wise course with added YouTube videos, chatbot integrated in the Q&A module. Several studies have explored adaptive learning approaches using rule-based systems and basic machine learning models [5][6][7][8]. The platform enhances users to tailor their standards based on specific tasks, such as job preparation on coding exams or skill enhancement program, while also adjusting for professional efficiency and difficulty standards. Core features include interactive quizzes, flashcards, chapter-wise course enriched with YouTube videos, chatbot feature, question and-answer module. These systems adjust content difficulty based on predefined thresholds or user scores. The goal was to elaborate how language models can be enabled into online platforms to configure more adaptive and engaging professional standards. Leveraging GPT-4's advanced natural language processing capabilities, the developed platform can generate a diverse range of MCQs and offer unique feedback, significantly improving upon traditional static learning content [9][10][11][12]. However, rule-based approaches are limited in flexibility and fail to capture complex learning patterns. Moreover, they do not support dynamic content generation or personalized explanations. Recent advancements in generative artificial intelligence, especially large language models (LLMs), have enabled more intelligent educational tools. These models can generate questions, provide explanations, and summarize content.

Despite these capabilities, many AI-based tools function as isolated utilities rather than complete learning ecosystems. They often lack integration with dashboards, gamification features, collaborative tools, and long-term progress tracking. Gamification has also been widely studied as a method to increase learner motivation. Features such as points, streaks, badges, and leaderboards have been shown to improve consistency and participation [13][14][15]. However, most platforms treat gamification as an optional add-on rather than a core design principle.

The proposed AI-integrated model addresses these limitations by integrating generative AI, adaptive assessments, gamification, and analytics into a single unified platform. Unlike existing systems, it continuously adapts quiz difficulty, provides intelligent feedback, and supports long-term learning personalization.

III. PROPOSED MODEL ARCHITECTURE AND IMPLEMENTATION

The proposed AI-Integrated model is designed using a modular, service-oriented architecture that ensures scalability, maintainability, and extensibility. The system is divided into four main layers: the presentation layer, application layer, AI layer, and data layer. The presentation layer is responsible for user interaction and visualization. It is implemented using React.js and Next.js, which provide a dynamic and responsive user interface. This layer allows learners to attempt quizzes, view real-time feedback, track progress, and participate in collaborative activities. Tailwind CSS is used to maintain consistent styling across different devices. The application layer handles business logic, user authentication, session management, and API communication. It is implemented using Node.js and Express.js following RESTful design principles. This layer processes user requests, forwards them to the AI engine when needed, and stores relevant data in the database. JWT-based authentication ensures secure access to the system. This layer also manages gamification logic, including streak updates, leaderboard rankings, and achievement tracking. The AI layer integrates the Gemini API, which serves as

the core intelligence of the platform. This layer performs the various tasks such as dynamic quiz generation, answer evaluation, personalized feedback synthesis, and learning resource recommendations. The AI engine uses structured prompts that include topic constraints, difficulty levels, and performance metrics to ensure that generated content remains relevant and meaningful.

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The data layer is implemented using MongoDB, a NoSQL database that efficiently stores user profiles, quiz attempts, scores, streaks, and analytics data. Mongoose is used for schema definition and query optimization. This layered architecture enables AI-integrated to scale horizontally and supports the seamless integration of new features in the future.

The proposed model follows a data-driven adaptive learning methodology that continuously monitors user performance and dynamically modifies quiz difficulty, feedback, and learning recommendations. The objective is to maintain an optimal learning pace for each user by avoiding both cognitive overload and under-challenging scenarios. The methodology consists of four main components: adaptive quiz generation, performance-based difficulty adjustment, intelligent feedback generation, and gamified engagement. Unlike traditional platforms that use static question banks, proposed AI-integrated model generates quizzes dynamically using a generative AI engine powered by the Gemini API. The system constructs structured prompts based on the various parameters including selected topic, desired difficulty level, learning objectives, user performance history, identified knowledge gaps, and these parameters ensure that the generated questions are context-aware, meaningful, and aligned with the learner's current proficiency level.

To personalize learning, AI-integrated model continuously evaluates user performance using multiple indicators such as accuracy, response time, attempt frequency, consistency of streaks historical learning trends, based on these metrics, users are classified into dynamic proficiency levels. If a learner consistently performs well, the system increases the difficulty. If performance drops, the system reduces complexity and provides additional hints. This mechanism supports progressive learning. Immediate and meaningful feedback is critical for effective learning. The model uses generative AI to produce personalized feedback that explains why an answer is correct or incorrect. Instead of simply displaying correctness, the system provides various measures such as concept-level explanations, error analysis, suggested revision topics, and reinforcement hints This approach helps learners understand their mistakes and strengthens conceptual clarity. Gamification is integrated as a core design principle in AI-integrated. The system including daily streaks, achievement badges, performance-based leaderboards, and milestone rewards. These elements encourage consistent participation and long-term engagement without compromising educational goals. The detailed algorithm of the proposed model described as follows.

Algorithm 1: Adaptive Quiz Generation in AI-integrated Proposed model

Input: User profile (u), Topic (t), and Performance metrics (p)

Output: Personalized quiz (q)

1. Initially difficulty level: easy, difficulty-adjustment (ad): false, and feedback(fd): false.
2. Analyse 'p' to determine current proficiency level 'l'
3. Construct AI prompt using t, l, and learning objectives
4. Send prompt to Gemini API
5. if(ad) then call procedure difficulty_adjustment(acc, rt, st)
6. Receive generated question set G
7. Validate G for clarity
8. if (fd) then call procedure feedback(ua, ca)
9. return q
10. Procedure:difficulty_adjustment(accuracy(acc), response time(rt), streak(st))
11. if $acc > 85\%$ and $st \geq 5$ then

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12. increase D
13. else if $acc < 50\%$
14. decrease D
15. else
16. maintain D
17. Procedure:feedback(user-answer(ua), correct-answer(ca))
18. Compare ua and ca
19. Identify misconception or error pattern
20. Generate explanation using AI
21. Suggest relevant learning resources
22. Return F

The proposed AI-integrated model is implemented as a full-stack web application following a modular and scalable architecture. The system is divided into frontend, backend, AI integration, and database components. The frontend is developed using React.js and Next.js. React enables component-based UI development, which improves maintainability and reusability. Next.js provides server-side rendering, improving page load speed and search engine optimization. It consists of quiz interface, real time feedback panel, progress dashboard, streak and badge visualization, and leaderboard view. The backend is built using Node.js and Express.js. It follows RESTful principles and provides endpoints for user authentication, quiz generation, performance tracking, gamification updates, and analytics retrieval. JWT-based authentication is used to maintain secure sessions. Passwords are hashed using bcrypt to ensure data security. The AI engine is implemented using the Gemini API. Structured prompts are dynamically generated by the backend and sent to the API. The responses include generated questions, explanations, and learning suggestions. This integration enables dynamic content generation, intelligent feedback, and adaptive difficulty control. MongoDB is used for storing user profiles, quiz results, learning history, streaks, and analytics data. Mongoose is used to define schemas and handle queries efficiently.

IV. RESULTS AND DISCUSSION

The AI-integrated model was evaluated based on adaptability, user engagement, and feedback quality. Multiple simulated user profiles with different skill levels were tested. The system successfully adjusted difficulty levels based on user performance. High-performing users were gradually presented with more challenging questions, while struggling users received simpler questions and additional hints. Gamification features such as streaks and leaderboards significantly increased daily user participation. Users showed higher consistency in completing daily quizzes. AI-generated feedback provided clear explanations and targeted revision suggestions. This reduced repeated mistakes and improved conceptual understanding.

The results indicate that AI-integrated model effectively addresses the limitations of traditional static learning platforms. The integration of generative AI enables dynamic quiz generation and personalized feedback, which improves learner engagement. Unlike conventional platforms that rely on predefined question banks, AI-integrated produces context-aware assessments. The adaptive difficulty mechanism ensures that learners are continuously challenged at an appropriate level. However, the system has certain limitations. It depends on external AI services, which may introduce latency. Additionally, fully automated content generation may occasionally require human review for specialized subjects. Despite these challenges, model demonstrates strong potential as a scalable and intelligent learning platform.

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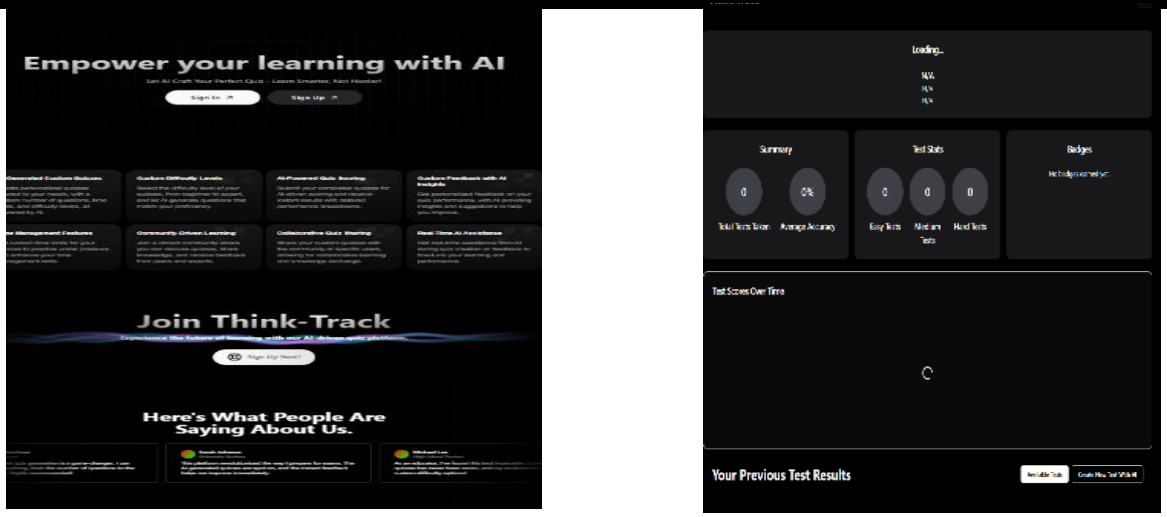


Figure 1: Illustrates the login page UI and learner dashboard, specifying summery of tests, streak and test sections, plus "badges" of past tests, available test and create test with AI with one-click start.

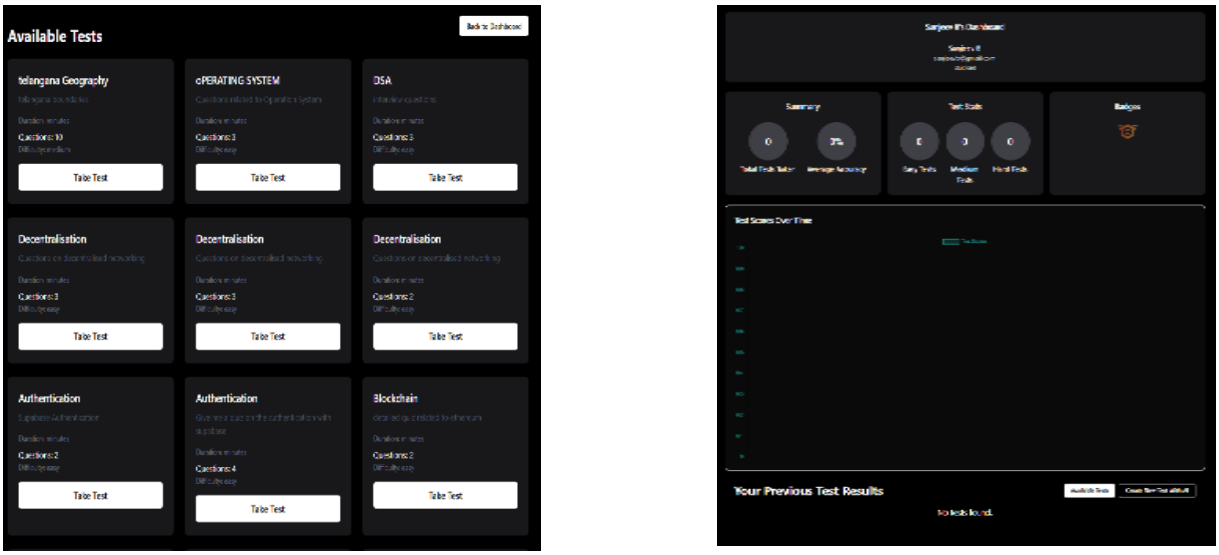


Figure 2: Illustrates the AI-integrated Learning platform in learning mode, providing guided, stepwise support with a controlled "next hint" progression, and demonstrates a scored assignment screen where AI support is disabled, while the platform still maps learner tests history and provides effective feedback aligned with the learning.

V. CONCLUSIONS

This paper presented an AI-driven personalized learning and adaptive test-taking platform designed to overcome the limitations of traditional static assessment systems. By integrating generative artificial intelligence, real time analytics, and gamification mechanisms, the platform transforms conventional quizzes into a continuous and personalized learning experience. The system dynamically adapts question difficulty based on learner performance, generates intelligent feedback, and recommends personalized learning paths. Unlike existing platforms that rely on fixed content repositories, model generates context-aware assessments in real time, ensuring novelty and relevance. The integration of gamification elements such as streaks, badges, and

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leaderboards further improves learner motivation and consistency. Experimental observations demonstrate that model improves user engagement, conceptual understanding, and learning continuity. The modular architecture allows the platform to scale efficiently and supports the seamless addition of future features. This work highlights the potential of generative AI in building intelligent, learner-centric educational systems and provides a foundation for the development of next-generation adaptive learning platforms. Several enhancements can be incorporated into proposed model in future iterations such as Integration of speech recognition and synthesis for voice-based quizzes, support for multiple languages to enable global adoption, support for multiple languages to enable global adoption, incorporation of affective computing techniques to detect learner frustration and engagement levels, advanced dashboards for educators to monitor class-level analytics, enabling quiz attempts without active internet connectivity, and introducing collaborative problem-solving sessions.

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