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AI-Based Adaptive Learning Platform: a Solution to Personalized Education in High Schools with Limited Infrastructure

Ian Harum Prasasti[1], Donny Muda Priyangan[2]
STMIK Kalirejo Lampung[1], Politeknik Gajah Tunggal[2]
ihp.harum8@gmail.com

The development of artificial intelligence (AI) educational technology presents new opportunities to improve the quality of learning, including in junior high schools with limited infrastructure. The main challenges for schools with limited infrastructure are limited access to learning resources, a lack of teaching resources capable of providing personalized instruction, and limited adaptation of instruction to individual students' needs. Research focuses on developing an AI-based learning platform that delivers a more personalized, efficient, and inclusive learning process. The planned platform aims to adapt content, learning methods, and pacing to suit students' profiles and needs. This study employs the Research and Development (R&D) method, adapted from Plomp, comprising preliminary research, prototyping, and assessment. Data were collected through interviews and observations in junior high schools in Lampung Province, involving 28 students and 4 teachers as the main respondents. This research resulted in an artificial intelligence (AI)-based adaptive learning platform designed to support personalized learning in junior high schools with limited infrastructure. Key findings indicate that the developed platform can provide adaptive material recommendations and exercises, display student learning progress dashboards, provide real-time feedback, and support material updates via synchronization features when an internet connection is available. In the trial stage, students responded positively to the platform, as reflected in increased engagement, learning motivation, and ease of understanding the material despite limited technological resources. This research contributes to the development of adaptive, inclusive, and sustainable educational technology, especially for secondary schools with limited resources.

Keyword: *Adaptive Learning, Personalized Education, and Minimal Infrastructure*

INTRODUCTION

Digital transformation has become a crucial part of the development of global education. Amid the Industrial Revolution 4.0, artificial intelligence (AI) technology has begun to be integrated into education to enhance learning quality. One rapidly developing area of AI application is adaptive learning, an approach that adapts content, methods, and pace to suit each student's characteristics. AI enables materials, assessments, and feedback to be tailored to each student's needs, learning style, and pace (Kaswan et al., 2024).

However, in Indonesia, there remains a significant gap between schools with complete infrastructure and those with minimal facilities. Secondary schools in remote areas often face limited numbers of technological devices, internet access, and teaching staff. These conditions make the implementation of personalized learning practices difficult. Given these challenges, the application of AI through adaptive learning platforms could be a solution. Leveraging AI to address

these challenges could result in a more efficient, inclusive, and ethical education system (Yambal & Waykar, 2025).

AI in education encompasses a wide range of applications, from recommendation systems and learning chatbots to learning data analytics and virtual tutors. According to Holmes et al., (2019). AI holds significant potential to support personalized learning by analyzing students' learning patterns and providing relevant recommendations. This system enables more inclusive learning by optimizing existing resources and providing learning services tailored to individual student needs. Educational technology contributes to improving learning outcomes and bridging gaps in emerging contexts (Makinde et al., 2025).

Adaptive learning refers to systems that tailor learning experiences based on each student's needs and abilities (Koper, 2014). Adaptive technology leverages student interaction data to deliver tailored materials, exercises, and feedback. Artificial Intelligence (AI) has raised concerns about student behavior and academic integrity. The development of AI technology presents both opportunities and challenges for educators and students.

The results of the needs analysis indicate that most teachers feel challenged to provide instruction that aligns with their students' diverse abilities. Teachers recognize the lack of variety in materials, particularly for students who need enrichment and improvement. In contrast, students often report difficulty finding additional learning materials that match their level of understanding, making personalized learning a significant challenge, especially in elementary schools with limited resources. There are many obstacles in schools, including limited facilities for accessing diverse subject matter and a learning platform that requires reliable internet access. Previous research (Chen et al., 2020) shows that AI-based solutions can still be implemented with a lightweight, resource-efficient technology approach. Artificial Intelligence (AI) has emerged as a key technology in the evolution of Industry 6.0, driving advances in automation, advanced analytics, and process optimization (Pineda et al., 2025).

The adaptive EduAI platform is expected to support this by providing personalized feedback, flexible learning paths, and enabling active student involvement in determining their own learning rhythm. Thus, personalization not only touches the cognitive aspects but also the affective aspects of students. According to the Technological Pedagogical Content Knowledge (TPACK) theory by Mishra & Koehler (2006)Successful technology integration depends on teachers' ability to balance pedagogical knowledge, content, and technology. Therefore, EduAI development should prioritize features that support teachers' roles rather than replace them, strengthening their capacity to deliver more targeted, data-driven learning.

Previous research by Indramini et al. (2025) has integrated artificial intelligence into language-learning models to improve multicultural literacy in schools with limited infrastructure, and their findings indicate that AI use in multicultural literacy learning provides a more interactive, adaptive, and tailored learning experience for students.

Thus, research on an AI-based adaptive learning platform (EduAI) for secondary schools with limited infrastructure is relevant and significant. It not only addresses a research gap on AI implementation in resource-constrained contexts but also provides a practical contribution in the form of a sustainable solution model. The development of AI-based learning applications offers a feature that provides recommendations on correct and incorrect answers, enabling students to identify their learning gaps and receive recommendations for material they have not yet qualified for. In addition, the EduAI Platform offers several advantages and innovations that distinguish it from existing AI-based adaptive learning solutions, particularly in high schools with limited infrastructure. The platform is specifically designed to run in areas with limited/unstable internet networks. EduAI is trying to make a breakthrough that has not been widely implemented as an effort to present personalized learning even in offline conditions. Another novelty lies in the flexible hybrid online-offline approach, which combines digital learning with rural areas with limited infrastructure. EduAI supports periodic data synchronization to ensure continued usability even without an internet connection. The results of this research are expected to support the goal

of inclusive education, namely, ensuring equitable, high-quality education and expanding lifelong learning opportunities for all.

METHOD

This study employed a Research and Development (R&D) methodology to design and develop an artificial intelligence (AI)-based adaptive learning platform in a secondary school with limited infrastructure. This methodology was chosen because it aligns with the research needs, not only as an exploratory approach but also as a development product that users readily accept. The R&D model adopted from Plomp (Plomp & Nieveen, 2013) comprises preliminary research, prototyping, and assessment. The stages of research are carried out as follows: 1) Preliminary Research Stage, literature studies are carried out, related research, and field surveys in rural schools involving teachers and students. The data were analyzed using the triangulation method to identify real needs, yielding needs analysis reports and platform technical specifications. 2) Prototyping stage, development of AI-based prototypes that are validated by technology experts and pedagogues, and tested for usability by teachers. This stage resulted in a draft prototype of EduAI I, with an achievement indicator of 80% of features functioning optimally and a usability score of>70 based on user feedback. If it does not meet the criteria, it will be revised until it does. 3) Assessment stage, a controlled trial was carried out in a secondary school with minimal infrastructure (rural) for two months to analyze the impact of learning and the effectiveness of the platform features that have been developed, whether it is in accordance with expectations. The output of this stage is a tested platform and an evaluation report. Indicators of its success include a 20% or greater increase in student scores and the school's ability to operate the platform.

The research began with a needs analysis conducted through interviews with guru dan siswa di SMP Negeri 2 Selagai Lingga di Kabupaten Lampung Tengah Provinsi Lampung. This needs analysis aimed to identify key challenges in the learning process, particularly related to material personalization, limited learning resources, and the obstacles teachers face in providing differentiated learning. The results of the needs analysis then formed the basis for designing an AI-based adaptive platform. During the system design phase, key features were defined, including a material recommendation system, a dashboard for student progress/completed questions, a question repository, and AI recommendations that teachers can use to monitor students' weaknesses in the teaching material. The platform was developed using lightweight web-based technologies to facilitate access on simple devices and to adapt to limited school infrastructure.

After the prototype was validated by material and technology experts, a limited trial was conducted at SMP Negeri 2 Selagai Lingga in Central Lampung Regency, Lampung Province, involving 28 students and four teachers as the main respondents. Respondents were selected through random sampling at the school, based on their learning applications, user needs, and effectiveness. The trial focused on using the platform in daily learning activities, assessing the effectiveness of its features, the level of student engagement, and the ease of use for teachers. Research data was collected through interviews and direct observation of user interactions with the system. The data were analyzed descriptively to illustrate the strengths, weaknesses, and potential of the AI-based adaptive platform for improving learning quality in secondary schools with limited infrastructure.

FINDINGS

This development research uses the Plomp model, which consists of three main stages: (1) Preliminary Research, (2) Prototyping, and (3) Assessment. The research focuses on students as the primary users of the AI-based adaptive learning platform. The research results are described below

Table 1. Findings on the AI-Based Adaptive Learning Platform

Plomp Stage	Focus	Observation & Interview Results	Product Results/Findings
Preliminary Research	Identify student needs	• Students prefer short, interactive practice questions. • Device and network limitations are obstacles. • They want instant feedback after answering questions.	Student needs were mapped: the platform should be lightweight, simple, practice-based, with recommendations for personalization & quick feedback.
Prototyping	Initial design & development of the student platform validated by a team of material and technology experts	• Students found the simple interface easier to use. • The progress tracker feature was found to be motivating.	Student platform prototype with the following features: 1) Concise material 2) Exercises 3) Real-time feedback 4) Sync menu 5) AI recommendations
Assessment	Limited trials with students and teachers are carried out during learning	Observation: Students were able to use the platform smoothly, despite internet issues. Interview: Students found the adaptive exercises and instant feedback very helpful, and the AI recommendation support allowed them to identify their personal abilities. This served as a basis for identifying gaps in the teaching materials.	The platform was deemed easy to use, tailored to students' needs, and motivated, but offline features still need to be developed. The sync feature can be used to update materials and questions while the platform is online.

The results of the Plomp model research indicate that the AI-based adaptive learning platform developed meets the needs of students in secondary schools with limited infrastructure.

- In the preliminary research phase, students emphasized the need for short exercises, instant feedback, and easy access.
- In the prototyping phase, the platform was successfully developed with adaptive exercise features, real-time feedback, concise materials, and a progress tracker.
- In the limited assessment phase, students responded positively to the platform's use. Students' positive responses were measured through observations and interviews conducted during the limited trial stage, which indicated increased engagement, learning motivation, and perceived ease and benefits of using AI-based adaptive learning platforms.

Thus, the platform prototype meets students' basic needs and is ready for further testing in the next development phase.

DISCUSSION

Before accessing the main menu, navigate to the login page, which serves as the primary gateway to the AI-based adaptive learning platform. This page is designed to be simple, intuitive, and user-friendly, enabling students of all levels of digital literacy to navigate it. The platform's logo and name are displayed at the top, conveying a professional and trustworthy image.

The login form consists of two main elements: a username field (Student Identification Number) and a password field, both combined with a clear "Login" button to facilitate easy identification.

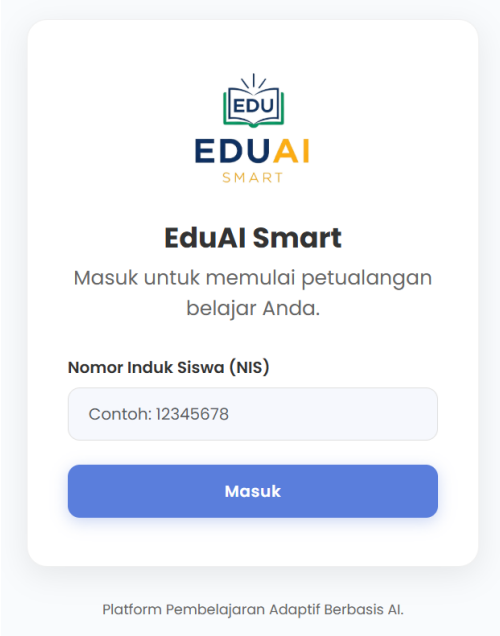

Figure 1. Login Page

Based on the results of development at the prototyping stage, the artificial intelligence (AI)-based adaptive learning platform begins with a login page for user authentication before accessing the system's main menu. The developed login page serves as the initial gateway to platform access and features a simple, easy-to-use interface for students. Observational results from the trial indicated that students were able to complete the login process without significant technical difficulties, despite varying levels of digital literacy.

The login page displays the logo and platform name at the top as the system identity. It provides a login form comprising a username field for the Student Identification Number (NIS) and a password field, with a clearly labeled "Login" button. This minimalist interface design aims to simplify the authentication process and minimize barriers to use, particularly in schools with limited technological infrastructure. The results of the observation indicate that the login page design supports ease of access and serves as the initial component that functions effectively in AI-based adaptive learning platforms.

The needs analysis results indicate that most teachers feel challenged to provide learning appropriate to their classmates' varying abilities. Teachers acknowledge a lack of variety in materials, especially for students who require enrichment and improvement. Conversely, students often report difficulty finding additional learning materials that match their level of understanding. This further reinforces the finding that personalized learning remains a significant challenge, especially in elementary schools with limited facilities. AI tools provide real-time feedback, enabling educators to support students more effectively (Rizvi et al., 2025). Furthermore, AI can analyze student learning data and identify knowledge gaps, thereby improving student success through personalized learning (Sumathy & Navamani, 2024).

Artificial intelligence (AI) can mimic problem-solving and decision-making. The potential for a disconnect between user preferences for AI, including the difficulties they encounter and the benefits AI tools provide, could improve how AI tools are integrated into educational settings and foster a more productive and supportive learning environment for students (Dalisaymo, 2025).

Based on these needs, a prototype AI-based adaptive learning platform was developed with several key features. First, a material recommendation system that uses a simple algorithm to analyze student achievement and deliver content tailored to individual needs. Second, a student dashboard that displays learning progress, allowing students to understand their position in the learning process. Third, AI recommendations that enable monitoring of overall and individual-class progress, making it easier for teachers to differentiate instruction. Fourth, a real-time feedback system that provides additional explanations, adaptive practice questions, or recommended learning activities tailored to students' difficulties. The implementation of an AI-based adaptive learning system is a significant innovation in educational technology, offering an efficient and personalized learning experience (Katonane Gyonyoru, 2024).

Integrating AI into Student Relationship Management (SRM) can yield a more intelligent, proactive, and student-centered support system, provided that institutions address infrastructure readiness and adopt robust governance protocols. AI can transform data analysis, process automation, and real-time decision-making through ML and Deep Learning algorithms (Acemoglu & Restrepo, 2017). Recent technological changes have played a key role in transforming adaptive learning in education (Strielkowski et al., 2025).

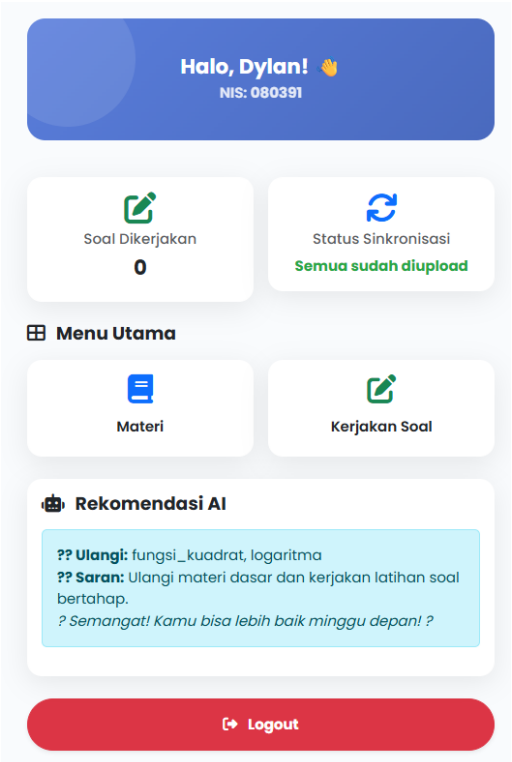

Figure 2. Key Features of the AI-Based Adaptive Platform

The main page of the Artificial Intelligence (AI)-Based Adaptive Learning Platform application demonstrates the implementation of learning personalization through user identification using the user's name and Student Identification Number (NIS). The dashboard presents information on student learning activities, such as the number of questions that have been worked on and the status of data synchronization, which indicates that the system supports *an offline-online* learning mechanism. This feature allows the learning process to continue to run optimally in a high school environment with limited internet infrastructure.

In addition, the system displays AI-based learning recommendations tailored to students' achievements and weaknesses, including suggestions for material repetition and step-by-step learning strategies. The recommendations are reinforced by motivational messages intended to increase student engagement and learning motivation. These results indicate that the platform can implement adaptive, student-centered learning, potentially increasing the effectiveness of personalized learning processes in high schools with limited technological resources.

Although generic AI reviewers are imperfect and limited tools, they are still welcomed by students for their effectiveness. However, the use of AI will be more effective when AI and humans collaborate in education, thereby improving teaching and learning practices through advanced AI applications. Personalized learning has emerged as a promising approach to meet the needs of each student and improve educational outcomes (Okonji & Igwe, 2025). Observing learning patterns, such as levels of engagement and difficulty in specific aspects of the material, allows teachers to adjust materials, assignments, and additional support according to student needs (Demartini et al., 2024). AI has transformative potential in education, while highlighting the balance needed to ensure these challenges are addressed for AI-based adaptive learning systems to thrive (Oubagine et al., 2025).

A limited trial was conducted with 28 students and four teachers at a secondary school. The trial revealed that students perceived the content as better suited to their abilities than conventional learning. Furthermore, students reported greater motivation to learn because the platform provided clear, easy-to-understand recommendations. Teachers participating in the trial also stated that the platform enabled more detailed observation of student progress, thereby informing the design of remedial and follow-up learning strategies. AI-based adaptive systems have significant potential to improve student learning outcomes and student engagement in the learning process, thus impacting the quality of education (Sari et al., 2024).

However, the application of AI in adaptive and personalized learning should not only focus on algorithms and technical efficiency but also be "humanized" to make the learning experience more inclusive, ethical, and meaningful for students (Lata, 2024). Therefore, AI significantly supports adaptive learning (Setyaningsih et al., 2025). Integrating AI can improve learning systems (Das et al., 2025). AI also supports educational administration, targeted infrastructure development, AI literacy initiatives for educators, and culturally responsive AI solutions. These insights contribute to ongoing efforts to bridge the digital divide and maximize the potential of AI in education (Haetami, 2025).

Some things that influence the future development of AI in academia are increasing research on the long-term impact of AI that is specific to scientific disciplines, and overcoming ethical, infrastructure, and policy barriers, so that the implementation of AI in academic institutions can take place sustainably and fairly (Ullah et al., 2025). Overall, the findings of this study are consistent with the theory that AI-based adaptive learning will enhance personalization and learning effectiveness. The developed platform demonstrates that a more inclusive learning environment can be provided, even within limited school infrastructure. This reinforces the notion that AI-based innovations are not only suitable for schools with complete infrastructure but can also serve as a strategic solution for schools in rural areas with limited infrastructure.

CONCLUSION

This research resulted in an artificial intelligence (AI)-based adaptive learning platform designed to support personalized learning in junior high schools with limited infrastructure. Key findings indicate that the developed platform can provide adaptive material recommendations and exercises, display student learning progress dashboards, provide real-time feedback, and support material updates via synchronization features when an internet connection is available. In the trial stage, students responded positively to the platform, as reflected in increased engagement, learning motivation, and ease of understanding the material despite limited technological resources.

The results of this study directly address research questions about how AI-based adaptive learning platforms can be developed and implemented in schools with limited infrastructure. Based on the results of development and trials, it can be concluded that a lightweight, contextual, AI-based adaptive learning approach is a viable solution for supporting differentiated learning in schools with limited resources.

The interpretation of the findings indicates that the success of the platform is determined not only by the sophistication of the AI algorithms but also by the suitability of the system design to the needs of users and the real conditions of the school. Simple yet functional adaptive features have been shown to help students recognize their learning strengths and weaknesses, while making it easier for teachers to monitor learning progress and design targeted follow-ups.

In terms of research implications, these results make practical and theoretical contributions to the development of educational technology, particularly in the context of adaptive and inclusive learning. In practice, the developed platform can serve as an alternative to personal learning solutions in schools with limited infrastructure. Theoretically, this study reinforces the finding that AI integration in learning can be implemented effectively even in resource-constrained educational environments, provided that the system design is tailored to the user's context.

Based on the results of the research, recommendations that can be submitted include: (1) advanced development of the platform by adding offline or semi-offline usage features to overcome network limitations; (2) providing training and mentoring for teachers and students to improve digital literacy and optimize the use of platforms; and (3) the expansion of trials on a larger scale and at different school levels or regions to test the consistency and sustainability of the effectiveness of the platform.

This research has several limitations, including trials that are still carried out on a limited scale with a relatively small number of respondents and qualitative-descriptive data collection. In addition, the offline learning feature remains underdeveloped. Therefore, further research is recommended to conduct quasi-experimental tests, involve more subjects, and examine the long-term impact of platform use on student learning outcomes.

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