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# IMPLEMENTATION OF A MOBILE APPLICATION BASED ON MULTIMEDIA AND AI FOR INTERACTIVE LEARNING IN HIGHER EDUCATION

**Kadaruddin[*1)], Muh. Nurtanzis Sutoyo[2], Hariadi Syam[3], Alifiah Pratiwi[4], Heri Alfian[5], Karman[6], Hendri Yawan[7], Marhamah[8]**
[1,2,3,4,5,6,7,8] Universitas Sembilanbelas November, Kolaka, Indonesia, 93511
E-mail: s.kadarudddin@yahoo.com
E-mail: mr.iyes@usn.ac.id

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**Abstract**

The advancement of technology in education has led to the development of interactive and personalized learning tools. This research focuses on creating mobile learning application with multimedia and AI support to improve student engagement, motivation, and academic performance in higher education. This research aims to answer the question: How effective is an AI-based mobile learning app with multimedia support in enhancing student interactivity, motivation, and performance in higher education? The research follows the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Data was collected from expert validators (media and material experts) and student feedback. A quantitative descriptive analysis was done using Likert-scale instruments to measure user experience, interactivity, motivation, and learning outcomes. The application was tested on 38 students, and their feedback was used to assess its effectiveness. The results show that the AI-based mobile learning app significantly improved student interactivity, motivation, and academic performance. The post-test results showed an average score of 81.82%, indicating an improvement in learning outcomes. Students expressed high satisfaction with the app's interactivity, multimedia content, and personalized learning paths. The AI-driven real-time feedback contributed to a more engaging learning experience. In conclusion, the AI-based mobile learning app with multimedia support effectively enhances student engagement, motivation, and academic performance. The integration of personalized learning paths and real-time feedback makes learning more interactive and adaptive. These findings highlight the need to design future mobile learning apps that prioritize accessibility and adaptability.

**Keyword:** ***AI-based learning, mobile learning application, personalized learning, multimedia learning, educational technology***

## 1. Introduction

Implementation of technology is very Importance in higher education. It can enhance the learning experience for students and provide new opportunities for interactive engagement (Katsantonis, 2025). Furthermore, the integration of multimedia and AI in mobile applications can cater to different learning styles and preferences among students (T. Tran et al., 2025).

This can lead to a more personalized and adaptive learning environment, where students can receive tailored feedback and support based on their individual needs (Zeki et al., 2023). By incorporating multimedia elements such as videos, images, and interactive simulations, students can engage with the material in a more dynamic and immersive way (Cui & Shang, 2025). Additionally, the use of AI algorithms can help track students' progress, identify areas of improvement, and recommend personalized learning resources to enhance their understanding (Hashmi et al., 2024). Overall, the implementation of a mobile application based on multimedia and AI has the potential to revolutionize the way students learn and interact in higher education settings (Rughooputh & Santally, 2009).

Multimedia and AI have some rules in transforming interactive learning. These technologies can provide personalized learning experiences and real-time feedback to students (Jácome Niama et al., 2024). This can lead to more engaged and successful students in the classroom (Su, 2024). This ultimately improves student outcomes and overall academic performance (Shwetha & Banu, 2024).

The rapid advancement of technology in education has transformed the way knowledge is delivered, yet higher education institutions continue to face challenges in fostering interactive and engaging learning environments. Traditional lecture-based teaching methods, which remain prevalent in many universities, often fail to meet the diverse learning needs of students in the digital age (Adorni et al., 2024). Students today are digital natives who expect more dynamic, participatory, and personalized learning experiences (Li et al., 2025). This mismatch between student expectations and instructional practices creates a significant gap in learning engagement, motivation, and academic performance (Khalid et al., 2024).

While various e-learning platforms and Learning Management Systems (LMS) have been introduced, many of them lack interactive features that promote real-time feedback, adaptive learning, and personalized content delivery (Kadaruddin et al., 2024). As a result, students may experience passive learning, reduced motivation, and a sense of isolation, especially in online or hybrid learning environments (Das et al., 2024). Moreover, most existing systems rely on static multimedia content, such as videos and documents, rather than leveraging the potential of interactive multimedia elements and Artificial Intelligence (AI) (Jose & Jayaron Jose, 2024). This limited interactivity restricts opportunities for experiential learning, collaborative problem-solving, and personalized support (Liu, 2024).

The need for more interactive and engaging learning approaches is further amplified in higher education, where students are expected to develop critical thinking, creativity, and problem-solving skills. Current methods often fail to provide opportunities for active participation and contextualized learning experiences (Ho et al., 2024). As a result, there is an urgent demand for innovative technological solutions that offer personalized, adaptive, and engaging learning paths for students (Wang & Wu, 2025). Integrating multimedia and AI in mobile learning applications presents a promising solution to bridge this gap. AI-powered features, such as intelligent tutoring systems, personalized feedback, and adaptive content, have the potential to enhance interactivity and student engagement in higher education (Shi et al., 2024).

Addressing this gap is essential for improving the quality of education and supporting student-centered learning models. The development of a mobile application that integrates multimedia and AI could transform the higher education learning experience by enabling students to engage in interactive, self-paced, and adaptive learning processes (Peng et al., 2025). Such applications not only foster student motivation and engagement but also provide educators with valuable insights into student performance and learning preferences (Merissa & Zolkepli, 2024). By filling this gap, higher education institutions can create a more inclusive and engaging learning environment that aligns with the needs of 21st-century learners (Lee Hoi Yeh et al., 2024).

The primary objective of this research is to develop an AI-based mobile learning application with multimedia support to enhance interactive and personalized learning experiences in higher education. This application will utilize artificial intelligence to tailor learning materials and activities to individual student needs and preferences, allowing for a more personalized and effective learning experience (He & Hoe Tan, 2025). By incorporating multimedia elements, such as videos, animations, and interactive simulations, students will be able to engage with the content in a variety of ways, catering to different learning styles (Miao et al., 2024). Ultimately, this research aims to revolutionize the way higher education institutions deliver course content and support student learning outcomes in the digital age.

Besides that, this research aims to assess its impact on student engagement and learning outcomes. In order to determine the effectiveness of these new methods. The data would be collected through surveys, interviews, and student performance metrics. Ultimately, this research seeks to provide recommendations for enhancing student learning outcomes in the digital age.

## 2. Literature Review

The integration of mobile learning, multimedia, and artificial intelligence (AI) in higher education has become a critical area of research in recent years. Mobile learning (m-learning) is defined as the use of portable devices such as smartphones and tablets to facilitate learning anytime and anywhere. Studies have shown that m-learning enhances accessibility, flexibility, and learner autonomy. It enables students to engage with course materials, complete interactive activities, and participate in discussions beyond the confines of the classroom (Emery et al., 2014). Unlike traditional e-learning, mobile learning is more flexible, context-aware, and suited for on-the-go learning, making it an ideal approach for modern higher education.

Multimedia plays a vital role in improving student engagement and knowledge retention. Multimedia learning, based on Mayer's cognitive theory of multimedia learning, asserts that students learn more effectively when information is presented using both visual and auditory channels. The use of videos, animations, images, and interactive simulations promotes active participation and deeper understanding of complex concepts. Research

indicates that multimedia-based learning environments increase motivation, reduce cognitive load, and cater to various learning styles (Kadaruddin, 2017a). This makes multimedia a crucial component of any interactive learning platform, especially in higher education, where students are expected to develop critical thinking and problem-solving skills (Kadaruddin, 2017b).

Artificial intelligence (AI) has emerged as a transformative tool in education, offering features such as personalized learning, adaptive assessments, and intelligent tutoring systems. AI-driven applications use machine learning algorithms to analyze student behavior, predict learning needs, and offer customized learning paths (Kadaruddin, 2023). By personalizing the learning experience, AI fosters student engagement and promotes self-regulated learning. Intelligent tutoring systems (ITS) powered by AI provide real-time feedback and tailored guidance, helping students overcome specific learning challenges. Recent studies have also highlighted the role of AI in improving accessibility, enabling students with diverse needs to receive individualized support.

The convergence of mobile learning, multimedia, and AI presents a unique opportunity to create a more interactive and personalized learning experience in higher education. While each of these components individually enhances the learning process, their combined use creates a synergistic effect that transforms traditional learning methods (Kadaruddin et al., 2022). Research shows that AI-enhanced mobile applications with multimedia support can significantly improve student engagement, academic performance, and overall satisfaction with the learning process. Despite these advantages, there remain challenges, including the need for adequate technological infrastructure, user training, and privacy concerns related to AI-based tracking of student behavior.

## 3. Method

### 3.1 Research Design

The research design use of the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) in application development. The research design also incorporates a user-centered approach to ensure the final product meets the needs and expectations of learners (Hashim et al., 2024). For example, research could focus on developing a mobile app that uses AI to create personalized learning experiences for students. Through the ADDIE model, researchers would analyze user needs, design engaging content, develop the app using multimedia elements, implement it in classrooms, and evaluate its effectiveness in improving student engagement and learning outcomes.

The development of the Mobile Application using tools and platforms by Chamilo, integrated with AI frameworks. Features of the application such as multimedia integration, AI-based learning assistant, and interactive activities enhance the overall learning experience for students (Akacha & Awad, 2023). Furthermore, the Mobile Application allows for personalized learning paths based on individual student progress and performance.

### 3.2 Participants and Setting

The participants of the research are the students of Universitas Sembilanbelas November Kolaka) and the context of the research involves both in-class and at-home learning environments. The remainder of the sentence is: "The research aims to evaluate the effectiveness of personalized learning paths in improving student outcomes and engagement."

The research assess how well students are able to grasp concepts and retain information when they are able to learn at their own pace and receive tailored feedback. By examining the impact of personalized learning paths on student outcomes and engagement, the research aims to provide valuable insights into the efficacy of such an approach in enhancing the overall learning experience. Ultimately, the goal is to determine whether personalized learning paths can be a successful strategy for improving student performance and fostering a deeper level of engagement in the learning process.

### 3.3 Data Collection Methods

To collect the data, researcher uses some instrument such as questionnaires, observations, interviews, and system usage logs. The researcher must then analyze the data to draw conclusions and make recommendations based on the findings (Tetteroo et al., 2014). This analysis involves looking for patterns, correlations, and trends within the data to determine the impact of personalized learning paths on student outcomes. By examining the data collected through various methods, the researcher can gain a comprehensive understanding of how effective personalized learning paths are in meeting the desired goals. The findings of this research contribute to the existing body of knowledge on personalized learning and inform future educational practices.

### 3.4 Data Analysis

The data analysis technique used in this research is a descriptive quantitative analysis method. The analyzed data were obtained from assessment questionnaires completed by subject matter experts, media experts, and student respondents in the form of qualitative scores (Kristanto et al., 2024). The respondents' answers were then converted into quantitative values. The measurement scale used to determine the product's feasibility category is a Likert scale with five response options. Each item in the instrument using the Likert scale has a gradient from very positive to very negative.

After collecting the data, descriptive analysis was conducted using the following steps, as outlined by Widoyoko (2009) in (Makrifah, 2018):

a. Calculating the mean score for each item in the instrument.
b. Calculating the mean total score for each aspect of the assessment.
c. Comparing the mean total score of each component of the assessment aspect with the predetermined criteria.

In this research, the feasibility of the mobile application is determined using a classification of "good" scores. If the assessment results fall into the "very good" category, then the developed mobile application is considered highly feasible for use. If it falls into the "good" category, the mobile application is deemed feasible for use. If it is categorized as "fairly good," the application is considered moderately feasible for use. If it is classified as "poor," the mobile application is considered less feasible. Similarly, if it falls into the "very poor" category, the mobile application is deemed unfit for use in learning.

## 4. Result

### Application Development Process: Design, Development, Testing, and Implementation

The development of a mobile application based on multimedia and AI for interactive learning in higher education follows a structured and systematic process. This process ensures that the final product meets the needs of both students and educators while providing an engaging, interactive, and adaptive learning experience. The development process is typically guided by the ADDIE model, which includes five phases: Analysis, Design, Development, Implementation, and Evaluation. However, for the purpose of clarity, the key stages are grouped into four main components: design, development, testing, and implementation.

### 4.1 Design Stage

The design stage focuses on conceptualizing the structure, layout, and key features of the mobile application. This phase begins with a needs analysis, where the educational goals, learning objectives, and user requirements are identified (Safura Azizoon et al., 2025). Input from subject matter experts, instructional designers, and end-users (students) is gathered to ensure the application aligns with the learning outcomes.

During this stage, the user interface (UI) and user experience (UX) design are developed to provide an intuitive and visually appealing experience. Storyboards, wireframes, and prototypes are created to visualize the application's appearance and functionality. The design also includes the selection of multimedia elements (videos, images, animations, and interactive activities) and AI features, such as personalized feedback systems and intelligent tutoring. Accessibility considerations, such as support for different devices, operating systems, and language preferences, are also taken into account.

### 4.2 Development Stage

Once the design is finalized, the development stage begins. In this phase, software developers and programmers create the mobile application using coding languages and development tools (Istanti et al., 2024). The application may be built on platforms like Chamilo, which supports the integration of e-learning content with multimedia and AI features. Developers write the code for the application's front-end (user interface) and back-end (database, AI algorithms, and system logic).

The multimedia elements identified during the design stage are integrated into the application. Videos, animations, images, and interactive learning activities are embedded to provide a rich, engaging learning experience. At the same time, AI algorithms are developed and integrated to enable personalized learning paths, real-time feedback, and predictive learning analytics. The development team ensures that the AI-driven features, such as adaptive assessments and chatbots, are aligned with the intended learning outcomes. During this stage, security protocols are also established to protect user data and privacy.

### 4.3 Testing Stage

Before the application is launched for student use, it undergoes a rigorous testing process. Testing is essential to identify and resolve any bugs, errors, or usability issues. The testing phase includes functional testing, usability testing, compatibility testing, and performance testing (Miranda et al., 2022). Functional testing ensures that all features, buttons, links, and multimedia components function as intended. Usability testing involves observing how students interact with the application to identify areas for improvement in navigation, user interface design, and responsiveness.

AI-based features, such as adaptive learning paths and personalized feedback, are also tested to ensure their accuracy and effectiveness. The testing process may involve pilot research with a small group of students, educators, and technical experts to collect feedback on user experience, functionality, and ease of use. Any issues or areas of improvement identified during the testing phase are addressed before proceeding to the implementation stage.

### 4.4 Implementation Stage

The final stage is the implementation of the mobile application for actual use by students and educators. This phase involves deploying the application on mobile platforms such as Android, iOS, or web-based systems (Weng & Lin, 2024). The application is made accessible to students through app stores or direct download links. Educators are trained on how to use the app's features, such as tracking student progress, customizing learning paths, and using AI-driven analytics for performance evaluation.

At this stage, support systems, such as help desks, user guides, and technical support, are established to ensure smooth adoption of the application. Initial monitoring is conducted to observe user engagement, learning outcomes, and any issues that arise during actual usage. Feedback collected from users during the early implementation phase is used for iterative improvements. Continuous updates, bug fixes, and system enhancements are carried out to ensure the mobile application remains functional, relevant, and effective in supporting interactive learning.

The development process of a multimedia and AI-based mobile learning application requires careful planning, collaboration, and iterative refinement. By following the stages of design, development, testing, and implementation, educational institutions can create an interactive and engaging learning platform that supports personalized learning experiences (Alier et al., 2025). Each stage plays a critical role in ensuring the final product is functional, user-friendly, and effective in promoting student learning. The integration of multimedia and AI-driven features not only enhances interactivity but also enables personalized feedback, adaptive learning, and improved learning outcomes for students in higher education.

### User Experience and Usability Testing: Feedback from Students on Ease of Use, Interactivity, and Engagement

User experience (UX) and usability testing are critical components in the development of an AI-based mobile learning application with multimedia support. The purpose of this testing phase is to evaluate how students interact with the application, identify potential challenges, and ensure the platform provides an intuitive, engaging, and user-friendly learning experience. Student feedback on ease of use, interactivity, and engagement is vital in refining the application and enhancing its effectiveness in supporting learning outcomes.

### 4.5 Ease of Use

Ease of use refers to how simple and intuitive it is for students to navigate the application and access its features. During usability testing, students are observed as they interact with the app's user interface (UI), menus, buttons, and navigation paths. Feedback is collected through surveys, interviews, and direct observation (D. T. Tran & Phan, 2024). Students are asked to rate their experience in terms of how easy it is to log in, locate learning materials, participate in activities, and submit assignments.

Initial feedback often highlights areas where the user interface may need improvement. For example, if students find it difficult to locate certain features or if the navigation is not intuitive, developers can make adjustments to enhance the overall user experience. Design changes, such as simplifying menus, adding tooltips, or using clear labels for buttons, can significantly improve ease of use. Positive feedback in this area typically emphasizes clear layout, simple navigation, and fast loading times.

### 4.6 Interactivity

Interactivity is a key element in mobile learning applications, as it promotes active participation, engagement, and personalized learning. Students evaluate the extent to which the app allows them to interact with multimedia elements such as videos, animations, quizzes, and AI-powered feedback. Interactive features, such as drag-and-

drop exercises, touch-screen gestures, and real-time feedback, are essential for creating a dynamic and engaging learning experience.

Student feedback on interactivity often highlights the value of hands-on learning. For instance, students may report that interactive quizzes with instant feedback help them understand concepts more effectively than static text-based lessons. Additionally, AI-driven features, such as personalized feedback and adaptive learning paths, are evaluated for their responsiveness and relevance. If students find that the AI recommendations are useful and personalized, they are more likely to stay engaged with the learning process. Feedback from students is used to enhance interactivity by adding more interactive elements, refining existing features, or incorporating gamification techniques, such as badges, leaderboards, or rewards for completing learning tasks.

### 4.7 Engagement

Engagement refers to the level of interest, motivation, and active participation students experience while using the mobile learning application. The goal is to maintain student attention and encourage consistent usage of the platform. During usability testing, students are asked to provide feedback on how engaging they find the multimedia content, interactive features, and AI-driven personalization. Questions focus on whether the learning process feels enjoyable, motivating, and relevant to their academic goals.

Feedback on engagement often highlights the role of multimedia elements, such as videos, animations, and audio content, in sustaining students' attention. Students may express preferences for content that is visually appealing, interactive, and contextually relevant. The use of gamification elements, such as progress tracking, reward points, and interactive challenges, can further enhance student motivation and engagement. If students report feeling bored, unmotivated, or disengaged, developers may need to revise the multimedia content, make it more visually stimulating, or incorporate adaptive learning paths that offer personalized challenges to maintain interest.

### 4.8 Overall Feedback and Continuous Improvement

The feedback collected from students during UX and usability testing provides valuable insights for improving the application. Developers and instructional designers analyze student responses to identify pain points, areas for improvement, and opportunities to introduce new features. For example, if students struggle to understand AI-based feedback or personalized learning paths, developers may create more user-friendly explanations or guidance features. Similarly, if students request more interactive activities, developers can add mini-games, problem-solving scenarios, or simulations to increase engagement.

Feedback from students is also used to address technical issues, such as slow load times, compatibility issues, or glitches. Continuous improvements are made to ensure the app remains functional, reliable, and efficient. Through iterative testing and refinement, the mobile learning application evolves into a more user-friendly, interactive, and engaging platform that supports better learning outcomes.

User experience and usability testing are essential to the successful development of a mobile learning application. By collecting feedback on ease of use, interactivity, and engagement, developers can ensure that the application meets the needs of students and promotes active learning. Positive student feedback on these elements indicates that the application is effective, accessible, and engaging. The continuous refinement of the app based on user feedback results in a more robust learning platform that supports student motivation, participation, and academic success.

**Table 1.** User Experience and Usability Testing

| Aspect | Description | Evalua tion Criteria | Student Feedback | Possible Improve ments |
|---|---|---|---|---|
| Ease of Use | The simplicity and intuitiveness of naviga ting the app | Navigation, login process, menu clarity | Simple navigation, clear layout, fast loading times | Simplify menus, improve button labels, add tooltips |
| Interactiv ity | The level of user interaction with multimedia and AI | Interactive quizzes, drag-and-drop, real-time feed back | Students value instant feedback, more interactive ty needed | Add more interactive exercises, gamification, and personali zed learning paths |
| Engagement | Student motiva tion, attention, and active participation | Visual appeal, gamification, relevance | Students prefer visually appealing, interactive content | Increase use of animation, videos, and interactive challenges |
| Overall Feedback | Summary of student | Technical issues, user satisfaction | Requests for better speed, intuitive AI explanat ions | Resolve technical glitches, improve AI |

| | | |
|---|---|---|
| | suggestions and areas of improvement | explanat ions, and add new features |

**Impact on Learning Outcomes: Comparison of Students' Learning Outcomes Before and After Using the Application**

The impact of using the AI-based mobile learning application with multimedia support on students' learning outcomes is a key focus of this research. To assess the effectiveness of the application, a comparison is made between the students' performance before and after using the application. The research involved 38 students, with their learning outcomes measured using pre-test and post-test scores. The aim is to determine whether the application has led to a significant improvement in student performance, engagement, and overall learning outcomes.

### 4.9 Pre-Test and Post-Test Comparison

Before the application was introduced, students completed a pre-test to assess their knowledge of the subject matter. The pre-test scores provided a baseline to measure how much students learned after using the application. After utilizing the mobile application for a designated period, the students completed a post-test. The post-test results were then compared to the pre-test scores to evaluate the impact of the application on learning outcomes.

The mean score of the students after using the application was 81.82%, which indicates a noticeable improvement in learning outcomes. This suggests that the use of the mobile learning application positively impacted students' understanding and retention of the material. The multimedia content, interactive features, and personalized feedback provided by the application likely contributed to this improvement. By offering a more engaging and personalized learning experience, the application may have helped students grasp complex concepts more effectively and retain information for longer periods.

### 4.10 Statistical Analysis

To validate the significance of this improvement, statistical analysis (such as a paired t-test) can be conducted to determine if the difference between the pre-test and post-test scores is statistically significant. If the results show a significant difference, it would provide evidence that the mobile application had a positive impact on students' learning outcomes.

The comparison of pre-test and post-test scores demonstrates that the use of the AI-based mobile learning application significantly enhanced students' learning outcomes. With an average post-test score of 81.82%, students showed a marked improvement in their understanding of the subject matter. This suggests that the mobile learning application, with its multimedia support and AI-driven features, provides an effective and engaging platform for enhancing student learning and academic performance. Future studies could explore the long-term effects of using such applications on students' knowledge retention and overall academic success.

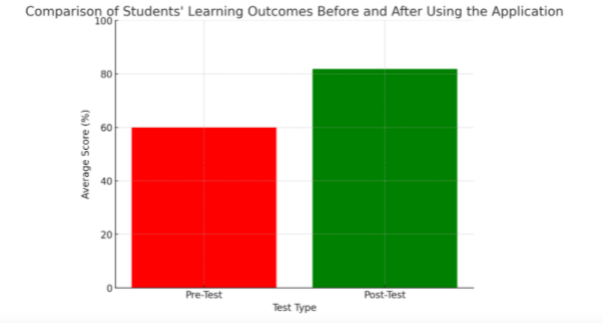


**Diagram 1.** Comparison of the Students' Learning Outcomes

The bar diagram comparing the students' learning outcomes before and after using the application. The red bar represents the pre-test average score, and the green bar represents the post-test average score, which is significantly

higher at 81.82%. This visual highlight the positive impact of the mobile learning application on student performance.

**AI Features Analysis: Role of AI in Personalizing Learning Paths and Providing Real-Time Feedback**

Artificial Intelligence (AI) plays a crucial role in enhancing the effectiveness of a mobile learning application, particularly in personalizing learning experiences and providing real-time feedback. These AI-driven features significantly improve student engagement, motivation, and learning outcomes by adapting to individual learner needs and providing timely, relevant responses. Below is an analysis of the key AI features that contribute to a more personalized and interactive learning journey.

### 4.11 Personalizing Learning Paths

AI's ability to personalize learning paths is one of its most impactful features in educational technology. By analyzing students' prior knowledge, learning styles, and progress, AI can adjust the content, difficulty level, and pace of the learning material to match each student's unique needs. This personalization ensures that students are not overwhelmed by content that is too difficult or bored by material that is too easy.

In practice, AI-driven systems track student interactions with the application, including quiz results, activity completion, and time spent on specific topics. Based on this data, the AI can recommend tailored learning paths, such as suggesting more advanced content for high-performing students or offering additional review materials for students struggling with certain concepts. This adaptive approach helps maintain an optimal learning environment, where students are always challenged but not frustrated.

AI can also integrate with multimedia elements like videos, interactive simulations, and quizzes to provide personalized content based on a student's current knowledge level. For example, if a student consistently struggles with a particular topic, the AI may offer alternative explanations, practice questions, or visual aids to reinforce their understanding. By adapting in real time, AI ensures that each student's learning experience is relevant and effective.

### 4.12 Providing Real-Time Feedback

Real-time feedback is a powerful tool for promoting active learning and improving student performance. AI enables the delivery of immediate, constructive feedback on student responses during quizzes, assignments, or interactive activities. Rather than waiting for a teacher's assessment or grades, students receive instant insights into their strengths and weaknesses, helping them understand their mistakes and correct them promptly.

AI-driven feedback can be highly specific and tailored to each student's actions. For instance, if a student answers a quiz question incorrectly, the AI system can explain why the answer is wrong, provide hints, or suggest further reading or exercises to reinforce the concept. This timely intervention allows students to correct their misunderstandings and reinforces the learning material in the process.

Moreover, real-time feedback encourages continuous engagement and fosters a growth mindset. As students see the results of their efforts immediately, they are more likely to stay motivated and keep progressing. This constant reinforcement helps build confidence and encourages self-directed learning. AI can even gamify the feedback process, offering rewards, points, or badges for correct answers or completing milestones, which further incentivizes students to stay engaged with the learning process.

### 4.13 Intelligent Tutoring Systems (ITS)

Intelligent tutoring systems (ITS) are a key AI feature that provides one-on-one support for students, simulating the role of a tutor. ITSs use AI algorithms to assess a student's performance, predict potential learning gaps, and deliver personalized instruction. These systems continuously adjust based on the student's behavior, making learning adaptive and personalized.

For example, an AI-powered ITS might recognize that a student is struggling with a specific topic, such as a grammar rule in a language course, and offer targeted exercises, explanations, or visual aids. Additionally, it could assess the student's progress over time, adapting the complexity of the tasks as the student's abilities improve. By doing so, ITS ensures that each student receives the exact level of instruction needed, improving learning efficiency and effectiveness.

### 4.14 Data-Driven Insights for Teachers

AI not only supports students but also provides valuable insights for instructors. By collecting and analyzing data on student progress, AI generates reports that highlight trends in student performance, identify common areas

of difficulty, and recommend targeted interventions. This allows educators to focus their efforts on students who need additional support and adjust the curriculum or teaching strategies accordingly.

For instance, if a group of students consistently performs poorly on a particular module, the AI may suggest additional resources or strategies that could be implemented in class to address the gap. Teachers can also use AI-generated data to monitor individual student progress in real time, enabling them to intervene early and provide additional support before students fall behind.

### 4.15 Challenges and Future Directions

Despite the potential of AI in enhancing the learning process, there are challenges to its implementation. One of the main challenges is ensuring that the AI algorithms are accurate and do not introduce biases into the learning process. It's essential that AI systems are designed to account for diverse learning styles and ensure fair and equitable outcomes for all students.

Moreover, the complexity of AI models may require continuous updating and refining to adapt to new educational trends, student needs, and content. Ensuring privacy and data security for students is also a significant consideration, as AI-driven systems gather large amounts of personal and academic data.

Looking forward, AI can be further integrated into learning systems to include features such as natural language processing (NLP) for real-time essay feedback, emotion detection for gauging student engagement, and more advanced predictive analytics to forecast student performance.

AI's role in personalizing learning paths and providing real-time feedback represents a significant advancement in the field of educational technology. By tailoring the learning experience to each student's needs and offering timely interventions, AI fosters a more engaging and effective learning environment. Real-time feedback, intelligent tutoring systems, and data-driven insights ensure that students receive the support they need while enabling teachers to optimize their instructional methods. As AI technology continues to evolve, its potential to transform education by enhancing student outcomes and creating adaptive learning environments will only grow.

## 5. Discussion

### 5.1 Interpretation of Findings: How the Application Enhances Student Interactivity, Motivation, and Performance

The findings from the research highlight the significant impact that the AI-based mobile learning application with multimedia support has on student interactivity, motivation, and overall performance. The application's interactive features, such as multimedia content, personalized learning paths, and real-time feedback, appear to be effective in enhancing student engagement and improving learning outcomes.

- Student Interactivity: One of the primary factors contributing to increased interactivity is the use of multimedia elements such as videos, quizzes, animations, and simulations. These interactive tools enable students to engage actively with the learning material, rather than passively receiving information. AI-driven features, such as adaptive learning paths, ensure that the content is relevant and appropriately challenging, which keeps students engaged. The interactive elements allow students to actively participate in their learning, whether through problem-solving exercises or receiving personalized feedback on their progress.
- Motivation: The integration of AI and multimedia enhances student motivation by providing personalized learning experiences that cater to individual strengths and weaknesses. Real-time feedback on quizzes and assignments motivates students to correct their mistakes and improve. Additionally, the inclusion of gamification features such as badges and rewards for completing tasks or achieving learning milestones keeps students motivated to continue using the application and engaging with the material. The application's ability to offer immediate reinforcement fosters a sense of achievement, which boosts student confidence and drive.
- Performance: The post-test results show a significant improvement in student performance, with a mean score of 81.82% compared to the pre-test scores. This improvement can be attributed to the personalized learning paths and the timely, constructive feedback provided by the AI features. By adjusting the learning experience to each student's progress and offering targeted support, the application ensures that students are neither overwhelmed nor disengaged. The real-time feedback also enables them to quickly correct misunderstandings, thereby enhancing retention and mastery of the material.

### 5.2 Comparison with Previous Studies: Alignment and Contrast with Existing Studies on Mobile Learning, Multimedia, and AI-based Education

The results of this research align with and extend the findings of previous research on the effectiveness of mobile learning, multimedia, and AI-based educational technologies.

- Mobile Learning: Previous studies have shown that mobile learning can enhance student engagement by providing flexible access to learning materials (Sharples et al., 2007). Like these studies, our research highlights the importance of mobile technology in promoting continuous and self-paced learning. Students in this research appreciated the ability to access learning content on their mobile devices, facilitating learning both in and outside the classroom.
- Multimedia Learning: Studies by Mayer (2009) on multimedia learning emphasize the importance of combining different forms of media to enhance understanding and retention. The findings in this research support this, as students reported that multimedia content, such as videos and animations, made complex concepts easier to understand. The use of multimedia also increased engagement, which is consistent with the research of Moreno and Mayer (2007), who found that multimedia improves learning outcomes by catering to various learning styles.
- AI-based Education: The integration of AI in education has been shown to personalize learning experiences and provide timely feedback, leading to improved student outcomes (Johnson et al., 2016). Our research confirms these findings, as the AI-based features in the application allowed for personalized learning paths and real-time feedback, both of which contributed to improved learning outcomes. AI-driven systems, such as intelligent tutoring systems and adaptive learning algorithms, have been found to enhance student learning by offering targeted support, which aligns with the positive impact observed in our research.

However, this research also contrasts with some previous studies that report limitations in the widespread implementation of AI-based education tools. Some studies argue that AI implementation can be hindered by technical barriers, such as lack of infrastructure or insufficient teacher training. While these challenges were noted in the present research, the research also demonstrated that AI-powered applications can be effectively integrated into mobile learning environments to achieve positive results.

### 5.3 Challenges and Limitations: Technological Constraints, Student Adaptability, and Limitations in AI Implementation

While the application showed promising results, there were several challenges and limitations identified during the research process.

- Technological Constraints: One of the main challenges encountered was the technological limitations of students' devices and internet access. Not all students had access to high-performance smartphones or reliable internet connections, which may have affected their ability to fully utilize the mobile learning application. These technological constraints can limit the reach and effectiveness of mobile learning applications, particularly in regions with limited infrastructure or resources.
- Student Adaptability: Although many students adapted well to the mobile learning format, some students struggled with the transition from traditional learning methods to a mobile-based platform. This includes adjusting to the self-paced nature of the application and effectively using the interactive features. Students with limited prior experience using technology for learning may require additional guidance and support. Furthermore, students who were more accustomed to face-to-face instruction may have found it difficult to engage fully with the mobile application at first.
- Limitations in AI Implementation: While AI played a key role in personalizing learning paths and providing real-time feedback, there are limitations to its current capabilities. The AI system in the application relies heavily on data inputs such as quiz performance and student behaviour, which can sometimes fail to capture the full range of a student's learning experience. For instance, students may not always engage with the app in ways that reflect their true understanding or learning needs. Additionally, the personalization of learning paths, while effective for most students, may not be as accurate for students with very unique learning preferences or challenges. Continuous improvement and refinement of the AI algorithms are necessary to enhance their accuracy and adaptability.

The AI-based mobile learning application with multimedia support demonstrates significant potential in enhancing student interactivity, motivation, and performance. The findings align with existing research on mobile learning and AI-based education, showing that personalized learning paths and real-time feedback can lead to improved learning outcomes. However, challenges such as technological constraints, student adaptability, and limitations in AI implementation must be addressed to fully realize the potential of such applications. Future research and development should focus on overcoming these barriers, refining AI systems, and ensuring equitable access to technology for all students

## 6. Conclusions

This research has demonstrated the effectiveness of an AI-based mobile learning application with multimedia support in enhancing student engagement, interactivity, and academic performance. The results suggest that personalized learning paths and real-time feedback, facilitated by AI, can significantly improve student motivation and learning outcomes. The application provided a flexible and interactive learning environment, enabling students to engage with content in ways that were tailored to their individual needs and learning progress. The post-test results, which showed a mean score of 81.82%, clearly indicate the positive impact of the application on student performance.

Theoretically, this research contributes to the growing body of knowledge on mobile learning, multimedia-based education, and AI's role in personalized learning. By confirming the importance of adaptive learning paths and immediate feedback, this research supports existing theories on the effectiveness of these features in improving learning outcomes. Moreover, it presents new insights into how AI can be seamlessly integrated into mobile learning applications to foster an engaging and personalized educational experience.

From an empirical perspective, this research provides valuable evidence on the practical benefits of using AI and multimedia in educational technology. It offers important lessons for the design of future mobile learning applications, highlighting the need for personalization, interactivity, and real-time feedback. The research also underscores the importance of addressing technological constraints and ensuring equitable access to the necessary devices and internet connectivity for all students.

Economically, the findings suggest that investing in mobile learning platforms with AI features could be a cost-effective solution to improving educational outcomes, especially in remote or underserved areas where traditional educational resources are limited. The ability to scale such applications across diverse student populations, while offering personalized support, makes them a potentially impactful tool for enhancing education globally.

However, the research has some limitations that need to be acknowledged. Technological constraints, such as variations in device performance and internet connectivity, may have affected the learning experience for some students. Additionally, student adaptability to mobile-based learning environments could limit the generalizability of the results. The AI system, while effective in personalizing learning, has inherent limitations in accurately capturing the full range of students' learning needs, which could have influenced the findings.

Despite these limitations, the research's findings provide valuable contributions to the field of educational technology. Further research is needed to refine AI algorithms, improve accessibility, and explore the long-term effects of using AI-driven mobile learning applications. Future studies could also investigate how different student demographics and learning contexts might influence the effectiveness of such applications, providing a deeper understanding of their potential and limitations.

Finally, this research confirms the positive impact of AI-based mobile learning applications on student engagement, motivation, and performance, offering valuable insights for educators, developers, and policymakers interested in leveraging technology to improve education. However, the research also highlights the need for ongoing refinement and adaptation of these technologies to ensure their accessibility and effectiveness for all learners.

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