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Artificial intelligence-integrated interactive multimedia to improve conceptual understanding in eighth-grade science learning

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ABSTRACT

This study assessed the effectiveness of interactive multimedia connected to Artificial Intelligence (AI) in improving the concept understanding of eighth-grade students. The research method used was an experimental design with a Pretest-Posttest design model. Data were collected through observation of student participation, evaluation of concept understanding before and after treatment, and survey of students' responses to learning. Data analysis was carried out using a paired T-test, which was conducted using descriptive statistical analysis, namely calculating the mean, median, and standard deviation from the results of the pretest and posttest tests. The study found significant improvement in students' concept understanding and participation after utilizing AI-based interactive multimedia. This research implied the use of AI in interactive multimedia is an effective way to improve the quality of science education in high schools. The use of AI-based interactive multimedia provided a new approach that improved students' understanding of science concepts.

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INTRODUCTION

In an ideal educational environment, all students should be able to understand and apply scientific concepts in depth. Therefore, all students are expected to achieve a high level of understanding and application of scientific concepts in ideal educational circumstances (Davenport et al. 2022; Maryanti et al. 2021). Effective science education is about equipping learners with the knowledge and skills necessary to understand the world around them and solve complex problems. The purpose of science education is to help students understand the nature of science,

KEYWORDS

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and all citizens need to know (Prachagool and Nuangchalerm 2019).

Conceptual understanding is essential for students' ability to apply knowledge effectively in a variety of contexts (Aydin, Ceran and Ates, 2020; Meryastiti et al. 2023). When students engage with Artificial Intelligence (AI)-integrated interactive multimedia, their conceptual understanding improves significantly (Pisica et al. 2023; Herianto and Wilujeng 2021). This improvement is relevant to the development of critical thinking skills, as students are accustomed to critically analyzing information, asking questions, and exploring concepts in depth rather than passively receiving information (Muhali et al. 2021).

Typically, conventional science teaching relies heavily on textbooks and static presentations, which may fail to engage students or accommodate various learning preferences (Winarno et al. 2020). On the other hand, interactive multimedia includes various components such as animations, simulations, and interactive exercises that can greatly increase student engagement and motivation (Syawaludin et al. 2019). When AI is combined with these multimedia tools, the learning experience becomes more customized and responsive to the unique needs of each student (Sukenda et al. 2019). In eighth-grade science education, where students discover basic concepts that support their future learning, the adoption of interactive multimedia integrated with AI can be very beneficial. In addition to assisting in conceptual understanding, it also prepares students for more advanced studies by instilling a solid understanding of important scientific ideas and methodologies (Gunawan et al. 2020).

The integration of AI in educational settings facilitates innovative teaching methods that enhance interactivity and practical applications. For example, AI-based tools like chatbots can engage students in conversational learning, allowing them to ask questions and receive instant responses tailored to their questions. This is in stark contrast to traditional methods that often rely on passive information consumption without direct feedback (Lee et al. 2023). Additionally, AI technology enables simulation-based learning experiences that allow students to visualize complex concepts through virtual reality or interactive scenarios, promoting experiential learning (Chen and Liu 2024). Overall, while traditional media provides basic knowledge through structured formats, AI media enhances the learning process by creating personalized, interactive, and adaptive educational experiences that meet the diverse needs of learners.

AI enables personalized learning by adapting teaching materials and techniques to suit each student's specific needs and abilities (Abuhassna et al. 2023). Advanced educational technologies such as interactive multimedia and AI can enhance learning by analyzing students' activities and offering suggestions to improve their understanding. The use of advanced educational technology, such as interactive multimedia and AI is believed to significantly improve the learning process and conceptual understanding. Recently, the incorporation of AI in educational technology has become a promising strategy for improving student learning and engagement, especially in the field of science education (Kaban 2023).

Integrating AI into Interactive Multimedia for eighth-grade Science learning is essential because it provides a personalized and flexible learning environment. Interactive multimedia integrated with AI can be operated using gadgets in the form of digital applications or websites (Widodo et al. 2020). AI can evaluate student engagement with content, offer immediate feedback, and modify the complexity of the material according to the student's skill level. This helps students stay motivated but not feel overwhelmed, so that the learning process can run more effectively and efficiently. The teaching and learning process using interactive multimedia can foster students' interest in learning and increase their understanding of concepts (Herianto and Wilujeng 2021).

Interactive multimedia integrated AI refers to the use of AI technology in interactive multimedia applications. This technology allows for the adjustment of the difficulty level of the material to improve students' understanding of concepts. The use of AI algorithms to analyze usage data, provide personalized feedback, and adaptively adjust learning materials is part of this technology (Koć-Januchta et al. 2022). This combination allows for the creation of a more mobile learning environment and responsive to the needs of each student. Students can take lessons in a place and time that suits the material adapted to their learning style and level of understanding (Pisica et al. 2023).

In this study, generative AI is used which is integrated into interactive multi-media. The integration of AI into interactive multimedia further strengthens its effectiveness by enabling personalized interactions through intelligent agents or chatbots. These AI systems can facilitate real-time conversations with students, guide them through the learning experience and provide tailored support based on their progress. For example, AI chatbots can answer specific questions related to a science experiment or concept being studied, helping students clarify doubts immediately (Qazi et al. 2024). This combination of multimedia elements with AI enhances the overall educational experience by making it more engaging and relevant to each learner's unique needs (Chen and Liu 2020).

Previous research has shown the advantages of using interactive multimedia to improve students' understanding of concepts. However, research specifically exploring the integration of AI in interactive multimedia in science learning is still limited. Most of the research has centered on the use of AI in the context of education in general without considering its specific impact on science learning at the junior high school level. In addition, there is a need to empirically evaluate the effectiveness of this approach in improving students' understanding of scientific concepts. The incorporation of AI into interactive multimedia is still relatively new and more research is needed to fully understand its impact. The gap highlights the urgency of research on the use of AI in interactive multimedia to improve conceptual understanding among eighth graders.

The purpose of this study is to investigate and assess the extent to which the use of AI-connected interactive multimedia can improve the scientific concept understanding of eighth-grade students. This research is expected to make a great contribution to the field of science education by presenting innovative solutions that can be applied in schools to improve the quality of learning.

MATERIALS AND METHODS

The research approach was quantitative with a pre-experimental design with a One-Group Pretest-Posttest Design. Detailed information regarding this method is explained elsewhere (Susilawati et al. 2025) The design of this study was implemented in one class that received treatment and no control class was used as a comparison. The subject of this study was the eighth-grade students of SMP 14 in Makassar, Indonesia as many as 50 students. They were randomly selected and given treatment with the implementation of science learning supported by interactive multimedia integrated with AI.

The procedure for conducting research starts with creating interactive multimedia teaching materials connected to AI. This material includes interactive videos, animations, simulations, interactive exercises, and the integration of AI, namely Google Gemini as a learning resource. Gemini functions as a study buddy, providing tailored assistance to students based on their learning styles and needs. It can adapt its explanations and materials to suit different comprehension levels, making it particularly beneficial for students who require additional support or face learning challenges (Imran and Almusharraf 2024). In implementation, students are first given a pretest to find out their initial understanding of the concept. After that, students are taught about the human digestive system using interactive multimedia integrated with AI. The implementation was carried out for two weeks with 4 meetings. After completing the implementation, students are given a final test to measure their understanding of the concept after being given treatment. We employed a concept understanding ability test, primarily consisting of descriptive questions related to specific mathematical topics, such as quadrilaterals. This instrument was meticulously developed and validated by experts to ensure its reliability and effectiveness in measuring students' conceptual grasp (Royana and Istihapsari 2022). The indicators of concept understanding that are used as a reference for assessment are in Table 1.

Table 1: Concept comprehension indicators

Indicators of Concept Understanding	Item Indicators
Interpretation	Interpret information related to organs and types of digestion that occur in the organ.
Exemplifies	Giving an example of digestion mechanical that occurs in organs other than the oral cavity.
Classify	Classify the organ digestion based on its role in digesting food.
Summarize	Summarizing the digestive process in the oral cavity and end result.
Conclude	Summarizing the benefits of green vegetables on the health of the digestive system
Explain	Explain the structure of the digestive organs about their Function
Compare	Comparing mechanical digestion and chemical digestion

The data collection instrument uses test instruments (pretest and posttest) to measure changes or improvements in students' understanding of concepts. Observation is carried out throughout the learning process using student activity observation sheets and teacher activity observation sheets. To collect data on student responses to learning, a questionnaire instrument was used.

Data analysis was carried out by descriptive statistical analysis, namely calculating the average, median, and standard deviation of the pretest and posttest test results. In addition, a paired t-test was also applied to evaluate the effectiveness of the treatment by comparing pretest and posttest scores between the experimental and control groups. Detailed information regarding t-tests is explained elsewhere (Fiandini et al. 2024).

RESULTS AND DISCUSSION

The purpose of this study is to assess how effective the use of interactive multimedia connected to AI is in improving the conceptual understanding of eighth-grade students in science subjects. The use of interactive multimedia in science learning has great potential to increase the effectiveness and efficiency of the learning process (Setiadi and Andriani 2024). After the implementation of learning using interactive multimedia integrated with AI, the data was analyzed by paired T-Test (Table 2).

Table 2: Paired Sample Statistics

Test	Mean	Standard Deviation
Pretest	43	6.308
Posttest	72	5.095

The average score on the pretest was 43 and the average score on the posttest was 72, which shows an increase in the average score of concept understanding after students learn using the support of interactive media integrated with AI. Thus, the use of interactive media integrated with AI affects improving students' understanding of concepts.

Table 3: Paired Samples T Test

	Mean	Std. Deviation	t	df	Correlation	Sig.
Pretest & Posttest	-28.600	5.253	-38.500	49	0.594	0.000

Based on the data in Table 3 above, it can be read that the use of AI-connected interactive multimedia is significantly effective in improving eighth-grade students' understanding of science concepts compared to traditional learning methods without using AI-integrated interactive media support. The use of AI in the world of education is an effective way to improve the quality of learning and student understanding. (Widodo et al. 2023). This proves that the use of AI in interactive multimedia has a significant impact on improving students' understanding of concepts.

Students said that they were more interested and able to understand the material delivered through interactive multimedia. They also feel more motivated to learn and more actively involved in the learning process. A lot of research backs up the claim that students are more driven to learn and actively participate in the learning process. Motivation is a key aspect of student involvement, which improves the learning experience. According to research, students who fulfill their academic goals are more motivated and engaged, which leads to favorable views about their studies and lower levels of burnout (Cazan 2015). This link emphasizes the significance of creating an atmosphere that promotes goal achievement to increase motivation.

This study noted that the use of interactive multimedia integrated with AI has a great impact on increasing the understanding of eighth-grade students towards concepts in science subjects. Significant improvements in various aspects were identified through observation of student activity, such as questions and answers, group discussions, and assignments. This increase shows that the use of AI-powered interactive multimedia not only increases the appeal of learning but also stimulates the active involvement of students in the learning process. AI tools should be designed to support diverse learners, including those with disabilities or language barriers. Features such as voice recognition and adaptive content can make

educational resources more inclusive (Kritandani et al. 2024).

In addition, the positive response from students to the use of interactive multimedia connected to AI was also revealed in the questionnaire results. A lot of this enthusiasm is grounded in the multistage benefits that interactive multimedia provides to increase student engagement and learning outcomes. Research has shown that multimedia tools enhance student engagement and provide multiple learning experiences that match different learning preferences and styles (Winarso 2023; Prasetya 2024; Akinbadewa and Sofowora 2019). For example, educational content has become more interactive and multimedia-based including audio, video, etc. not only to retain students' attention but also to help them understand complex ideas better (Anwar et al. 2019; Kiat et al. 2020). Furthermore, the utilization of AI in multimedia learning systems enhances personalization.

In multimedia learning environments, the incorporation of AI is usually associated with personalized learning experiences and further interests in pupils, allowing them to interact with course materials of their own free will and at their own pace based on their demands (Barua et al. 2022). This flexibility boosts students' enthusiasm, which leads to active engagement, two critical aspects for optimal learning (Sun and Rueda 2011). Furthermore, some studies have found that students exposed to interactive multimedia outperform standard university instruction, resulting in higher satisfaction and academic achievements (Chipangura 2019).

Students said that they felt that the material was easier to understand, learning was more interesting and fun, their enthusiasm for learning increased, and their confidence in understanding science material was stronger. This is relevant to the results of previous research which showed that the use of interactive multimedia was effective in increasing student engagement and motivation, as well as overall understanding of concepts (Hasanah et al. 2023). This is consistent with the study's findings, which demonstrated that innovative learning methodologies can boost students' understanding and motivation to learn science (Herianto and Wilujeng 2021).

AI facilitates the creation of interactive simulations, educational games, and multimedia resources that make learning more engaging. For instance, Gemini combines audio, video, images, and text to create immersive experiences that help students grasp abstract concepts more effectively than traditional textbooks or lectures (Imran and Almusharraf 2024). This multimodal approach caters to various learning preferences, thereby increasing student motivation and participation. AI systems provide immediate feedback on student performance through automated assessments and quizzes. This capability allows students to understand their mistakes in real-time and adjust their learning strategies accordingly, which is often lacking in traditional educational settings where feedback can be delayed (Solihat et al. 2024).

What's more, the application of AI in interactive media provides customized and adaptive feedback, allowing students to learn according to their abilities. This helps improve the understanding of concepts as students can correct their mistakes immediately and get additional explanations as needed. AI technologies enable personalized learning pathways that adapt to individual student needs. By analyzing performance data, AI can offer tailored resources and support, fostering a deeper understanding of the subject matter. This approach not only addresses diverse learning styles but also promotes critical thinking skills essential for navigating complex information environments (Kritandani et al. 2024). The integration of AI technologies into education is not merely about teaching students how to use these tools; it is fundamentally about enhancing their conceptual understanding across disciplines. This study confirms that the application of AI in education can be one of the effective ways to overcome barriers in conventional learning and provide a more individualized and meaningful learning experience.

CONCLUSION

From the results of research and surveys, the use of interactive multimedia connected to AI in the eighth grade can increase student participation and get a positive response. Student participation in asking, answering, discussing, and doing assignments shows an important improvement. In addition, students find the material easier to understand, the learning process more engaging, their motivation to learn increases, and their confidence grows.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

R was the main contributor and editor of the final manuscript. STN mainly did experiments and wrote the first draft. AR and M gave support and advice for this research.

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