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THE IMPACT OF ARTIFICIAL INTELLIGENCE ON STUDENTS' INTEREST AND ACHIEVEMENT IN LEARNING MATHEMATICS

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Abstract

This study investigates the impact of Artificial Intelligence (AI) on students' interest and achievement in learning mathematics compared to the use of printed textbooks. A quasi-experimental design was employed with two groups of senior high school students: the experimental group utilized AI-based applications, while the control group relied on printed textbooks as the main learning resource. Research instruments included a learning interest questionnaire, achievement tests, and classroom observations. The results indicate that students learning with AI demonstrated higher levels of interest due to interactivity and personalized content. Furthermore, there was a significant difference in learning outcomes between the AI group and the textbook group. The findings suggest that integrating AI into mathematics instruction can serve as an innovative strategy to foster student motivation and improve academic performance, while printed textbooks remain valuable as supplementary learning resources.
Keywords: Artificial Intelligence, learning interest, learning outcomes, mathematics

INTRODUCTION

The rapid development of information technology in the era of the Fourth Industrial Revolution has significantly transformed the field of education, particularly in how students acquire knowledge and interact with learning resources. One emerging innovation is the application of Artificial Intelligence (AI) in teaching and learning. AI is increasingly implemented in diverse forms, such as intelligent chatbots, adaptive learning platforms, and interactive applications capable of providing real-time feedback.

Its presence is believed to address contemporary educational challenges, where students are expected to be more active, critical, and independent learners. Despite these technological advancements, printed textbooks continue to play an essential role in classroom instruction. As a traditional learning medium, textbooks provide systematic content organization, validated information, and ease of use without requiring technological support. For decades, they have been a primary instructional tool, particularly in mathematics education. However, textbooks are often considered less interactive, which may reduce student interest, especially in mathematics—a subject many learners perceive as difficult.

Mathematics remains a fundamental component of the school curriculum but continues to be a major challenge for many students. The Programme for International Student Assessment (PISA) report highlights that Indonesian students' mathematical literacy is still below the OECD average (OECD, 2019). Low achievement in this area is partly attributed to a lack of student motivation and teaching approaches that fail to fully engage learners. This situation underscores the need for innovative teaching strategies in mathematics, including the integration of technology such as AI.

Previous research has emphasized the potential of AI in enhancing learning. Holmes et al. (2019) revealed that adaptive AI-based systems improve student motivation and comprehension by presenting content tailored to individual needs. Similarly, Chen and Xie (2020)

demonstrated that AI accelerates mastery of mathematical concepts while fostering higher-order thinking skills. Yang et al. (2021) further highlighted that AI provides instant feedback, thereby strengthening students' confidence in solving mathematical problems.

In the Indonesian context, Rachmawati (2022) reported that AI applications employing adaptive problem-solving features improved senior high school students' mathematics achievement by 23% compared to traditional methods. Likewise, Huda et al. (2018) found that technology-based instruction enhanced students' critical thinking skills more effectively than conventional approaches. Conversely, research also shows that printed textbooks remain valuable. Dwi and Susanto (2021) found that students who consistently used textbooks achieved higher levels of reading comprehension compared to those relying solely on digital media. Similarly, Singer and Alexander (2017) reported that conceptual understanding was stronger when students read printed texts rather than digital versions.

From a theoretical perspective, this study draws on Vygotsky's (1978) social constructivist theory, which emphasizes the role of social interaction and scaffolding in learning. AI can function as a form of digital scaffolding by offering adaptive support according to learners' needs. Additionally, Cognitive Load Theory (Sweller, 1988) explains how AI-based learning can reduce cognitive burden by presenting content aligned with students' ability levels, thereby improving learning efficiency. Meanwhile, textbooks remain consistent with Skinner's (1953) behaviorist perspective, which stresses the importance of practice and reinforcement in mathematics learning.

Given these perspectives, a crucial question arises: Is AI truly more effective than printed textbooks in enhancing students' interest and achievement in mathematics? This question is relevant, considering that most teachers still rely on textbooks as the primary learning source, while today's digital-native students are more familiar with interactive technologies.

Accordingly, the objective of this study is to examine the impact of AI on students' interest and academic achievement in mathematics compared to printed textbooks. This study aims to explore how AI influences students' intrinsic motivation and academic performance, while also providing theoretical contributions to the literature on technology-enhanced mathematics learning and practical recommendations for teachers in designing effective instructional strategies.

Thus, this study is expected to provide a more comprehensive understanding of the effectiveness of using AI compared to printed textbooks in mathematics learning. The findings are not only beneficial for mathematics teachers in selecting appropriate learning media but also for policymakers in designing curricula that are more relevant to the advancement of educational technology.

METHOD

This study employed a quasi-experimental approach using a nonequivalent control group design. The participants were two Grade XI classes at a senior high school in Rejang Lebong, each consisting of 30 students. The experimental group learned through AI-based applications, while the control group used printed textbooks as their primary learning resource.

The research instruments included: Learning Interest Questionnaire**,** adapted from Hidi and Renninger's (2006) indicators. Achievement Test**,** comprising multiple-choice and short-answer questions that had been validated by experts. Observation Sheet**,** designed to record student engagement during classroom activities.

The study was conducted over six sessions covering algebra and quadratic functions. Data were collected through pretests, posttests, questionnaires, and classroom observations. Data analysis involved an independent-samples t-test to compare student achievement between groups after ensuring normality and homogeneity assumptions were met.

Questionnaire responses were analyzed based on the mean score of each indicator, while observation data were analyzed descriptively. This methodological framework was chosen to provide an objective comparison of students' interest and achievement between AI-assisted and textbook-based mathematics instruction.

RESULTS AND DISCUSSION

Results

The study involved 60 students, with 30 in the experimental group (AI) and 30 in the control group (textbooks).

Table 1. Average Scores of Students' Learning Interest

Indicator	AI	Textbook
Interest	4.40	3.70
Attention	4.20	3.60
Instrinsic Motivation	4.15	3.80
Engagement	4.25	3.50
Overall Mean	4.25	3.65

Source: Processed Data (2025)

Table 1 shows that the average score of students' learning interest in the AI group (4.25) was higher than that of the textbook group (3.65). This difference was consistent across all indicators, namely interest, attention, intrinsic motivation, and engagement. These results indicate that the use of AI can enhance students' learning interest compared to printed textbooks. This finding is also illustrated in Figure 1, which depicts the differences in scores more clearly.

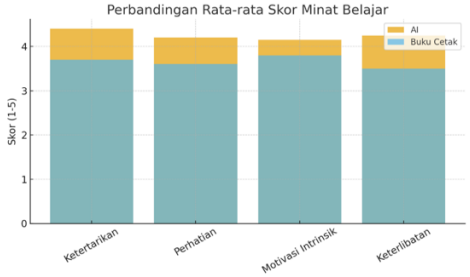

Figure 1. Bar Chart of Students' Average Learning Interest

Table 2. Mean Scores of Pretest and Posttest

Group	Pretest	Posttest	Gain
AI	67.5	82.7	+15.2
Textbook	65.8	74.3	+8.3

Source: Processed Data (2025)

As shown in Table 2, the AI group achieved a greater improvement (+15.2) compared to the textbook group (+8.5). The independent-samples t-test confirmed a significant difference between the two groups ($p < 0.05$), demonstrating that AI-based instruction more effectively enhanced students' academic achievement. The visualization in Figure 2 further highlights the considerable difference between the two groups.

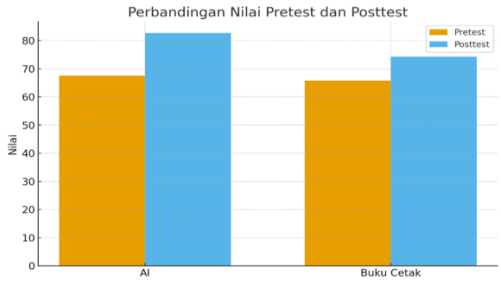

Figure 2. Bar Chart Comparing Students' Pretest and Posttest Scores

The posttest score of the AI group (82.67) was also higher than that of the textbook group (74.33), with the independent-samples t-test indicating a significant difference ($p < 0.05$).

Table 3. Student Engagement during Lessons

Group	Student Engangement (%)
AI	82
Textbook	68

Source: Processed Data (2025)

Table 3 shows that student engagement was notably higher in the AI group (82%) compared to the textbook group (68%). This suggests that AI-based learning environments encouraged more active participation.

These data demonstrate that AI was able to foster higher student participation in the learning process. This is further illustrated in Figure 3, where the difference in engagement between the groups appears clearly.

Figure 3. Bar Chart of Students' Engagement Percentage in Learning

Overall, the quantitative data presented in the tables and figures confirm that the use of AI is more effective in enhancing students' interest, learning outcomes, and engagement compared to printed textbooks.

DISCUSSION

In line with the findings of Jumri, Widada, and Herawaty (2018), collaborative learning models have been proven to enhance the effectiveness and outcomes of student learning. The application of AI in mathematics instruction can also be regarded as a form of collaborative innovation between humans and technology in achieving similar goals.

Jumri and Murdiana (2022) demonstrated that innovative approaches such as Resource-Based Learning can improve students' mathematical representation skills. This aligns with the role of AI, which provides diverse learning resources and personalized content. Furthermore, the study by Rahmat Jumri et al. (2024) showed that the use of concrete media in teaching fractions increased elementary students' learning interest;

similarly, the integration of AI has the potential to foster enthusiasm for mathematics through technological support.

The findings of this study indicate that AI significantly enhances students' interest and achievement in mathematics compared to printed textbooks. Students felt more engaged, focused, and active when using AI-based tools, consistent with Vygotsky's (1978) constructivist theory, which emphasizes the importance of scaffolding within the zone of proximal development. AI serves as digital scaffolding by offering adaptive support, instant feedback, and adjustments in task difficulty.

These results are consistent with previous studies underscoring the importance of innovative approaches in mathematics learning. Just as ethnomathematics has been shown to improve conceptual understanding through cultural contexts (Sarwoedi et al., 2018; Herawaty et al., 2019), the use of AI strengthens student motivation and interest by providing more personalized and adaptive learning experiences. Earlier studies by Holmes et al. (2019), Chen and Xie (2020), and Yang et al. (2021) confirmed that AI enhances motivation, conceptual understanding, and students' confidence through immediate feedback.

Pertiwi, Kulsum, and Hanifah (2025) found a positive correlation between AI and motivation as well as academic achievement among elementary school students, while Qushwa (2024) highlighted the role of AI in increasing personalization and engagement in online learning. Zain and Abdullah (2024) further reported that AI raised student engagement (time-on-task) by 22% and improved STEM scores by 12%.

Other studies also support these findings. Keong (2025) found that personalized AI tools increased university students' intrinsic motivation. Similarly, Alneyadi, Wardat, and colleagues (2024), in a systematic review, concluded that integrating AI into science education improved student achievement, comprehension, and engagement. In the Indonesian context, Rachmawati (2022), Huda et al. (2018), and Suyadi & Yulianti (2017) asserted that digital technologies, including AI, enhance students' critical thinking and active learning behavior.

Specifically, these findings also reinforce the research of Singer and Alexander (2017) and Dwi and Susanto (2021), who emphasized that printed textbooks remain relevant for supporting deeper conceptual understanding. However, AI has advantages in promoting interactivity, motivation, and personalization in learning. This is consistent with blended learning approaches, where AI can complement the strengths of printed textbooks, enabling students to gain a more comprehensive learning experience. Furthermore, these findings align with recent international studies showing that AI consistently contributes to improved academic achievement across contexts: Al-Mahrooqi and Denman (2023) in Oman, Lee et al. (2022) in Korea, Park and Kim (2022) in STEM education, and Nugroho et al. (2022) in Indonesia. Their studies suggest that AI functions not only as a medium but also as a *learning partner* that helps students think more critically and independently.

Thus, this study confirms that AI has a significant impact on students' interest and achievement in mathematics. Nevertheless, printed textbooks remain important as sources of conceptual reference and practice. Therefore, the most effective instructional strategy is the synergistic integration of AI and textbooks.

CONCLUSION

This study concludes that the use of Artificial Intelligence (AI) in mathematics instruction has a positive and significant impact on students' learning interest and academic achievement compared to the use of printed textbooks. Students who learned with AI demonstrated higher levels of interest, as reflected in their questionnaire scores, and achieved greater improvements in test performance. In addition, they showed more active, interactive, and participatory engagement during the learning process. These findings align with Vygotsky's (1978) social constructivist

theory and Cognitive Load Theory (Sweller, 1988), highlighting AI's role in providing adaptive scaffolding, interactivity, and immediate feedback to support effective learning.

Nevertheless, printed textbooks remain valuable for strengthening conceptual understanding and offering structured learning content. Therefore, the optimal strategy is not to replace textbooks entirely, but to integrate AI and textbooks in a complementary manner, allowing students to benefit from both interactive and systematic learning experiences.

RECOMMENDATIONS

Based on the findings of this study, several recommendations can be made: For Teachers: Mathematics teachers are encouraged to integrate AI into classroom instruction, particularly for adaptive practice, concept visualization, and instant feedback, while still utilizing printed textbooks to reinforce fundamental understanding. For Schools and Policy Makers: Educational institutions and policymakers should provide training and professional development programs to equip teachers with the skills necessary for effective AI integration. For Future Research: Further studies should involve larger samples, employ diverse AI applications, and consider additional variables such as learning styles, critical thinking skills, and student attitudes toward mathematics. Such research will provide a more comprehensive understanding of AI's role in education and inform policy development.

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