

Effectiveness of Using AI Chatbots as Interactive Tutors to Improve Personalized Learning and Learning Outcomes of Eighth-Grade Informatics Students

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Abstract: This study was motivated by the need for adaptive and personalized learning support for eighth-grade Informatics students at SMPN 1 Pasaman. This study aimed to examine the effectiveness of an AI chatbot as an interactive tutor in improving personalized learning and Informatics learning outcomes, both partially and simultaneously. A quantitative approach with a quasi-experimental method and a Non-Equivalent Control Group Design was employed. The sample consisted of 63 eighth-grade students, with 31 students in the experimental class receiving AI chatbot integration and 32 students in the control class receiving conventional CBL-based instruction. Data were collected through questionnaires and cognitive tests and analyzed using Multivariate Analysis of Covariance (MANCOVA) to control for pretest scores. The results showed significant partial effects on personalized learning ($F = 47.879$; $p = 0.000$), with the experimental group achieving a posttest mean of 66.03, an increase of 19.45 points. A significant partial effect was also found on cognitive learning outcomes ($F = 6.248$; $p = 0.015$), with a posttest mean of 81.29, an increase of 27.10 points. Simultaneously, AI chatbot use significantly affected both variables (Wilks' Lambda = 0.476; $F = 31.967$; $p = 0.000$), with an effect contribution of 52.42%. These findings indicate that AI chatbots can serve as interactive tutors that provide adaptive cognitive scaffolding according to individual learning needs.

Keywords: Chatbot AI; Informatics; Interactive Tutor; Learning Outcomes; Personalized Learning.

Introduction

The rapid advancement of digital technology has brought significant changes across various sectors, including education. Digital technology is no longer merely a medium for delivering information but has evolved into a tool capable of facilitating adaptive learning tailored to students' individual characteristics. One of the most prominent technological developments in education today is the application of Artificial Intelligence (AI) in the learning process. AI enables educational systems to provide automated feedback, adapt learning materials to students' abilities, and support personalized learning experiences, thereby

enhancing the quality and flexibility of learning (Holmes et al., 2019; Luckin & Holmes, 2016; UNESCO, 2021).

In educational settings, the implementation of AI aligns closely with the concept of personalized learning, an instructional approach that places students' characteristics, learning needs, abilities, and learning pace at the center of the educational process. Personalized learning provides learning experiences that are adapted to individual student needs rather than applying identical learning experiences to all learners (Pane et al., 2015; Vorobyeva et al., 2025). This approach is particularly relevant for junior secondary school students because learners at this level may demonstrate differences in prior knowledge, learning abilities,

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engagement, and learning pace. Personalized learning has been associated with improvements in student motivation, engagement, learning autonomy, and academic achievement, particularly when supported by adaptive educational technologies (Ayeni et al., 2024; Pane et al., 2015). Therefore, the implementation of personalized learning requires instructional strategies and technological support that can respond to students' individual learning needs.

One practical application of AI in education is the use of AI chatbots as interactive learning tutors. AI chatbots can interact with students through conversational interfaces, enabling them to explain learning materials, answer questions, provide learning exercises, and deliver immediate feedback (Følstad & Brandtzæg, 2017; Holmes et al., 2019). Their interactive characteristics allow students to obtain learning assistance according to their needs and learning pace. Previous studies have also reported that the use of AI chatbots can support student motivation, independent learning, and learning outcomes (Juanta et al., 2024; Riyadi et al., 2025; Sutriyana et al., 2024). In this context, AI chatbots can function as complementary tutors that provide individualized learning support while students engage in classroom learning activities.

At SMPN 1 Pasaman, Informatics instruction is implemented through the Case-Based Learning (CBL) model, which engages students in learning activities through the analysis and resolution of relevant cases. Although CBL provides opportunities for students to actively engage in problem solving, its implementation does not necessarily ensure that every student receives individualized assistance during the learning process. Students may encounter different difficulties when analyzing cases, while teachers have limited capacity to provide immediate and personalized feedback to all students simultaneously. Preliminary data collected at SMPN 1 Pasaman showed that the average Informatics learning mastery rate was only 51.53%. In addition, the personalized learning questionnaire indicated that students' personalized learning level remained relatively low, with an average score of 46.60%. These findings indicate the need to strengthen the existing learning process with technological support that can provide more flexible, responsive, and individualized learning assistance.

Previous studies have demonstrated the potential of AI and AI chatbots to improve students' motivation, independent learning, understanding, and academic achievement (Azzura & Sartono, 2025; Dharmawan et al., 2025; Juanta et al., 2024; Riyadi et al., 2025). However, the existing studies in the provided literature have largely examined AI chatbot use in relation to individual learning outcomes or have focused on higher education contexts (Hutauruk et al., 2025; Vitriani & others, 2025).

Research specifically examining the integration of an AI chatbot as an interactive tutor within the Case-Based Learning (CBL) model to support personalized learning and Informatics learning outcomes among junior secondary school students remains limited. Therefore, the novelty of this study lies in the integration of an AI chatbot as an interactive tutor within the CBL learning process and the simultaneous examination of its effects on personalized learning and Informatics learning outcomes. This integration is expected to complement case-based learning by providing students with immediate and adaptive assistance while they analyze and solve learning cases. Furthermore, the use of Multivariate Analysis of Covariance (MANCOVA) enables the simultaneous examination of the intervention's effects on the two dependent variables while controlling for pretest differences.

Based on this rationale, this study aims to examine the effectiveness of integrating an AI chatbot as an interactive tutor into the Case-Based Learning model in improving personalized learning and Informatics learning outcomes among eighth-grade students at SMPN 1 Pasaman. The study examines whether students who learn through CBL integrated with an AI chatbot demonstrate different levels of personalized learning and Informatics learning outcomes compared with students who learn through CBL without AI chatbot integration, as well as whether the integration of the AI chatbot produces a simultaneous effect on both dependent variables.

Method

This study employed a quantitative approach using a quasi-experimental method with a Non-Equivalent Control Group Design. This design was selected because the researcher could not randomly assign individual students to the experimental and control groups due to the existing classroom arrangements. Two intact classes were therefore selected as the research groups. Both groups received Informatics instruction using the Case-Based Learning (CBL) model, while the experimental class received additional integration of an AI chatbot functioning as an interactive tutor. The control class received CBL instruction without AI chatbot assistance. The research design is presented in Table 1.

Table 1. Research design

Group	Pretest	Treatment	Posttest
Experimental	O ₁	CBL integrated with AI chatbot	O ₂
Control	O ₃	CBL without AI chatbot	O ₄

The study was conducted at SMPN 1 Pasaman during the 2025/2026 academic year. The population consisted of all Grade VIII students. The research sample comprised 63 students, including 31 students in Class VIII.1 as the experimental group and 32 students in Class VIII.2 as the control group. The sample was selected using purposive sampling based on the similarity of students' initial academic abilities and school recommendations. The independent variable was the integration of an AI chatbot as an interactive tutor into the CBL model, while the dependent variables were personalized learning and Informatics learning outcomes. Personalized learning refers to learning experiences that accommodate individual differences in learning pace, content adaptation, learning autonomy, and personalized feedback (Ayeni et al., 2024; Pane et al., 2015). Learning outcomes refer to students' cognitive achievement measured after participating in the instructional process (Müller & Mildenerger, 2021).

Data were collected using two research instruments. The first instrument was a personalized learning questionnaire developed based on four dimensions, namely content adaptation, learning pace, learning autonomy, and personalized feedback. The second instrument was a multiple-choice cognitive achievement test designed to assess students' understanding of Informatics concepts. Prior to implementation, both instruments were validated through expert judgment and empirical testing. Item validity was analyzed using the Pearson Product Moment correlation, while reliability was determined using Cronbach's Alpha. In addition, item discrimination and difficulty indices were examined to ensure the quality of the achievement test before its administration in the experiment (Arikunto, 2021; Jalmur, 2016).

The experimental procedure was conducted through the Case-Based Learning (CBL) model, with the AI chatbot integrated into the learning activities of the experimental class. CBL involves learning activities centered on the analysis and resolution of cases, with students actively examining cases, seeking relevant information, developing solutions, and discussing their findings. The CBL process can include activities such as establishing a case, analyzing the case, independently searching for relevant information, determining a solution, presenting the findings, and evaluating or improving the proposed solution. The learning process began with a pretest administered to both groups to determine students' initial abilities. Both groups subsequently engaged in CBL-based Informatics learning activities. In the experimental class, the AI chatbot functioned as an interactive tutor that supported students during CBL activities by providing explanations, answering questions, offering learning

exercises, and delivering immediate feedback according to students' learning needs. In the control class, students participated in the same CBL-based learning activities without AI chatbot assistance and received guidance and feedback directly from the teacher. After the intervention, both groups completed the posttest and personalized learning questionnaire.

Data analysis was conducted using IBM SPSS Statistics. Descriptive statistics were first used to summarize students' personalized learning scores and Informatics learning outcomes. Prior to hypothesis testing, assumption tests were conducted, including normality, homogeneity of variance-covariance matrices using Box's M Test, and homogeneity of variances using Levene's Test. Because the study involved two dependent variables and controlled for students' pretest scores, hypotheses were tested using Multivariate Analysis of Covariance (MANCOVA) at a significance level of $\alpha = 0.05$. Partial effects were examined using Tests of Between-Subjects Effects, while simultaneous effects were determined using Multivariate Tests based on Wilks' Lambda. The use of MANCOVA is appropriate when examining group differences across multiple dependent variables while statistically controlling for covariates (Field, 2013).

Result and Discussion

Results

This study examined the effect of integrating an Artificial Intelligence (AI) chatbot into the Case-Based Learning (CBL) model on students' personalized learning and Informatics learning outcomes. The study involved 63 eighth-grade students of SMPN 1 Pasaman, consisting of 31 students in the experimental class and 32 students in the control class. Both groups received instruction using the CBL model, while the experimental class received additional AI chatbot assistance as an interactive tutor. The control class received the same CBL-based instruction without AI chatbot assistance. Data were analyzed using descriptive statistics and Multivariate Analysis of Covariance (MANCOVA), with pretest scores controlled as covariates.

Descriptive Statistics

Descriptive statistics were used to describe changes in students' personalized learning and Informatics learning outcomes before and after the intervention. The results for both groups are presented in Table 2.

As presented in Table 2, both groups demonstrated improvements in personalized learning and Informatics learning outcomes following the intervention. However, the experimental group showed greater gains than the control group for both variables. Personalized learning increased by 19.45 points in the experimental group,

compared with 14.45 points in the control group. Similarly, Informatics learning outcomes increased by 27.10 points in the experimental group and 22.50 points in the control group. The descriptive findings therefore indicate a greater improvement among students who received AI chatbot assistance within the CBL learning process.

Table 2. Descriptive Statistics of Personalized Learning and Learning Outcomes

Variable	Group	Pretest	Posttest	Gain
Personalized Learning	Experimental	46.58	66.03	19.45
	Control	42.29	56.74	14.45
Learning Outcomes	Experimental	54.19	81.29	27.10
	Control	53.75	76.25	22.50

The higher gain observed in the experimental group is consistent with the potential of AI-supported learning to provide adaptive assistance, immediate feedback, and individualized learning support. AI in education can facilitate learning environments that respond to students' individual needs and provide more flexible instructional support (Holmes et al., 2019; UNESCO, 2021). Recent studies have likewise reported that AI chatbots can support students' learning processes through interactive communication and individualized assistance (Juanta et al., 2024; Riyadi et al., 2025).

To determine whether the observed differences remained statistically significant after controlling for students' pretest scores, Tests of Between-Subjects Effects were conducted. The results are presented in Table 3.

Table 3. Tests of Between-Subjects Effects

Dependent Variable	F	Sig.	R ²	Interpretation
Personalized Learning	47.879	0.000	0.658	Significant
Learning Outcomes	6.248	0.015	0.364	Significant

Table 3 shows that the adjusted effect on personalized learning was statistically significant, with $F = 47.88$ and $p < 0.001$. The R^2 value of 0.66 indicates that the model accounted for approximately 65.8% of the variance in personalized learning after controlling for the pretest score. For Informatics learning outcomes, the analysis also showed a statistically significant effect, with $F = 6.25$ and $p = 0.02$. The R^2 value of 0.36 indicates that the model accounted for approximately 36.4% of the variance in learning outcomes. These findings indicate that the differences between the two groups were not merely attributable to their initial abilities. After

students' pretest scores were statistically controlled, the experimental group continued to demonstrate significantly better outcomes. The finding supports previous research indicating that AI-based learning environments can provide adaptive support and facilitate individualized learning experiences (Ayeti et al., 2024; Saifullah, 2024). AI chatbots may also support students by providing immediate responses and continuous learning assistance, which can help reduce barriers during the learning process (Azzura & Sartono, 2025; Sutriyana et al., 2024).

To further identify the differences between the experimental and control groups, pairwise comparisons were conducted. The results are presented in Table 4.

Table 4. Pairwise Comparisons

Variable	Mean Difference	Sig.	Interpretation
Personalized Learning	7.327	0.000	Experimental group performed better
Learning Outcomes	4.990	0.015	Experimental group performed better

The pairwise comparisons revealed statistically significant differences between the experimental and control groups for both dependent variables. The adjusted mean difference in personalized learning was 7.33 points ($p < 0.001$), indicating that students in the experimental group achieved significantly higher personalized learning scores than students in the control group. A significant difference was also observed in Informatics learning outcomes, with an adjusted mean difference of 4.99 points ($p = 0.02$).

The greater performance of the experimental group can be interpreted in relation to the role of the AI chatbot as an interactive learning assistant within the CBL process. Instead of replacing the teacher, the chatbot provided additional opportunities for students to ask questions, obtain explanations, receive feedback, and review concepts during case-based learning activities. This role is consistent with the broader view of AI as a support technology that can complement teachers and facilitate more individualized learning experiences (Holmes et al., 2019; UNESCO, 2021). The findings are also consistent with Riyadi et al. (2025), who reported that AI chatbot utilization can support students' learning independence through continuous interaction and learning assistance. Similarly, Sutriyana et al. (2024) found that AI chatbots can facilitate students' learning through interactive assistance and individualized support. These findings strengthen the interpretation that the additional chatbot support in the experimental group may have contributed to the greater improvement observed in both personalized learning and learning outcomes.

To examine the simultaneous effect of AI chatbot integration on personalized learning and Informatics learning outcomes, a MANCOVA was conducted. The results are presented in Table 5.

Table 5. Multivariate Test Results

Statistic	Value
Wilks' Lambda	0.476
F	31.967
Sig.	0.000

Source: SPSS Version 21 Output.

The MANCOVA results demonstrated a statistically significant multivariate effect of AI chatbot integration, with Wilks' Lambda = 0.48, $F = 31.97$, and $p < 0.001$. This finding indicates that, after controlling for students' pretest scores, the instructional treatment produced a significant combined effect on personalized learning and Informatics learning outcomes. The multivariate finding is important because the contribution of the AI chatbot was not limited to a single learning dimension. The experimental treatment simultaneously addressed students' learning processes and their academic achievement. This result is consistent with the conceptualization of AI in education as a technology capable of supporting adaptive learning, personalized feedback, and instructional interaction (Ayeni et al., 2024; UNESCO, 2021).

Discussion

The results demonstrate that integrating an AI chatbot into the CBL model significantly improved students' personalized learning. The experimental group obtained a higher posttest score and a greater gain than the control group. The adjusted pairwise comparison also showed a significant difference of 7.33 points between the groups. This finding suggests that the AI chatbot provided additional learning support that enabled students to interact with instructional content according to their individual learning needs.

The improvement can be explained by the adaptive characteristics of AI-supported learning. Personalized learning emphasizes the accommodation of differences in students' abilities, learning pace, learning needs, and learning experiences. AI-based systems can support this process by providing individualized responses and feedback rather than delivering identical assistance to every learner (Ayeni et al., 2024; Pane et al., 2015). In the present study, the chatbot provided students with opportunities to ask questions repeatedly, request explanations, and receive immediate responses during the CBL activities. Such interactions allowed students to obtain assistance at the point when they experienced difficulty.

These findings are consistent with Saifullah (2024), who reported that AI chatbot integration can support personalized learning and student motivation through continuous interaction. Similarly, Sutriyana et al. (2024) found that AI chatbot use can facilitate students' independent learning and academic achievement (Riyadi et al., 2025). The results demonstrate that integrating an AI chatbot into the CBL model significantly improved students' personalized learning.

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The finding is also consistent with the constructivist perspective of learning. According to (Piaget, 1973), learners construct knowledge through active interaction with their environment. In the present learning context, the chatbot did not function as the primary source of instruction but as an additional resource that students could use while analyzing and solving learning cases. Students therefore remained actively involved in constructing their understanding while using the chatbot to obtain explanations and feedback.

This process can also be interpreted through Vygotsky (2021) concept of the Zone of Proximal Development. Students may encounter tasks that they cannot initially complete independently but can accomplish with appropriate assistance. In this study, the AI chatbot provided explanations, examples, hints, and corrective responses that could function as digital scaffolding during learning activities. The chatbot therefore extended the support available to students beyond direct teacher interaction.

These findings are consistent with Saifullah (2024), who reported that AI chatbot integration can support personalized learning and student motivation through continuous interaction. Similarly, Sutriyana et al. (2024)

found that AI chatbot use can facilitate students' independent learning and academic achievement. Riyadi et al. (2025) also reported that chatbot-based AI can support students' learning independence by providing accessible learning assistance. The present study extends these findings by demonstrating the effectiveness of AI chatbot integration specifically within CBL-based Informatics instruction at the junior secondary school level.

The findings also demonstrate a significant effect of AI chatbot integration on students' Informatics learning outcomes. The experimental group achieved a posttest mean of 81.29, compared with 76.25 in the control group. The experimental group also demonstrated a greater gain of 27.10 points, while the control group increased by 22.50 points. The adjusted difference between groups was statistically significant. One possible explanation is that the chatbot provided students with immediate opportunities to clarify concepts while they were working on learning cases. In Informatics education, students are required to understand concepts and apply logical reasoning to solve problems. When students encountered difficulties, immediate explanations and feedback could help them identify misconceptions and continue working on the problem rather than waiting for teacher assistance.

This finding is consistent with the view that AI can function as an instructional support mechanism by providing immediate feedback and adaptive assistance (Holmes et al., 2019; UNESCO, 2021). Azzura & Sartono (2025) also reported that AI chatbot use can contribute to students' understanding of learning materials through interactive assistance. Likewise, Dharmawan et al. (2025) found that the use of AI chatbots in learning was associated with improved student learning outcomes. The result also demonstrates the potential benefit of combining chatbot technology with case-based learning activities. The CBL environment provides students with contextual problems that require analysis and solution development, while the chatbot provides additional assistance when students encounter difficulties. Thus, the chatbot does not replace the case-based learning process; rather, it provides additional support within that process. This distinction is important because the effectiveness observed in this study should be interpreted as the effect of AI chatbot integration into CBL, rather than the effect of the chatbot operating independently from the learning model.

The MANCOVA results provide further evidence that AI chatbot integration had a significant simultaneous effect on personalized learning and Informatics learning outcomes. The Wilks' Lambda value of 0.48, $F = 31.97$, and $p < 0.001$ indicate that the two dependent variables were significantly different between the experimental and control groups after

controlling for pretest scores. The simultaneous finding suggests that the benefits of AI chatbot integration extend across both the learning process and learning achievement. Personalized learning concerns how students experience and regulate their learning according to their individual needs, while learning outcomes represent the academic results achieved after instruction. The improvement in both dimensions suggests that providing individualized support during learning may contribute to better engagement with instructional content and, ultimately, improved achievement.

This interpretation is supported by research emphasizing the potential of AI to provide adaptive learning experiences and individualized instructional support (Ayeni et al., 2024; Holmes et al., 2019). Saifullah (2024) similarly reported that AI chatbot-supported learning can contribute to personalized learning and motivation, while Sutriyana et al. (2024) demonstrated the potential of AI chatbots to support both learning independence and achievement. The findings therefore suggest that AI chatbots can serve as digital scaffolding within a teacher-guided CBL environment. The teacher remains responsible for organizing learning activities, facilitating discussion, monitoring students, and providing pedagogical guidance, while the chatbot provides supplementary assistance that can be accessed when students need additional support. This complementary relationship is important for classroom implementation because AI technology should function as an instructional support rather than as a substitute for teachers.

Overall, the findings provide empirical evidence that integrating an AI chatbot into the CBL model can improve both personalized learning and Informatics learning outcomes among eighth-grade students. The novelty of the study lies in examining these two dependent variables simultaneously in a junior secondary Informatics context, while positioning the AI chatbot as an interactive tutor integrated into an existing case-based learning process. This integration is particularly relevant because personalized learning and academic achievement are not necessarily separate instructional goals. An adaptive learning assistant can provide students with individualized support while they engage with contextual cases, thereby connecting the personalization of the learning process with the achievement of learning objectives. The findings therefore strengthen previous evidence regarding the educational potential of AI chatbots (Juanta et al., 2024; Riyadi et al., 2025; Sutriyana et al., 2024) while providing empirical evidence from the context of Informatics learning at the junior secondary school level.

Conclusion

This study concludes that integrating an Artificial Intelligence (AI) chatbot into the Case-Based Learning (CBL) model significantly improved students' personalized learning and Informatics learning outcomes. Students who received AI chatbot-assisted CBL demonstrated significantly higher personalized learning and learning outcomes than those who participated in CBL without AI chatbot assistance, both in the partial and simultaneous analyses after controlling for pretest scores. The findings indicate that AI chatbots can function as interactive learning tutors by providing adaptive support, immediate feedback, and individualized guidance within a case-based learning environment. Therefore, AI chatbot integration into CBL has potential as a technology-enhanced instructional approach for Informatics education at the junior secondary school level. Future research is recommended to examine the long-term effects of AI chatbot integration, involve larger and more diverse samples, and compare different AI platforms and instructional contexts to further validate its effectiveness.

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Conflicts of Interest

The authors declare no conflict of interest.

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