Effectiveness of Using Artificial Intelligence Chatbox Integrated Case Method on Science Learning Outcomes of Basic Education Students

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Abstract: Advances in artificial intelligence (AI) have been widely used in learning innovation. This study aims to determine the effectiveness of using AI chatboxes integrated with case method on the science learning outcomes of basic education students. This research is a quasi-experimental research with a pretest-posttest control group design, which allows to compare learning outcomes in both sample classes. Data collection was carried out through pretest and posttest tests to measure the improvement of learning outcomes, and analysis of research data using SPSS 22. The population used was basic education students at Padang State University. The results showed that the use of AI chatbox integrated case method was quite effective in improving science learning outcomes with the acquisition of n-gain in the experimental class of 0.62 with a moderate category. The results of hypothesis test analysis show the Sig value. 0.004 <0.05 so that Ha is accepted. These results prove that the use of AI chatboxes integrated with the case method is effective in improving the science learning outcomes of basic education students. This research shows that the innovative use of AI technology in learning can have a positive impact on student academic achievement, especially in the field of basic education.

Keywords: Artificial Intelligent Chatbox; Case Method; Science Learning Outcomes.

Introduction

Technology is the application of providing connections between users to design, create and solve problems in the world of education (Agutu, Steffen, & Schmidt, 2024; Fortuna et al., 2024; Yigitcanlar et al., 2024; Putri, Insyasiska, & Wahyono, 2023). The development of technology is currently growing rapidly in various countries in education, health, technology and others, bringing significant changes in behavior, interaction, work, and daily life (Chen, Zou, Xie, & Wang, 2024; Ganda, 2024; Rinkinen, Kinnula, & Nordquist, 2024; Sun, Chen, & Geng, 2024; Prasetyo et al., 2023). One technology that is developing rapidly is digitalization technology, digitalization technology is able to convert information that is analog in nature into digital which helps human work (Aulia Utami et al.,

2023). Digitalization technology has been widely used, especially in education at various levels of education in the world (Gunnars, 2021; Haleem, Javaid, Qadri, & Suman, 2022; Mei, Feng, & Cavallaro, 2023). Today, a striking advancement of the development of digitalization is artificial *intelligence* (AI) (Stolpe & Hallström, 2024; Sudibyo, 2024). AI deals with systems to perform tasks that normally require human intelligence (Artha et al., 2024; Eriana et al., 2023; Feng et al., 2024; Martin et al., 2024; Muthmainnah et al., 2024). One of the AI technologies used in learning is *artificial intelligence chatbox* (AI *chatbox*). Where AI *chatbox* is a computer program designed to provide automatic, intelligent and contextual responses according to the questions asked by users (Arini & Nursa'ban, 2024; Hidayat, Silvanie, & Subekti, 2022). The AI *chatboxes* used in learning are *chatgpt* AI, *perplexity* AI, *bard* AI,

claude AI, *chatpdf*, and others (Kurnia Ramadhan, Irfan Faris, Wahyudi, & Kamayani Sulaeman, 2023; Prananta, Susanto, Purwantoro, & Fuadah, 2023).

Based on observations of basic education UNP students, it was found that many students used AI *chatboxes* in learning. Students use AI *chatboxes* to find information and solutions to problems discussed in class. By opening one of the AI *chatboxes*, students are able to find solutions to the problems given quickly. However, students are still not wise in using AI *chatbox*. Students do not first analyze the answers given by AI, but immediately take all the answers. Students rarely look for problem solving solutions from reading books. The use of AI *chatbox* makes the source of books and articles less important to students. Students become lazy to record material that is considered important because they rely on AI *chatbox*. This will have an impact on student learning outcomes and on student problem-solving skills. Problem solving ability is a high-level learning stage that affects learning outcomes (Surya Astuti Zebua, Zalukhu, Berkat Tabah Hulu, Tambunan, & Pangaribuan, 2023).

The use of AI *chatbox* in learning has been studied by many researchers before. Some have implemented it in English language learning (Abimanto, 2023), making AI *chatbox* as learning media (Hafiz Aldwinarta í, Nurdiana, & Oktavia Sulistina, 2024), using AI to support self-directed learning (Kurnia Ramadhan et al., 2023), etc. But there is still a lack of empirical research and not much has been explored in previous studies on the evaluation of learning outcomes from combining the use of AI chatbox with the *case method* in a lesson, especially in the context of elementary school teacher education for science courses that provide a more specific and relevant context. This is the novelty and **innovation** that researchers do, namely seeing the effectiveness of a unique combination between the use of AI chatbox and *case method* seen from science learning outcomes and focusing on basic education students UNP. This research not only enriches the existing literature, it will also give birth to a new innovative learning model that can improve student engagement and learning outcomes. *Case* method is an active learning method that facilitates discussion in problem solving (Fauzi et al., 2022; Syam, 2022; Widiastuti et al., 2022; Seprianto & Hasby, 2023) Oktober et al., 2024). Active, innovative, creative learning and using learning models and media can improve student learning outcomes (Dian Alfana, Fernandes, & Yuliady, 2023; Ichsan, syahri, Rifelino, & Media, 2023; Nurdin & Dian Alfana, 2018; Suci Rahma Putri, Syahri, Refdinal, Adri, & Media, 2024; Syahri, Media, Jurusan, & Jepang, 2020). *Case method* is also a learning method that can improve problem-solving ability through problem-solving skills and can develop several other skills (Hamiyati, Pada,

Safrida, Khairil, & Artika, 2022; Huda, Desriana, Safrida, Nurmaliah, & Muhibbuddin, 2023; Wahyuni, Megalina, Tanjung, Amdani, & Lubis, 2023; Widiastuti et al., 2022). The implementation of *case method* in learning is more structured from the preparation stage to the closing stage (Roza, Erida, & Siregar, 2022). The use of this *case method* is very suitable when integrated with AI *chatbox*. AI *Chatbox* helps solve problems that occur in learning because its intelligence resembles human intelligence (Haristiani, 2019). The stages used in the *case method* are preparation which includes identifying and developing problem solving procedures, introduction which is the division of groups and cases to be solved, core activities in the form of gathering information and determining problem solving, and closing which includes presentation of problem solving and conclusion of results (Roza et al., 2022). The use of AI *chatbox* strongly supports the implementation of the *case method* in student-level problem solving. Problem solving ability is an indicator of success in learning so that learning outcomes increase (Sulistyowati, Widodo, & Sumarni, 2012). If we do a bibliometric analysis of the use of AI chatboxes in the last 5 years, we find the relationship of these AI chatboxes to other variables in learning which can be seen in Figure 1.
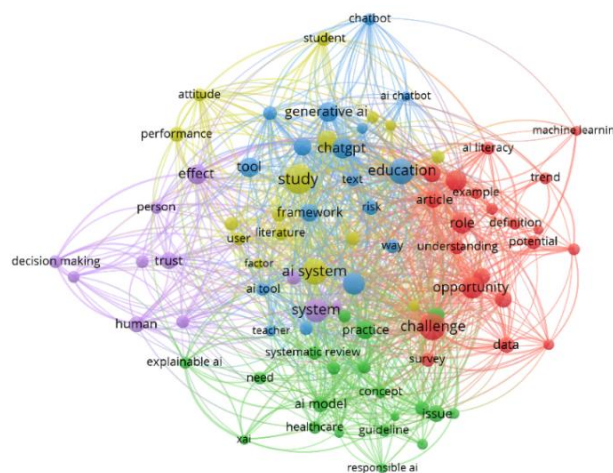

Figure 1. Network Visualization of AI Chatbox

In Figure 1, it can be seen that the results of bibliometric analysis on the use of AI chatbox in learning are student, AI system, user, chatgpt, chatbox, AI application, education, article, and other variables. So that the use of AI chatboxes greatly affects learning which has an impact on student learning outcomes. Overall, these bibliometric figures show that AI chatbot research is a very active field and attracts the interest of many researchers. This research not only focuses on developing more advanced AI chatbot technology, but also understanding how this technology can benefit society and overcome various existing challenges. It can

be concluded that with the current technological advances, it is important to conduct research that examines the effectiveness of using AI chatbox integrated with the case method on the science learning outcomes of UNP basic education students. The aim is to determine the effect of using AI chatbox, evaluate the improvement of learning outcomes, analyse critical thinking skills, and identify the advantages and disadvantages of AI Chatbox implementation.

Method

This research is a pseudo experimental research. Where in this study two classes were used, namely the experimental class and the control class. The sample was selected using cluster sampling technique. Cluster sampling is a sampling technique from a population that is divided into several groups or classes, then randomly selected or randomly a number of groups. The population in this study were UNP basic education students level 1. The research design used was pretest-postest control group. This research design uses two classes, namely the experimental class and the control class which are selected based on the average value of the pretest which is almost the same. The data analysis technique used to test the effectiveness of a method used is the N-gain test. The equation form can be seen:

$$Ngain = \frac{posttest - pretest}{ideal\ score - pretest} \qquad (1)$$

With the provisions of the NGain value as follows:

Table 1. Ngain Value Category

Category	Value
G-High	$G \geq 0.70$
G-Medium	$0.30 \leq G \geq 0.70$
G-Low	$G \leq 0.30$

The research design structure of the pretest-postest control group can be seen in Figure 2.
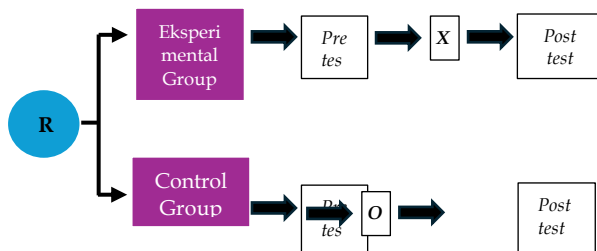

Figure 2. Research Design Structure of the Pretest-Posttest Control Group

Based on Figure 2 the research design structure of the pretest-postest control group, in this study we divide

it into two classes, namely the experimental class and the control class. Where in the experimental class, starting with doing a pretest to measure the initial ability of students, then given research treatment, namely using the AI Chatbox integrated case method, the last posttest is carried out. While in the control class, at the beginning a pretest was also carried out, then there was no treatment (conventional learning), finally a posttest was carried out. Then, in this study, the alternative hypothesis (Ha) is that the use of artificial intelligence chatbox integrated with the case method has a significant effect on the learning outcomes of basic education students. Conversely, the null hypothesis (H0) states that the use of artificial intelligence chatbox integrated with the case method does not have a significant effect on the learning outcomes of basic education students. The instrument that will be used in measuring the effectiveness of using AI Chatbox integrated with the case method is through learning outcomes (postest) which uses objective questions with 4 answer choices. Where before the test is carried out, an instrument trial is first carried out which then tests validity, reliability, and analyzes the items. The research stages can be seen in Figure 3 of the following flowchart.
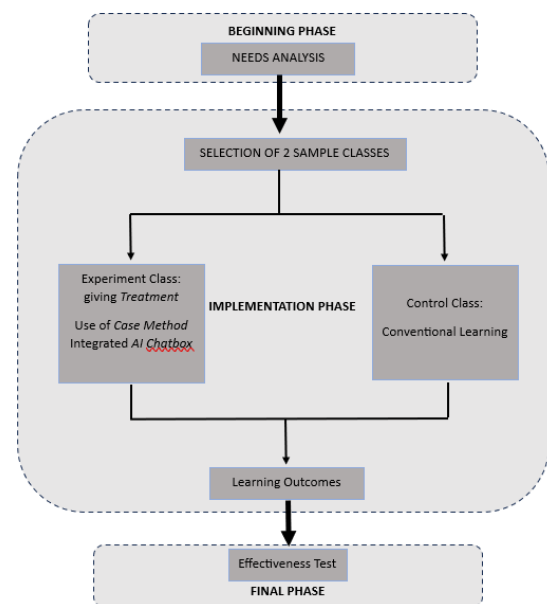

Figure 3. Research Procedure

The stages of the research based on Figure 3 above, researchers designed in three stages, namely:
1. Initial Stage, conducting a needs analysis on students and curriculum analysis in science courses.
2. Implementation Stage, this stage begins with giving *pretest* questions to several classes. Furthermore, two classes that have almost the same average score are taken as sample classes. The selection of two sample classes was carried out using *cluster random sampling*

technique. Furthermore, the research was carried out by conducting *treatment* in the experimental class and conventional learning in the control class. Finally, a written test was conducted on the two selected sample classes in order to see the changes after being given the treatment with before being given the treatment.

In the final stage, hypothesis testing was carried out using *t* test statistics *and* effectiveness test on learning outcomes to test the effectiveness of using *AI chatbox* integrated *case method* with Gain test.

Result and Discussion

The results of this study aim to determine the effectiveness of using AI *chatbox* integrated *case method* on the learning outcomes of basic education students UNP. The research instrument used to collect data is a written test in the form of multiple choice totaling 30 questions with a grid of questions that have been designed according to the cognitive level to be achieved. Before this instrument is used, first test the instrument to a class that is not a research sample but in a class that has studied the science material and then test the validity, reliability, differential power, and difficulty index of the question. The goal is to ensure that the questions in the instrument to be used are valid, reliable, and can provide an accurate picture of student learning achievement with a good category. By conducting trials, teachers can improve the quality of learning and ensure that the assessment is fair and objective. These good criteria instruments will be used in collecting the data needed in the research. The results of the analysis of this research instrument can be seen in Table 2.

Table 2. Analysis of Research Instruments

Instrument Test	Analysis Result
Validity	N = 30 questions
	Valid = 25 questions Discard = 5 questions
Reliability	r11= 0,87 (reliable)
Distinguishing Power	Good = 18 questions
	Sufficient = 7 questions
Difficulty Index	Medium = 19 questions
	Easy = 6 questions (revised)

Based on Table 2 From the results of the data analysis of the instruments carried out, namely the validity, reliability, differentiation, and difficulty index tests on the question instrument using SPSS 22, from the number of questions tested, there were 30 questions, after analyzing the questions that would be used for the trial class later, there were 25 questions because there were 5 questions that were discarded because they were invalid, and there were 6 questions that needed minor

revisions so that they could be used again. This shows that the majority of questions are able to measure the concept to be measured. The reliability of the instrument was also high, with a reliability coefficient of 0.87. This indicates that the instrument is quite reliable in providing consistent results. However, there are still some questions that need to be improved, especially questions that have low differentiation power and difficulty levels that are too easy. Improvements to these questions will improve the overall quality of the instrument and provide more accurate measurement results. By making improvements to the poor questions, this instrument can be used to measure students' abilities more accurately and objectively.

Next, a pretest was conducted on both sample classes, namely the experimental class and the control class, and the normality test, homogeneity test, and equality test of the two means of the experimental class and control class from the pretest value data using SPSS 22, and the test results were obtained in Table 3.

Table 3. Analysis on Pretest Data of Both Sample Classes

Pretest Data Analysis	Analysis Result	Description
Normality	Shapiro-Wilk Sig. (Experiment Class) =0.127 Sig. (Control Class) = 0.346	Normally Distributed Sig. > 0.05
Homogeneity	Based on the mean of the two sample classes = 0.087	Homogeneous Based on Mean > 0.05
Equality of two means	Sig. (2-tailed) both sample classes = 0.754	There is no difference Sig. (2-tailed) > 0.05

Based on Table 3, after analyzing the pretest data of the experimental class and control class, the results obtained in the normality test of the experimental class and control class, each class totaling <30 students, show that the results of the normality test in the experimental class and control class through the Shapiro-Wilk formula are nomally distributed. From the homogeneity test results, it can be seen that the two sample classes are homogeneous, which means that the level of data diversity in the two groups is the same. From the similarity test of the two means of the experimental class and the sample states that there is no difference between the experimental class and the control class. This shows that there is no significant difference between the average pretest scores of the two groups. This indicates that both groups departed from the same starting point before being given treatment, so that the difference in results at

the end of the study can be more valid in measuring the effectiveness of the treatment given. Thus, the two sample groups were balanced before the research began, so that if there were differences in learning outcomes after being given treatment, it could be interpreted as the impact of giving treatment to one of the sample classes.

Furthermore, the research was carried out by conducting treatment in the experimental class in the form of learning using AI chatbox integrated case method for several meetings. Students in the experimental class will interact directly with the AI chatbot to discuss real cases relevant to the subject matter. The AI chatbot will act as a virtual tutor that provides feedback, hints, and structured questions to guide students in analyzing cases and building a deeper understanding. Meanwhile, the control class uses conventional learning without the use of AI chatbox integrated case method. Learning in the control class will focus more on the lecture method, group discussions, and the use of textbooks as the main source of learning. Thus, the main difference between the two groups lies in the use of AI chatbot and the integration of case method in the learning process. After being treated for several lecture meetings, finally a written test in the form of a posttest was conducted on both sample classes in order to see the changes/effects after being given the treatment with before being given the treatment. The comparison of pretest and posttest results in the experimental class and control class can be seen in Figure 4.

From Figure 4 above, a comparison of pretest and posttest scores in the experimental and control classes is obtained. It can be seen that in the pretest value, the two groups have an average value that is not much different. However, after being given treatment and carried out a posttest, the average value of the experimental class experienced a significant increase compared to the control class. This indicates that the learning method using AI chatbot integrated with the case method in the experimental class has a more effective impact in improving student learning outcomes compared to conventional learning methods in the control class. The results of this study provide evidence that the use of AI chatbot integrated with case method can be an effective alternative to improve student learning outcomes. Where the posttest scores in the experimental class showed an increase from the pretest scores and were significantly better than the posttest scores in the control class.
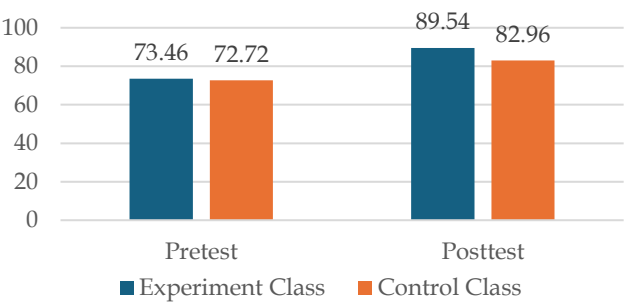

Figure 4. Comparison of Two Sample Classes

Furthermore, the hypothesis test was carried out using an independent sample T test with SPSS 22 from the posttest scores of the experimental class and control class, the T test results were obtained as in Table 4.

Table 4. T-test of Posttest Values of Experimental and Control Classes

		Levene's Test for Equality of Variances		T – test for Equality of Means						
		F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% confidence interval of the Difference	
									Lower	Upper
Posttest	Equal variances assumed	.319	.575	2.989	47	.004	6.582	2.202	2.152	11.012
	Equal variances not assumed			2.985	46.476	.005	6.582	2.205	2.144	11.019

Based on Table 4 above, the T test results of the posttest scores of the experimental class and control class are seen in the significant value (2-tailed) which has a value of 0.004 <0.05 and the T test results of 2.9> 0.05, so H_0 is rejected and Ha is accepted. This states that the use of AI chatbox integrated *case method* has a significant effect on the learning outcomes of basic education students UNP. The difference in mean scores between the two groups did not occur by chance, but was caused by different treatments given to each group. In other words, the use of AI chatbot-based learning integrated with the case method in the experimental class proved to be more effective in improving student learning outcomes compared to conventional learning methods

in the control class. This t-test result supports the hypothesis that the use of AI chatbot integrated with case method can significantly improve student learning outcomes.

Furthermore, the level of effectiveness of the use of AI chatbox integrated *case method* in the experimental class is seen with the gain score formula using SPSS 22. The results can be seen in Table 5.

Table 5. Experimental Class Effectiveness Results

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_skor	24	.33	1.00	.6551	.20648
Ngain_percent	24	33.33	100.00	65.5150	20.64752
Valid N (listwise)	24				

From Table 5 above, it can be concluded that learning using AI chatbot integrated with case method provides good effectiveness in improving student learning outcomes. This can be seen from the average value of gain score and gain percent which is quite high. The average gain score value of 0.6551 indicates a significant increase in understanding in most students after participating in learning. Similarly, the gain percent value of 65.5150 indicates an average increase of 65.51% from the initial score to the final score. The gain score value of 0.6551, interpreted into the value criterion <*g*>, obtained the effectiveness of learning using artificial intelligence chatbox integrated case method in the experimental class is classified as moderate, and also shows that learning using AI chatbox integrated *case method* is quite effective to improve the learning outcomes of basic education students. The results of this analysis support that the use of AI chatbot integrated with the case method can be an effective alternative to improve student learning outcomes.

Based on the discussion of the results of the research that has been carried out, it shows that the use of the chatbox method integrated with AI chatbox effectively improves the learning outcomes of basic education students at Padang State University. This can be seen from the increase in the average value in the post-test of the experimental class compared to the control class. In addition, the gain score analysis showed a significant increase in understanding in most students after participating in learning by using the AI chatbot integrated case method. These results indicate that student interaction with the AI chatbot integrated case method in solving real cases can increase student learning motivation, concept understanding, and critical thinking skills. The use of AI chatbot integrated case method makes learning interactive and responsive, improves the ability in problem solving, because AI chatbox is able to support independent learning, efficient (Patac & Patac, 2025), strengthen collaboration and discussion skills, support Hots-based learning, and greatly help students in solving problems in learning (Situmorang et al., 2023). Therefore, students can take advantage of the technology that is developing today, one of which is AI technology in order to be able to compete in facing future challenges and develop some of the skills needed according to the demands of the times.

Conclusion

This study aims to see the effectiveness of the use of AI chatbox integrated case method on the learning outcomes of basic education students at UNP. Based on the results of the pretest and posttest analysis in the experimental class and control class using the SPSS 22.0 application, it was found that the experimental class and control class showed normally distributed, homogeneous data, and there were no significant differences between the two classes before intervention or before treatment. The results of this study indicate that using AI chatbox integrated case method is quite effective in improving student learning outcomes. This finding shows that integrating AI chatbox in the learning process can be an effective solution to improve the understanding and academic achievement of basic education students. The use of AI chatbot integrated with case method provides flexibility in learning, allowing students to learn at their own pace and get more personalized feedback. This can overcome a variety of different learning styles in students. However, further research needs to be done to identify other factors that can influence the effectiveness of using AI chatbot to optimize the results, such as student characteristics, learning material design, and the quality of AI chatbot itself. In addition, it is also necessary to consider technical aspects such as the availability of the AI chatbot.

Conflicts of Interest

In this study all authors have no conflict of interest in the publication of this article.

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