

**THE EFFECT OF THE USE OF AI TECHNOLOGY (GPT Chat, Perplexity,  
Photomath, Canva), UNDERSTANDING OF SCIENCE CONCEPTS AND  
CRITICAL THINKING SKILLS IN SCIENCE LEARNING ON STUDENT  
LEARNING OUTCOMES IN PHASE D**

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**ABSTRACT**

*This study aims to analyze the effect of the use of artificial intelligence (AI) technologies such as ChatGPT, Perplexity, Photomath, and Canva on the understanding of science concepts, critical thinking skills, and learning outcomes of Phase D students in science learning. Rapid technological developments offer significant opportunities to integrate AI into education to create a more interactive, efficient, and adaptive learning environment tailored to students' needs. However, empirical studies examining the effectiveness of AI technology in science learning, particularly for Phase D students, are still limited. This study used a quantitative method with a descriptive correlational approach. The subjects were Phase D students involved in technology-based science learning. Data were collected through questionnaires, learning achievement tests, and interviews to obtain comprehensive information regarding the use of AI technology. Instrument validity and reliability tests were conducted to ensure data quality. Data analysis was conducted using descriptive and inferential statistical tests to examine the relationship between the use of AI technology and the variables studied. The results showed that the use of AI technology had a positive and significant effect on students' understanding of science concepts. Students who utilized ChatGPT, Perplexity, Photomath, and Canva demonstrated a better understanding of science concepts compared to students who only used conventional learning methods. Furthermore, the integration of AI technology also improved students' critical thinking skills, as reflected in their ability to analyze, evaluate, and solve problems logically and creatively. Overall, student learning outcomes showed significant improvement, confirming that the integration of AI technology positively contributes to the quality of science learning.*

**Keywords:** Artificial Intelligence, Understanding of Science Concepts, Critical Thinking Skills

### **A. Introduction**

Advances in information and communication technology have brought significant changes to the world of education, particularly in the way learning is designed and implemented. One of the most prominent developments is the application of artificial intelligence (AI), which enables the creation of more interactive, adaptive, and student-centered learning processes. In the context of science learning, the use of AI technology is becoming increasingly relevant, given the characteristics of science material that demands in-depth conceptual understanding and critical thinking skills in analyzing phenomena and solving problems.(Peter, nd)

In reality, science learning in schools is often dominated by conventional, teacher-centered methods, resulting in students being passive and having difficulty understanding abstract concepts. This situation results in low critical thinking skills and poor learning outcomes.(Brown & Harris, 2022). Science learning should encourage students to actively ask questions, analyze information, evaluate data, and draw logical conclusions.

Therefore, learning innovations are needed to address these challenges, one of which is through the integration of AI technology.

AI-based applications such as ChatGPT, Perplexity, Photomath, and Canva offer a wide range of potential in supporting science learning. ChatGPT and Perplexity enable students to obtain quick and interactive explanations of concepts, Photomath helps students understand the problem-solving process systematically, and Canva facilitates concept visualization through creative graphical representations.(Smith & White, 2023). The use of these applications is believed to help students build a better understanding of concepts and develop critical thinking skills needed in the digital age. However, empirical studies specifically analyzing the impact of AI technology on science concept understanding, critical thinking skills, and student learning outcomes, particularly in Phase D students, are still relatively limited (Kearney & Gilbert, 2022). Most studies emphasize general aspects of technology without comprehensively examining its impact on various science learning variables. This

situation indicates a research gap that requires further study.

Based on this description, this study aims to analyze the influence of the use of artificial intelligence (AI) technology such as ChatGPT, Perplexity, Photomath, and Canva on the understanding of science concepts, critical thinking skills, and learning outcomes of Phase D students. The results of this study are expected to provide practical benefits for teachers in designing innovative science learning as well as theoretical contributions in the development of AI-based learning studies.

The manuscript is written in Indonesian. It is typed using Arial (Microsoft Word) font with a 12-point font size on A4 paper, with 1.5 spacing, and the text is divided into two columns with the following paper margins: left and top margins of 30 mm, right and bottom margins of 25 mm.

In this section, explain the basic elements of the article being written, including a brief description of the background, research problem, research objectives, and research benefits. This section also describes the observed problem phenomena

and the actual conditions obtained, which can be supported by several theories. The next section can present data or facts that support the research and ideas. Then, the focus of the problem and the objectives of the research can be explained.

The sections mentioned above do not need to be outlined in separate bullet points. The clarity of these sections serves as the foundation for reviewers' assessment of submitted manuscripts.

## **B. Research Method**

This section explains the methodology used in the research which is considered necessary to strengthen the published manuscript.

This study uses a quantitative approach with an experimental method to measure the effect of using artificial intelligence (AI)-based technologies, such as ChatGPT, Perplexity, Photomath, and Canva, on students' understanding of science concepts, critical thinking skills, and learning outcomes. The experimental design used was a pretest–posttest control group design, which aimed to compare student learning outcomes before and after the implementation of AI-based learning.

The subjects of the study were Phase D students (grades VII–VIII) at MTs Al Huda Kediri, who were divided into two groups: an experimental class and a control class. The experimental class was given a treatment in the form of science learning with AI technology integration, while the control class underwent science learning using conventional methods without the use of AI technology. Before the treatment was given, both classes first took a pretest to measure students' initial abilities related to understanding science concepts and critical thinking skills. After the entire learning series was completed, students were given another posttest to determine improvements in learning outcomes after the treatment.

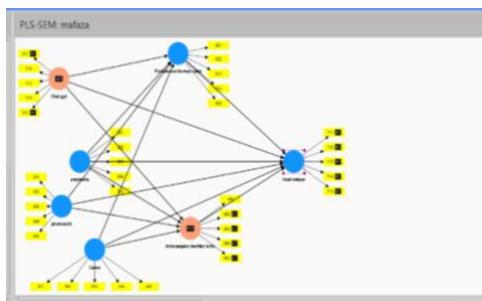
During the experimental class, students were guided to utilize various AI-based applications tailored to their learning objectives. ChatGPT was used to help understand theoretical science concepts, Perplexity was utilized to answer complex questions based on information retrieval, Photomath was used to systematically solve calculation problems, and Canva was used to present learning outcomes in visual formats such as infographics or presentations. This

integration of AI technology was designed to encourage active student engagement and develop critical thinking skills and a deeper understanding of concepts (Yilmaz & Durak, 2021).

Data collection was conducted using several techniques, including tests, observations, and questionnaires. Pretests and posttests were used to measure student learning outcomes. Observations were conducted during the learning process using observation sheets containing indicators of students' understanding of science concepts and critical thinking skills. Additionally, questionnaires were administered to students after the lesson to determine their perceptions of the effectiveness of using AI technology in science learning (Martin & Green, 2023).

Data obtained from the pretest and posttest were analyzed using N-Gain calculations to determine the level of improvement in student learning outcomes. Furthermore, questionnaire data and learning indicators were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with the assistance of SmartPLS 4.0 software to examine the relationship between

AI technology use, understanding of science concepts, critical thinking skills, and student learning outcomes. This method was chosen because it is able to analyze the relationship between variables simultaneously and comprehensively (Perez & Wallace, 2023).



### **C. Research Results and Discussion**

Briefly and clearly describe the results obtained and complete with a discussion that examines the results obtained with the supporting theory used.

the influence of the use of artificial intelligence (AI)-based technology in science learning on the understanding of science concepts, critical thinking skills, and learning outcomes of Phase D students. The variables used consist of exogenous and endogenous variables as follows.

1. AI Information TechnologyAI information technology in this research refers to the use of

artificial intelligence-based applications that support the science learning process in an interactive, adaptive, and problem-solving-based manner.

2. ChatGPTChatGPT is used as a learning medium to help students understand science concepts through questions and answers, material clarification, and in-depth conceptual explanations.
3. PerplexityPerplexity is used to help students find and understand scientific information accurately and answer complex, reasoning-based questions (Roberts & Young, 2023).
4. PhotomathPhotomath is used to help students solve science and mathematics problems systematically, thereby supporting problem-solving skills.
5. CanvaCanva is used as a visual medium to present science concepts through graphs, diagrams, and presentations, which support students' conceptual

understanding and critical thinking skills.

a) Science Concept Understanding Test Results. Science concept understanding was tested using pretests and posttests. The analysis showed a significant increase in students' understanding of science concepts after the implementation of AI technology in learning. Students who used ChatGPT, Perplexity, Photomath, and Canva demonstrated better abilities in identifying, explaining, and applying science concepts compared to those who did not use AI technology (Wang & Lee, 2023).

b) Critical Thinking Skills Test Results. Critical thinking skills were measured through a test that included analysis, evaluation, and conclusion-drawing skills. The results showed that the use of AI technology had a positive impact on students' critical thinking skills. The use of ChatGPT and Perplexity encouraged students to think analytically and reflectively, while Photomath and Canva helped students develop logical and visual thinking (Thomas & Walker, 2022).

c) Learning Outcome Test Results. Learning outcomes were analyzed by comparing student scores before and after the implementation of AI-based learning. The test results showed a significant improvement in student learning outcomes, both in test scores and active student engagement during the learning process, compared to conventional learning.

d) Outer Model Test Results (SEM-PLS)

1). Convergent Validity

Convergent validity was evaluated through loading factor values and Average Variance Extracted (AVE). All indicators had loading factor values  $\geq 0.7$  and AVE values  $\geq 0.5$ , thus being declared convergently valid.

Table 1. Convergent Validity (Loading Factor)

Indicator	Loading Factor	Criteria
ChatGPT	0.723	Valid
Perplexity	0.805	Valid
Photomath	0.789	Valid
Canva	0.711	Valid
Concept Understanding	0.752	Valid
Critical Thinking Skills	0.833	Valid
Learning outcomes	0.760	Valid

variables to adequately explain the indicator variance.

Table 2. Average Variance Extracted (AVE)

Latent Variables	AVE	Criteria
ChatGPT	0.521	Valid
Perplexity	0.623	Valid
Photomath	0.612	Valid
Canva	0.504	Valid
Concept Understanding	0.564	Valid
Critical Thinking Skills	0.691	Valid
Learning outcomes	0.548	Valid

## 2). Discriminant Validity

Discriminant validity was tested using cross-loading and showed that each indicator had the highest loading value on its respective construct compared to other constructs. This confirms that each indicator is capable of representing the latent variable specifically (Davis & Patel, 2021).

## 3). Average Variance Extracted (AVE)

The AVE value of all latent variables is above 0.5, which indicates the ability of the latent

## 4) Construct Reliability

Reliability was measured using Composite Reliability and Cronbach's Alpha. All latent variables had values  $\geq 0.7$ , thus being declared reliable.

Table 3. Composite Reliability and Cronbach's Alpha

Latent Variables	CR	Alpha	Criteria
ChatGPT	0.847	0.76	Reliable
Perplexity	0.893	0.822	Reliable

Photomath	0.87 1	0.80 6	Reliable
Canva	0.84 1	0.73 7	Reliable
Concept Understanding	0.87 3	0.80 1	Reliable
Critical Thinking Skills	0.91 4	0.85 9	Reliable
Learning outcomes	0.86 0	0.78 4	Reliable

#### Outer Model Interpretation

The results of the Outer Model test indicate that all indicators are valid and reliable in measuring the latent variables. Convergent validity, discriminant validity, and reliability have been met, thus making the measurement model suitable for use in Inner Model analysis (Ghozali, 2021). This finding aligns with SEM-PLS theory, which states that valid and reliable constructs are the primary prerequisites for testing structural relationships between variables.

Table 4 Experimental Class

N	Pre test ( $\bar{x}$ )	Pre test (S)	Posttest ( $\bar{x}$ )	Posttest (S)	N-Gain ( $\bar{x}$ )	N-Gain (S)
3	22.	6.4	68.5	24.8	0.	0.
6	10	5	0	0	60	14

Table 5 Control Class

N	Pre test ( $\bar{x}$ )	Pre test (S)	Posttest ( $\bar{x}$ )	Posttest (S)	N-Gain ( $\bar{x}$ )	N-Gain (S)
3	21.	6.3	58.2	23.1	0.	0.
6	80	0	0	0	43	25

Table 6 Pretest and Posttest of Experimental Class

Experimental Class	N	Pretest ( $\bar{x}$ )	Posttest ( $\bar{x}$ )	N-Gain
	3	21.8	74.20	0.6
	6	0		7

Supporting data:

Category	Pretest	Posttest
Lowest Value	12	68

The highest score	35	96
Average value	21.80	74.20

$$\frac{62,40 - 20,90}{100 - 20,90} = \frac{41,50}{79,10} = 0,53$$

#### **D. Conclusion**

Based on the results of the research that has been conducted, it can be concluded that the use of artificial intelligence (AI)-based technologies such as ChatGPT, Perplexity, Photomath, and Canva has a positive influence on the science learning of Phase D students. The use of AI technology has been proven to improve student learning outcomes through the presentation of more interactive and adaptive materials, thus making it easier for students to understand science concepts. In addition, AI technology contributes significantly to improving the understanding of science concepts because it is able to provide in-depth, varied explanations that are tailored to students' learning needs. The use of AI technology also encourages the development of students' critical thinking skills, which is reflected in their ability to analyze information, evaluate concepts, and solve problems logically and systematically. The integration of AI technology with appropriate pedagogical strategies has been proven to create a more

Table 7 Pretest and Posttest of Control Class

Control Class	N	Pretest ( $\bar{x}$ )	Posttest ( $\bar{x}$ )	N-Gain
	36	20.90	62.40	0.53

Supporting data:

Category	Pretest	Posttest
Lowest Value	11	55
The highest score	33	82
Average value	20.90	62.40

N-Gain Calculation

Formula:

$$N\text{-Gain} = \frac{\text{Posttest} - \text{Pretest}}{100 - \text{Pretest}}$$

Experimental Class

$$\frac{74,20 - 21,80}{100 - 21,80} = \frac{52,40}{78,20} = 0,67$$

Control Class

effective and enjoyable learning experience, thus supporting the success of the learning process optimally. Therefore, the use of AI technology in science learning needs to be continuously developed and further researched as an effort to improve the quality of education in the digital era.

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