

Correlation Between AI Usage and Students' Perceptions in Learning Kirchhoff's Law at Senior High School in South Jakarta

Rahma Amelia Oktapiani¹, Dwi Nanto^{1*}

¹Department of Physics Education, Universitas Islam Negeri Syarif Hidayatullah Jakarta, Indonesia

Corresponding Author: dwi.nanto@uinjkt.ac.id

Received: 01 March 2026. Accepted: 10 April 2026. Published: June 2026

Abstract

The Artificial Intelligence (AI) in Physics learning is growing. However, the correlation between AI usage and supporting students' understanding of basic electrical concepts, such as Kirchhoff's Law, still requires further investigation. The correlation between the level of AI usage and students' perceptions of its benefits in learning Kirchhoff's Law at several senior high schools was investigated in this study. Using an exploratory sequential mixed methods design, this study involved 250 students as quantitative respondents. They were divided into two groups based on their physics exam scores. One respondent represents the group that has a minimum of 80 points. Certainly, one respondent represents above or equal to more than 80 points. The questionnaire instrument was verified by two experts in the subject matter and educational technology. Quantitative results indicate that students' assessment of AI usage falls into the excellent category with an average indicator score of four. The groups with scores less than or equal to 80 tend to use AI more frequently and experience its benefits directly. Meanwhile, the groups with scores greater than 80 appear to have more experience in AI usage. Spearman's correlation analysis indicated a significant relationship between the frequency of AI usage and its preferences for the students. Qualitative results show that AI usage accelerates students' conceptual understanding of physics material, but they still have limitations in explaining complex Physics formulas. Overall, this research concludes that AI usage shows good potential in assisting the learning process of Kirchhoff's Law.

Keywords: Artificial Intelligence, Kirchhoff's Law, student perception, correlation, physics learning.

INTRODUCTION

The evolution of artificial intelligence (AI) has significantly changed various sectors, including education. The AI usage in education enables personalization, increased efficiency, and access to learning support at any time. Research indicates that AI supports students in understanding abstract ideas through tailored explanations, simulations, and data-based problem solving. Zinkiv, Kononova, Polska, Roshchenko, and Rozhnova (2025). Thus, the AI usage in the classroom has become a crucial teaching strategy to improve the quality of science learning, especially Physics.

Physics is known as a discipline that requires high analytical skills, especially on topics related to electrical circuit concepts, such as Kirchhoff's Law Podobnik (2025). Research according to Eisenberg states that Kirchhoff's Law material is often difficult

for students because it requires an understanding of the concepts of current, voltage, and the principle of charge conservation simultaneously Eisenberg (2023). Based on research Asmita, it is emphasized that teachers are expected to be able to create interesting and interactive learning media, so that students do not only remember formulas but also understand the underlying physical processes (Asmita, Kurniawan, Maison, Isnaini, & Sari, 2022). These difficulties in understanding the concepts of Kirchhoff's Law can be overcome. AI is the right choice to address these issues through step-by-step explanation features, customized practice questions, and visual simulations of electrical circuits.

Asmita also report many high school students are already familiar with using AI as a tool to easily understand the learning process as a

whole. Asmita et al. (2022). The AI usage also has variations, such as text-based applications like ChatGPT and voice-based applications like ElevenLabs. A research report by Savvytska and Vasileva (2025) explains that students use AI to seek clarification on material, ask about problem-solving procedures, and verify calculation results. However, the level of AI usage does not always correlate with the quality of students' conceptual understanding. Shaheen (2025). Based on these issues, it is necessary to examine the relationship between the frequency of AI usage and students' perception of its effectiveness in learning physics, particularly in Kirchhoff's Law material.

Students' perceptions are a crucial measure in evaluating the success of AI usage R. K. Raman and R. Raman (2022). Liu (2025) identifies that a generally positive perceptions of AI are influenced by ease of use, clarity of information, and AI's ability to understand students' questions. These factors also support AI's role as a collaborative learning partner that can influence students' motivation and learning strategies. Conversely, other work reports that the understanding of Physics concepts must be considered in terms of how much AI supports students in understanding the relationship between current and voltage in accordance with Kirchhoff's Law D. Domenichini et al. (2024). If students' perceptions are positive but not accompanied by an increase in understanding of physics concepts, this indicates the need for improvements in the AI usage in the learning context.

From a theoretical perspective, the application of artificial intelligence in Physics learning can be understood through various educational theories. According to constructivist learning theory, students actively develop their understanding of Physics through interaction, feedback, and reflection. Maulia and Widayatsih (2023). AI in Physics learning can serve as a helpful tool by providing immediate feedback and personalized explanations. Cognitive load theory indicates that complex Physics topics, such as Kirchhoff's Laws, can overwhelm students' working memory when they receive little instructional support. AI-based learning tools can lighten this cognitive load by offering step-by-step problem-solving procedures, visualizations of electrical circuits, and simpler explanations (Riantoni, Maison, & Pathoni 2025). From the perspective of self-regulated learning theory, AI can serve as an external support that helps students plan, monitor, and assess their learning strategies in Physics.

Thus, the effectiveness of AI in Physics learning depends not only on how often it is used but also on how students engage with it to improve their understanding of concepts.

AI in Physics learning can act as a cognitive tool that supports this process by giving immediate feedback and personalized explanations. In addition, cognitive load theory posits that certain Physics topics, like Kirchhoff's Laws, may overwhelm students' working memory if not adequately supported in the teaching process. Using AI-based learning tools can lessen learners' cognitive load with step-wise solution procedures, visualizations of electrical circuits, and simpler explanations (Riantoni, Maison, & Pathoni 2025). From the perspective of self-regulated learning theory, AI, therefore, is conceptualized as an external scaffold for students for planning, monitoring, and assessing their learning strategies in Physics. As a result, not just high-frequency use of AI, but also student engagement with it to assist with conceptual understanding in Physics learning, is closely related to the effectiveness of AI

METHOD

This research applied a mixed-method approach by combining quantitative and qualitative analysis, Creswell (2012), which states that the use of a mixed-method approach provides a better understanding of the research problem than using a single approach, such as a quantitative approach alone or a qualitative approach alone. The research design used in this study was an exploratory sequential mixed-method design. This research uses the method to present a comprehensive picture of the relationship between AI usage and students' perception of teaching Kirchhoff's Law at senior high schools in South Jakarta. A correlation survey was applied quantitatively involving 250 selected students. They were selected using random sampling to maintain proportionality in the distribution between schools and classes. The independent variable (X) was the AI usage in Physics teaching, while the dependent variable (Y) was students' perception of Kirchhoff's Law. Based on the study by Park (2024), it covers the frequency of AI use, AI utilization, communication, collaboration, and AI competence in its use. However, this research does not analyze AI communication.

The primary instrument for measuring the students' perception towards AI and how they may

utilize it consists of a 1–5 Likert scale question based on three indicators: frequency of usage, partner, and ability. The questionnaire had 4 indicators covering: (1) how often AI is used, (2) benefits of AI in Physics learning, (3) AI as a collaborative partner, and (4) competency of using AI. The items on the questionnaire are the frequency of using AI (items 1–3), benefits from using AI (items 4–7), co-operation using AI (items 8–10), and competence to use AI (items 11–14). The content validity was carried out by involving two experts, namely a physics learning expert and an expert in the field of education, in order to measure the quality of the instrument. Both experts evaluated the suitability of the indicators, the relevance of the questions, and the clarity of the language and sentence structure. The recommendations from both experts were applied to refine the measuring instruments before distribution. The validity of the instrument was analyzed using Aiken's V formula, and obtained validity scores ranging from 0.82 to 0.91, indicating that the instrument was categorized as highly valid. Reliability testing was conducted on 30 students outside the research sample using Cronbach's Alpha analysis, resulting in a reliability coefficient of 0.87, which indicated high reliability.

In addition to numerical data, our work also collected qualitative data through semi-structured interviews to support the survey results. Two informants were selected using purposive sampling based on their physics scores: Participant A (score

≤ 80) and Participant B (score > 80). Both were considered to represent two different academic performance groups, thus providing a more in-depth perspective on the experience of utilizing AI in learning Kirchhoff's Law. The observation sheet was developed based on four main indicators of AI usage in Physics learning. The indicators are represented through the following guidance statements: (1) AI usage frequency, represented by the statement "AI usage to help with physics learning, especially in Kirchhoff's Law material", (2) AI as a collaborative partner, represented by the statement "AI is very helpful in solving problems and providing useful recommendations in teamwork in physics learning", (3) AI benefits, represented by the statement "AI helps in explaining physics concepts in detail on Kirchhoff's Laws regarding current and voltage", and (4) AI usage competence, represented by the statement "Able to analyze and understand the capabilities and limitations of the AI I use". The observation instrument blueprint included indicators of AI usage behavior, collaborative interaction, conceptual understanding support, and students' competency in utilizing AI tools. The interviews covered their experiences, struggles, and wishful features that can assist in understanding electrical circuit concepts with the accuracy of what AI offers. Qualitative data were thematically analysed, and the quantitative and qualitative findings were merged in a discussion to provide deeper/greater insights into associations between variables.

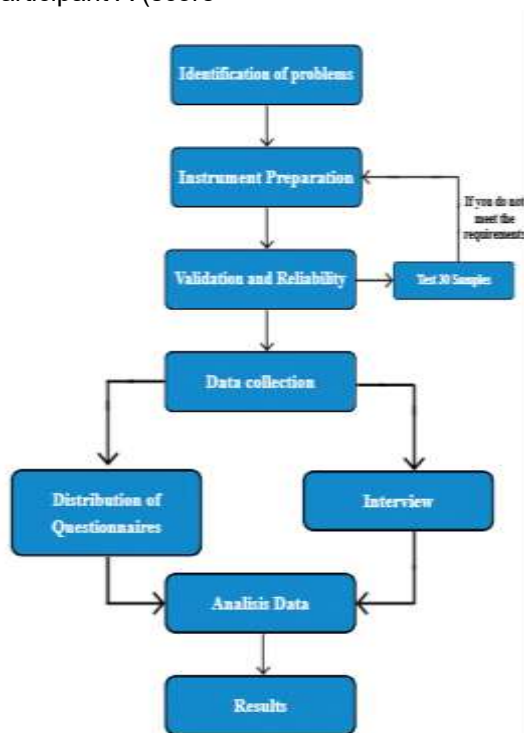


Figure 1. Data Collection Techniques

The data collection technique in this research involved several structured steps, as shown in Figure 1. The process began with problem identification. Initially, formulating research needs related to the AI usage in learning Kirchhoff's Law at some senior high schools in South Jakarta. After the problem was defined, the researchers developed instruments, such as perception questionnaires and interview guides, tailored to the research indicators. The instruments were then validated and tested for reliability by two experienced experts in the fields of Physics education and learning technology. If the instruments did not meet the criteria, improvements were made and tested on 30 respondents in a small sample to ensure the consistency of the questions. After being declared valid and ready for distribution, the next step was data collection, which was divided into two main methods: questionnaire distribution and interviews. The survey was distributed to 250 students to obtain a quantitative picture of the use frequency and utilization of AI and their perception of learning Kirchhoff's Law. Figures 2 and 3 are the process of collecting data. Meanwhile, interviews were conducted with two participants selected based on their grade categories, namely the > 80 category (Participant B) and the ≤ 80 category (Participant A), to gain a deeper understanding of their experiences using AI.

Table 1. AI-Assisted Learning Syntax in Kirchhoff's Law Learning

Phase	Learning Activities
Problem orientation	Students were introduced to Kirchhoff's Law problems related to electrical circuits.
AI exploration	Students used AI platforms such as ChatGPT or Google Gemini to obtain explanations regarding current and voltage concepts.
Collaborative discussion	Students discussed AI-generated answers in groups and compared them with textbook explanations.
Concept verification	Teachers guided students to verify formulas, calculations, and conceptual explanations generated by AI.
Problem solving	Students solved Kirchhoff's Law problems independently using AI as a supporting tool.
Reflection and evaluation	Students reflected on the advantages and limitations of AI in Physics learning.

Table 1 shows the steps in the learning process where the implementation of AI-assisted learning in Kirchhoff's Law material is carried out through several structured stages. Initially, students are introduced to contextual problems related to electrical circuits and the concept of Kirchhoff's Law. Next, students explore AI platforms such as ChatGPT and Google Gemini to obtain explanations, examples, and alternative solutions related to current and voltage analysis. After the exploration phase, students discuss the AI-generated responses collaboratively in groups and compare them with textbook material and teacher explanations. The teacher then guides students to verify formulas, calculations, and conceptual explanations to minimize misunderstandings generated by the AI. Next, students solve physics problems independently using AI as a learning tool. At the end of the learning process, students reflect on the advantages and limitations of using AI in understanding the concept of Kirchhoff's Law.

All information obtained was then analyzed through quantitative and qualitative data analysis processes, resulting in comprehensive findings regarding the relationship between AI use in Physics teaching. Quantitative data were analyzed using descriptive statistics and Spearman Rank Correlation analysis with SPSS version 26, while qualitative data were analyzed using thematic analysis through data reduction, coding, categorization, and interpretation.

RESULT AND DISCUSSION

This research was conducted from September to November 2025 at eleven high schools in South Jakarta. Four main indicators were analyzed to reflect students' perception of the use of AI in Physics learning, particularly Kirchhoff's law, which are AI usage frequency, AI benefits, AI role as a collaborative partner, and AI usage competence. These indicators were analyzed to answer the research problem regarding the relationship between AI usage frequency and students' perceptions of learning Kirchhoff's Law.



Figure 2. Data Collection at School

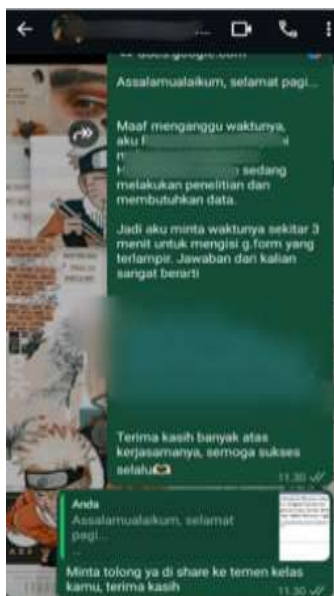


Figure 3. Data Collection via Social Media

1. Quantitative Description of Students' Perceptions of AI



Figure 4. Average Score of Students' Perceptions of The AI Usage in Learning Kirchhoff's Law Material Using a Likert Scale

The results reveal that students' perception of the use of artificial intelligence (AI) in Physics teaching is very positive. This fact is reflected in the average scores of the four main indicators, all of which are above 4 on a scale of 1–5. The findings of the overall quantitative analysis show that students have a positive attitude towards

understanding AI as an assistant tool in learning Physics. The highest score was given for the AI Benefits indicator, at 4.22, saying that the students believe that AI helps them to understand Physics material very well, solve problems, and learn more efficiently. Students feel that AI could get them concept explanations, sample questions, and feedback more quickly than traditional methods. Keshtkar et al. According to (2024, p. 7), students think about AI as supportive assistance tailored towards their learning styles that explains concepts better.

These findings bolster the speculation that the AI Usage Frequency Indicator, however, met the highest score of 4.19, as students frequently used AI platforms both inside and outside the classroom. This indicates AI is now among the learning habits of students. Applications such as ChatGPT, Photomath, Google Gemini, and other digital assistants (such as a notebook) allow students to practice more, ask questions about Physics, and check their understanding independently. Notably, the prevalence of AI use shows that students are comfortable with and acclimated to a digital learning environment.

Such conclusions support the hypothesis that the AI Usage Frequency Indicator, however, achieved the highest score of 4.19 since students used AI platforms on a daily basis for classroom and outside research. This means AI is a deadline by October 2023. in student learning methods. ChatGPT, Photomath, Google Gemini, and others (digital assistants such as a notebook) help students practice more and ask physics questions without the help of other people, but rather to check whether their understanding is correct. There is a growing use of AI being able to witness here, and it highlights that students are also getting used to the digital world and are accustomed to it.

Basch (2025) notes that this familiarity connects with positive views on AI's role in improving students' skills, leading to comfort and confidence in navigating the digital learning context. The findings suggest that integrating AI has gradually become part of students' digital learning culture.

The indicator of AI as a collaborative partner scored 4.16, showing that students see AI not just as a tool, but also as a discussion partner. They feel supported when using AI to check answers, explore alternative solutions to problems, discuss complex concepts, or expand ideas while working on projects. Figure 4 shows that AI is viewed as a way

to enhance the collaborative learning experience, even in a virtual setting. In Physics education, working with AI allows students to test hypotheses, visualize ideas, and understand complex physical phenomena. Arini et al. (2025) report that incorporating AI into Physics education greatly boosts students' understanding of Physics concepts. This finding addresses the research goal that AI is seen not merely as a technical tool but also as a collaborative learning partner. The final indicator, AI usage competence, achieved an average score of 4.17, suggesting that students are generally skilled at using various AI applications to aid their Physics learning. They can use essential functions like explaining concepts, solving problems, analyzing graphs, and conducting simple simulations. However, the data also reveals areas for improving skills, especially in evaluating information, such as distinguishing between valid and invalid sources and critically assessing AI responses from a scientific standpoint.

Table 2. Average Results Based on Score Groups

Indicator	Group >80	Group ≤80
Frequency of AI use	4.17	4.19
Benefits of using AI	4.08	4.18
The role of AI as a collaborative partner	4.2	4.21
AI usage competence	4.21	4.15

When they split up the students by scores into those above 80, and the rest at 80 or below, the view on AI in physics class came out high for both sides. Some parts of the questions showed different numbers, but overall, it seems like everyone rated the help with understanding the material and the way the learning went as pretty good. The results point to how the higher-scoring students and the others might go about using AI in different ways for physics. I think that part stands out, but maybe the details are not totally clear from just the grouping. Both groups still gave it decent marks, though, and that seems consistent even with the variations in the indicators.

On the AI usage frequency indicator, the high-achieving student group (>80) scored 4.17, slightly lower than the ≤80 group, which scored 4.19. These results indicate that students with moderate to low scores use AI more often, possibly because they need extra support in understanding Physics concepts and solving problems. Patel claimed that AI serves as an easily accessible alternative source when explanations from teachers

are considered inadequate, so its use becomes more frequent in this group Patel (2023). This finding suggests that AI functions as supplementary learning support, especially for students who experience conceptual difficulties.

The AI benefits indicator also shows a similar pattern. The >80 group scored 4.08, while the ≤80 group scored 4.18. This fact confirms that students with lower academic achievement feel greater direct benefits from using AI. Mustapa, Tri, and Santoso (2025) reported that AI was believed to provide quick feedback, easier-to-understand explanations, and examples of question variations that support students in better understanding basic Physics concepts. Meanwhile, the data shows that students with high achievements generally already have a better understanding, so the benefits of AI are still significant but not as great as for other groups. These findings strengthen the assumption that AI can help reduce learning barriers among students with lower academic achievement.

Unlike the two indicators mentioned above, in the indicator of AI role as a collaborative partner, both groups showed very similar scores, namely 4.20 for the >80 group and 4.21 for the ≤80 group. This fact shows that, in general, students at all achievement levels can use AI as a discussion partner in Physics learning. They utilize AI to check calculation results, ask for explanations of concepts, search for other methods, or discuss specific Physics phenomena. The small difference in scores indicates that students' perceptions of the collaborative function of AI are consistent. This finding indicates that collaborative perceptions toward AI are relatively similar regardless of students' academic achievement.

The AI usage competence indicator shows an interesting trend variation. The high performing group (>80) has a score of 4.21, which is higher than the ≤80 group, precisely score of 4.15. This finding shows that high-achieving students have better abilities in managing and assessing the use of AI. They are more capable of filtering relevant information, recognizing the limitations of AI, and strategically utilizing AI to improve analysis and solve problems. Meanwhile, the ≤80 group still demonstrates good competence, but they are more likely to use AI directly without in-depth evaluation. The findings indicate that academic achievement influences students' critical abilities in evaluating AI-generated information.

2. Qualitative Description of Students' Perceptions of AI

Based on the interview results, the author describes students' AI usage based on academic competence, grouped by score range, with a sample size of 2 respondents to represent each category. In this work, Participant A represents the group with a score of ≤ 80 , and Participant B represents the group with a score of >80 . The qualitative findings were intended to strengthen and explain the quantitative findings obtained from the questionnaire analysis.

a. The Role of AI as a Collaborative Partner

Students who have a score of 80 or below see AI as a tool with many limitations. Many students feel that any explanation or answer given by such AI needs to be verified with other learning sources, such as a textbook and a teacher. Consequently, they underestimate AI's capacity as a collaborative partner that can properly assist with the learning process. One participant stated that AI can only offer general information. Participant A stated, "For more detailed clarifications, I would prefer to refer to books or teachers." The statement indicates that students in this group still think of the AI's answers as not detailed, accurate, or reliable.

On the other hand, students who scored above 80 showed a more positive perception. They began to use AI as a collaborative learning partner, not just a tool. They utilized AI's explanations and feedback to hone their learning strategies, understand complex concepts, or strengthen their analysis. One participant said, "*I often use AI to get additional explanations of complex concepts, and it helps me understand the material more quickly*". AI is like a very effective assistant (Participant B). Research Oktapiani and Suwarna (2025) also confirm that AI plays a greater role as a tool to improve cognitive understanding. This finding suggests that students with higher academic achievement tend to use AI more strategically and analytically.

b. AI Enhances Physics Understanding at the Senior High School

Differences in opinion also emerged in the evaluation of AI's ability to improve understanding of Physics concepts. Students with scores ≤ 80 believed that AI did not have a significant impact on improving their understanding. They believe that understanding Physics is more influenced by self-motivation, individual practice, and conventional learning methods. One student stated, "*AI does not really help me improve my understanding of*

physics. I am more convinced that understanding comes from self-motivation and practice" (Participant A). The statement shows that students in this group consider the role of AI to be limited and not fully capable of replacing manual learning methods. This is compounded by the statement, "*I am still confused when given the answer from GPT, especially for Kirchhoff's circuit, but I don't know where the result comes from.*" The statement confirms that their perspective is still focused on the answer rather than on how to analyze the process, especially in Kirchhoff's Law material. This is confirmed in the study of Baksa, Konecki, and Konecki (2024), which states that no AI can replace humans in education. Another study reported by Satria and Saputra (2025) also stated that AI was only a tool to assist in the learning process, helping in traditional learning, especially in motivating students to solve problems.

Conversely, students who scored >80 showed a much more optimistic view of the role of AI in improving their understanding of Physics. They felt that AI helped explain concepts, provided alternative explanations, and accelerated their understanding of the material. One participant said, "*AI makes it very easy for me to learn physics. With AI, I can improve my knowledge and get quick and accurate answers*" (Participant B). The statement shows that high-achieving groups utilize AI as a means of academic support and as a learning resource that can deepen their overall understanding of Physics concepts. Research Vrdoljak (2024) highlights that high-achieving groups can utilize AI as an academic support tool to improve their understanding of Physics concepts.

c. Limitations of AI in Supporting Learning

When they split up the students by scores into those above 80, and the rest at 80 or below, the view on AI in physics class came out high for both sides. Some elements of the questions showed a difference in grades, but overall, they all seemed to think the help with understanding the material and the way it was learnt was pretty good. The findings indicate how students who scored higher and those who scored lower differ in their modes of using AI for physics. I believe that particular element is highlighted, but the finer points may not show up clearly in the grouping. Even though there were some differences in the indicators, both divisions gave a decent mark, and that seems consistent.

Using participant B as an example, one participant who gets a score of 80 also experiences something similar. According to this participant, the

equations given on AI do not match the teacher explanations. This indicates that the problem-solving steps can become different from those learned in the classroom. It looks like that difference may bring about some confusion. Formulas provided by artificial intelligence (AI) are often vague, which complicates students' understanding of the physics content. I believe the restrictions here are more extensive than whether the responses are correct.

d. AI Solutions in Supporting Learning

Students had some ideas about what future AI should do to help with physics. They wanted better ways to break down those hard formulas into something easier to follow step by step. It seems like both groups had this in mind, even though their scores were different. One person mentioned that AI needs to explain things with formulas in a basic way. That probably means showing how the math works out and not just giving the final answer. I think that is important because understanding the reasoning matters a lot here. Another student talked about there being AI that can handle tough physics formulas. Maybe it should also fit better with what is taught in class, and understand the bigger picture instead of just solving problems. Some details on how that would actually work still feel unclear to me.

Recognizing this need, future AI development must focus on integrating mathematical analysis skills with responsive teaching methods. By receiving direct input from students, AI can evolve into a tool that not only answers questions but also becomes a learning companion capable of:

1. Providing structured work procedures.
2. Explaining formulas conceptually.
3. Tailoring answers to school educational criteria.
4. Helping students improve their confidence in understanding Physics concepts.

If those suggestions were implemented in AI development, then AI would not only function as a tool but also play a vital role in a more effective and inclusive Physics learning process.

e. Comparison of Samples in AI Utilization

Differences between the two samples when searching for solutions using AI are depicted in Figures 5 and 6.

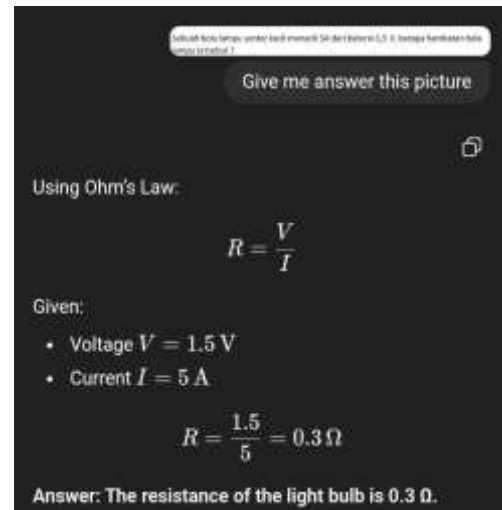
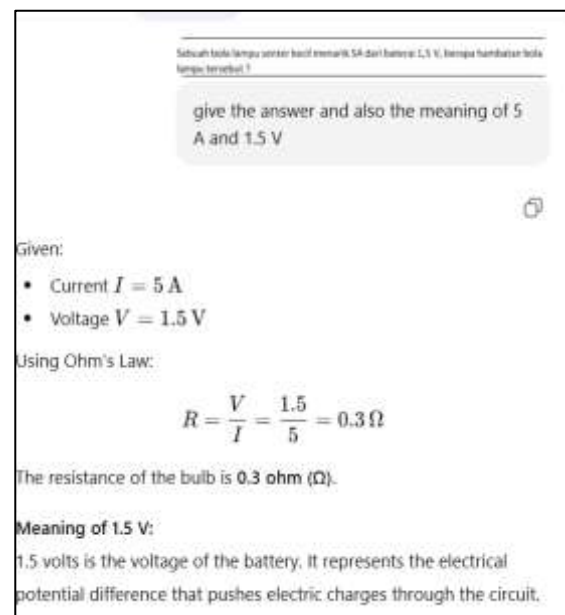
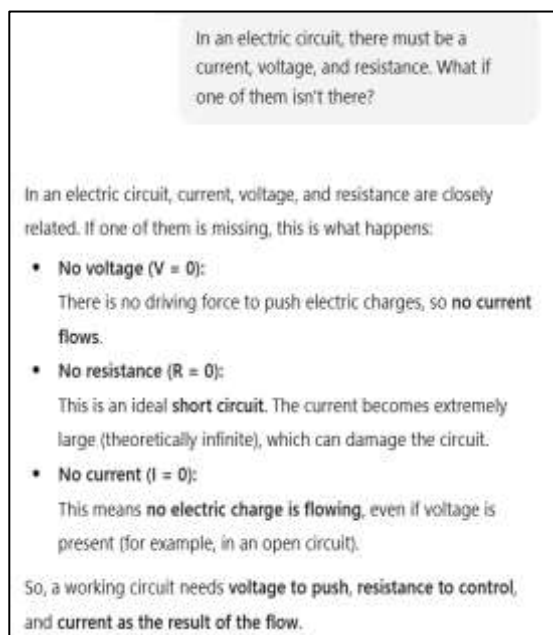


Figure 5. Samples in The ≤ 80 Category



(a)



(b)

Figure 6. (a). Fundamental Questions about Kirchhoff's Law. (b). Further Verify Questions about Kirchhoff's Law. Samples in The Score of >80 Category

Observations show that students in the ≤ 80

Table 3. Correlation between AI Usage Frequency and Three Indicators

Spearman's Rho	AI Usage Frequency	Correlation	AI Benefits	AI Role as a Collaborative Partner	AI Usage Competencies
		Correlation coefficient	0.359	0.063	0.314
		Sig. (2-tailed)	<0.0001	<0.0001	<0.0001
		N	225	228	227

Differences between groups based on students' physics exam scores are reflected not only in their level of Physics concept understanding, but also in how they position AI as a partner and their digital literacy skills in utilizing technology as a learning tool.

Based on Spearman's correlation analysis, it was found that the level of AI usage has a significant relationship with the three tested indicators, although the strength of the relationship between variables varies. First, the relationship between the frequency of AI usage and the AI Benefits indicator shows a correlation coefficient of 0.359 with a significant score of $p < 0.001$, which indicates a fairly strong and significant positive relationship. This finding indicates that the more often students utilize AI, the higher their preference and intensity in using the technology as part of the learning process.

In the second indicator, namely the AI role as collaborative partner, the relationship obtained was

category tend to use AI to find answers directly.

They follow predetermined procedures without re-verifying or delving deeper into concepts, resulting in a limited understanding of the relationships between Physical quantities such as current, voltage, and resistance. This one-way interaction suggests that AI is not yet being used as a learning partner, but rather as a tool to provide direct solutions. Students in the >80 category demonstrate a more proactive and collaborative pattern of AI use. They not only seek answers but also ask clarifying questions, request conceptual explanations, and examine relationships between Physics variables. This indicates that AI functions as a supportive discussion partner to enhance understanding and enrich thinking, as shown in Figure 6 (b).

In addition to a deeper understanding, the group >80 also demonstrated more developed AI skills, as evidenced by their ability to formulate relevant questions, manage ongoing dialogue, and analyze information conveyed by the system.

very weak with a coefficient of 0.063, but still statistically significant with $p < 0.001$. This fact shows that how often AI is used does not directly affect students' attitudes toward accepting AI as a collaborative partner. In other words, even though students frequently use AI, their perception of AI as a collaborative partner in learning does not increase significantly. Other aspects, such as learning experience, understanding of the ethics of AI usage, and students' level of trust in technology, are likely to have a greater influence on this indicator.

Furthermore, the relationship between the AI usage frequency and the AI usage competency indicator shows a correlation coefficient of 0.314 with a significance of $p < 0.001$, which also reflects a positive and significant relationship. In other words, the more often students use AI, the more their ability to complete tasks, conduct independent assessments, and reflect on the learning process improves. AI appears to provide assistance in terms of efficiency and quality of task completion,

for example, by providing quick feedback, examples of problem solving, or explanations of physics concepts that are easier to understand.

These correlational results support the findings: the frequency of AI utilization has a positive and significant relationship with its preference and intensity of use ($r = 0.359$; $p < 0.001$) and also correlates positively with understanding of AI characteristics ($r = 0.314$; $p < 0.001$). However, the relationship between attitudes toward accepting AI as a collaborative partner is weak ($r = 0.063$), indicating that even though students frequently use AI, not all students see it as an equal learning partner.

Overall, these findings indicate that the frequency of AI use has a significant effect on students' preferences for use and task performance but does not significantly affect the AI role as a collaborative partner. These results imply that the application of AI in Physics learning must be accompanied by teaching strategies that motivate students to not only use AI as a technical tool but also as a collaborative tool that supports the development of scientific communication and critical thinking.

CONCLUSION

The research findings indicate that the use of artificial intelligence (AI) in teaching Kirchhoff's Law in South Jakarta senior high schools has a positive relationship with students' perceptions, although the intensity varies across indicators. Overall, students gave very positive assessments of the use of AI, as shown by an average perception score exceeding 4.00. AI is considered capable of helping students understand electrical circuit concepts through quick explanations, visualizations, and more efficient problem solving, especially for students with academic scores ≤ 80 who feel the most benefit. These findings indicate that AI-assisted learning can support students' conceptual understanding and provide alternative learning assistance in Physics education.

Qualitative findings reveal differences in students' perspectives based on academic achievement levels. Students with higher academic performance (> 80) generally utilize AI more strategically as a collaborative learning partner to gain deeper conceptual understanding, whereas students with scores ≤ 80 tend to perceive AI as a supporting tool that still requires verification through teachers or textbooks. Both groups identified

several limitations of AI, particularly in explaining complex Physics formulas, leading students to expect AI systems that are more educational, structured, and compatible with Physics learning standards. These findings indicate that teacher assistance and digital literacy remain essential in helping students critically assess information generated by AI.

Overall, this study demonstrates that AI usage has an important role in supporting the learning of Kirchhoff's Law and fostering positive student perceptions, especially regarding its usefulness and frequency of use. Nevertheless, improvements are still required in optimizing AI as a collaborative learning partner, particularly in terms of the accuracy and pedagogical quality of Physics explanations, so that AI integration can be implemented more effectively in 21st-century learning environments. Therefore, future implementation of AI in Physics education should emphasize not only technological development but also the enhancement of students' critical thinking abilities, conceptual understanding, and scientific reasoning skills.

REFERENCES

- Asmita, Dela Yulianti , Dwi Agus Kurniawan , Maison , Nurul Isnaini, K. N., & Sari, I. D. P. (2022). Analysis of Teacher Problems in Implementing Learning Media in Physics Subjects at MAN 1 Tanjung Jabung Barat Asmita1). *Jurnal Pendidikan MIPA*, 12, 170–177.
- Baksa, T., Konecki, M., & Konecki, M. (2024). *High School Students' Perception of AI and Its Future Impact on Education*. <https://doi.org/10.1109/ICIET60671.2024.1054275410542754>
- Basch, C. (2025). *Artificial Intelligence In Higher Education: Student Knowledge, Attitudes , And Ethical Perceptions In The United States*. 6(February).
- Creswell, J. W. (2012). *Table of Contents PART I - Preliminary Considerations*.
- D. Domenichini, A. Bucchiarone, F. Chiarello, G. S. and G. F. (2024). An AI-Driven Approach for Enhancing Engagement and Conceptual Understanding in Physics Education. *IEEE Global Engineering Education Conference (EDUCON)*, 1–3. <https://doi.org/https://doi.org/10.1109/educon60312.2024.10578670>
- Eisenberg, R. (2023). *Circuits, Currents, Kirchhoff, and Maxwell*. <https://doi.org/10.32388/L9QQSH.3>
- Keshtkar, F., Rastogi, N., Chalarca, S., Ahmad, S., Bukhari, C., & Science, C. (2024). *AI Tutor: Student's Perceptions and Expectations of AI-*

Driven Tutoring Systems: A Survey-Based Investigation.

- Liu, Y. (2025). *Education : A Six C's Perspective*. 0, 54–59. <https://doi.org/10.54254/2753-7048/2025.LD27054>
- Maulia, N., & Widayatsih, T. (2023). *Physics Learning using Constructivism Approach in Palembang High School*. 2(2), 210–223.
- Mustapa, A., Tri, J., & Santoso, B. (2025). *Improving Grade X Students' Understanding Of The Concept Of Scarcity*. 13(3), 259–272.
- Oktapiani, R. A., & Suwarna, I. P. (2025). *Integration of Artificial Intelligence (AI) in Moral Learning for Physics Education Students at UIN Syarif Hidayatullah Jakarta*. 2(1), 253–260.
- Park, H. (2024). *Developing a Lesson Plan for Pre-Service Elementary School Teachers through Collaboration with AI: Focusing on ChatGPT Collaborating with AI to create a physics lesson plan for pre-service elementary school teachers: Focusing on ChatGPT*. 74(2).
- Patel, K. D. (2023). Review of Artificial Intelligence Applications and Modelling AI Framework in Education System. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*. <https://doi.org/https://doi.org/10.32628/cseit2390542>
- Podobnik, T. (2025). *Concepts of Electric Circuit Analysis Revised: Analysis without Current Direction*. 1–7.
- Raman, V. V. R. K. and R. (2022). Student Perceptions on Artificial Intelligence (AI) in higher education. *IEEE Integrated STEM Education Conference (ISEC)*, 450–454. <https://doi.org/10.1109/ISEC54952.2022.10025165>.
- Riantoni, C., Maison, M., & Pathoni, H. (2025). *AI-scaffolded DC electricity: Simple engineering experiments with ChatGPT to foster higher-order thinking skills Listrik DC berbantuan scaffolding AI: A simple engineering experiment with ChatGPT to improve higher-order thinking skills..* 08(November), 549–567. <https://doi.org/10.24042/ijsme.v8i3.28832>
- Satria, F., & Saputra, R. H. (2025). *Analysis of Student Perceptions of the Use of Artificial Intelligence in Learning in the Digital Age*. Riicis 2024.
- Savytska, I., & Vasileva, V. (2025). *Application of Artificial Intelligence to Automatically Verify Student Calculations in Higher Education Institutions*. 3, 283–288.
- Shaheen, F. (2025). *Relationship Between Generative Artificial Intelligence Tools and Conceptual Understanding among Undergraduate Students Literature Review*. 13(02), 388–395. <https://doi.org/10.52131/pjhss.2025.v13i2.2874>
- Wahyu Arini, Yaspin Yolanda, O. P. U. G. (2025). The Utilization of Artificial Intelligence (AI) in Physics Learning for Physics Education Students. *Jurnal Penelitian Pendidikan IPA*, 11(5). <https://doi.org/10.29303/jppipa.v11i5.11552>
- Zinkiv, I., Konovalova, I., Polska, I., Roshchenko, O., & Rozhnova, T. (2025). *Integration of Artificial Intelligence into the Curricula of Higher Education Institutions Integración de la Inteligencia Artificial en los Planes de Estudio de las Instituciones de Educación Superior*. <https://doi.org/10.62486/latia2025300>