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ANALYSIS OF CHATGPT-5'S SCIENTIFIC EXPLANATION ABILITY IN SOLVING DIRECT CURRENT CIRCUIT PROBLEMS

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Abstract

This study examined GPT-5's ability to construct scientific explanations when solving direct-current (DC) circuit problems. The analysis focused on whether the model could provide correct claims, relevant evidence, and logically connected reasoning grounded in physics concepts. A qualitative descriptive design was employed, with GPT-5 accessed through ChatGPT Plus as the unit of analysis. The model responded to six image-based multiple-choice items adapted from a basic DC-circuit assessment. The items addressed electric current, potential difference, and electric power as represented by bulb brightness in series and parallel circuits. To standardize the elicited responses, each item was presented in a new conversation together with the same structured prompt requiring a claim, evidence, and reasoning. The responses were evaluated using an analytic rubric with a maximum score of five per item. GPT-5 obtained 30 out of 30 points, corresponding to 100% across the six items. Its responses consistently selected the correct option, applied appropriate equations and circuit principles, and connected the evidence to the claim through coherent reasoning. These findings indicate that, under the specific prompting conditions and limited item set used in this study, GPT-5 demonstrated strong scientific explanation performance in basic DC-circuit contexts. Nevertheless, the findings should not be generalized to other physics topics, prompt formats, or AI systems without further investigation.
Keywords: Scientific explanation ability, ChatGPT, Direct current circuit.

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INTRODUCTION

Contemporary science education increasingly emphasizes not only conceptual knowledge but also participation in scientific practices. This emphasis is reflected in major reform documents, including the Framework for K-12 Science Education and the Next Generation Science Standards, which position scientific and engineering practices as central components of science learning. These practices include asking questions, developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations, engaging in argument from evidence, and communicating information (National Research Council, 2012; Costa & Broietti, 2021).

Constructing scientific explanations is one of the most important of these practices. A scientific explanation describes what occurs and accounts for why it occurs by coordinating a claim, supporting

evidence, and reasoning that links the evidence to accepted scientific principles. This claim-evidence-reasoning structure provides a useful framework for evaluating not only students' understanding but also the quality of explanations produced by artificial intelligence systems (Sandoval & Reiser, 2004).

The rapid development of artificial intelligence (AI) has intensified interest in its use in educational settings. Recent studies suggest that AI-supported learning environments can provide individualized feedback, identify misconceptions, and support students' conceptual understanding in science (Chen et al., 2020; Almasri, 2024). In physics education, these capabilities are particularly relevant because many topics require learners to coordinate verbal explanations, visual representations, equations, and conceptual models. The integration of AI into educational environments has gained considerable attention in recent years, as AI technologies are increasingly recognized for their ability to provide personalized feedback, identify students' misconceptions, and support the overall learning process (Yilmaz et al., 2023; Buabeng, 2018).

ChatGPT is among the most widely used generative AI applications in education. It can respond conversationally, generate explanations, and assist users with a broad range of academic tasks. Previous research has reported that students generally perceive ChatGPT as accessible and useful for learning (Maulana et al., 2023; Valova et al., 2024). At the same time, its educational use raises important concerns. AI-generated responses may contain inaccurate, biased, or overconfident statements, and performance can vary substantially across question formats and physics topics (Clark, 2023; Misnawati, 2023; Lopez & Junior, 2024).

These concerns are especially important when physics problems contain diagrams or require visual interpretation. Polverini and Gregorcic (2024), for example, found that ChatGPT's performance on the Test of Understanding Graphs in Kinematics was broadly comparable to that of students, but the model exhibited weaknesses in visual graph interpretation and reasoning. Similarly, Aldazharova et al. (2024) reported that generative AI can solve many physics problems correctly while still producing false-positive or false-negative reasoning patterns. Thus, answer accuracy alone is insufficient; the structure and scientific quality of the explanation must also be evaluated. Thus, answer accuracy alone is insufficient; the structure and scientific quality of the explanation must also be evaluated. In addition, ChatGPT has been recognized as an accessible tool capable of providing useful responses as a learning resource (Chellappa & Luximon, 2024).

DC circuits provide a suitable context for this analysis because they require coordinated reasoning about current, potential difference, resistance, series and parallel connections, and electric power. These concepts are fundamental in school physics and closely connected to everyday electrical phenomena. They also frequently produce misconceptions, making the quality of an explanation particularly important.

A preliminary trial conducted before the main study showed that GPT-5 did not perform uniformly across two DC-circuit questions. On one item, the model produced a correct claim, appropriate calculations, and coherent reasoning. On another, it provided relevant evidence but expressed uncertainty and selected an incorrect claim. This variability reinforced the need for a systematic analysis using a consistent prompt and a defined explanation rubric. The emergence of ChatGPT has changed science education, requiring educators to reconsider its use, limitations, and implications for teaching (Cooper, 2023).

Although several studies have investigated ChatGPT's ability to answer physics questions, relatively little research has examined GPT-5's scientific explanations specifically through a claim-evidence-reasoning lens in image-based DC-circuit tasks. Accordingly, this study aimed to analyze GPT-5's scientific explanation performance in solving basic DC-circuit problems. The findings are expected to provide empirical evidence for educators considering the use of generative AI as a supporting resource in physics teaching and learning.

METHOD

This study employed a qualitative research design. Qualitative research is an approach used to explore and understand the meaning of data obtained from individuals or groups concerning social and human issues (Rafiqoh & Zulhawati, 2020). The subject of this study was GPT-5 accessed through ChatGPT Plus, available on the ChatGPT platform during the period in which the research was conducted, to answer questions on direct current electric circuits. This model was selected because of its natural language capabilities, enabling it to generate logical and contextually appropriate responses. In understanding statements and answering questions, GPT-5 draws upon a wide range of information sources, allowing it to provide scientific explanations. In addition, GPT-5 is capable of generating responses that meet the required context while presenting explanations in clear and simple language.

The research instrument consisted of six multiple-choice questions accompanied by reasoning prompts, adapted from Balta and Logman (2022). The direct current electric circuit questions focused on the concept of Ohm's law, with Questions 1 and 2 assessing the concept of electric current, Questions 3 and 4 assessing the concept of voltage, and Questions 5 and 6 assessing the concept of electrical power (lamp brightness). The questions involved both series and parallel circuits. Therefore, the findings provide an overview of GPT-5's performance on these specific concepts and cannot be generalized to all areas of physics. The multiple-choice questions required GPT-5 to provide scientific explanations consisting of a claim, in the form of the answer to the question; evidence, in the form of facts supporting the claim through both conceptual and mathematical reasoning; and reasoning, in the form of a logical connection between the evidence and the claim, linked to everyday life.

Data were collected by presenting each question to GPT-5 in the form of an image. Each question was submitted in a separate chat session using the same prompt to ensure that the response to each question was not influenced by the context of previous questions or answers. All responses generated by GPT-5 were documented in full during the problem-solving process and subsequently analyzed using an assessment rubric. Data analysis was conducted using an assessment rubric designed to evaluate GPT-5's ability to construct scientific explanations for the given questions based on specific criteria, including claims, evidence, and reasoning, adapted from Lange (2022), as presented in Table 1.

Table 1. Scientific Explanation Scoring Rubric

Component	Assessment Indicator	Max Score
Claim	ChatGPT does not select an answer	0
	ChatGPT selects the correct answer	1
Evidence	ChatGPT does not provide evidence, such as calculations	0
	ChatGPT provides one or more pieces of evidence, such as calculations, but they are incorrect	1
	ChatGPT provides one or more correct pieces of evidence, such as accurate calculations	2
Reasoning	ChatGPT does not provide reasoning, provides incorrect reasoning, or fails to establish a connection between the claim and the evidence	0
	ChatGPT provides reasoning that is inaccurate or does not adequately connect the claim with the evidence	1
	ChatGPT provides accurate reasoning that logically connects the claim with the evidence	2
Maximal Score		5

The assessment covered three aspects: claim, evidence, and reasoning. The scores obtained were then categorized using criteria adapted from Purwanto (2001) and Kurnianingrum (2021), as presented in Table 2.

Table 2. Interpretation of Percentage Scores

Percentage Score	Modified Category	Original Category
NP > 75%	High	Very Good & Good
59% < NP ≤ 75%	Moderate	Fair
NP ≤ 59%	Low	Low Poor & Very Poor

The results of the analysis are presented descriptively to illustrate the quality of GPT-5's scientific explanations, supported by the scores obtained.

RESULTS AND DISCUSSION

This study presents a qualitative analysis of GPT-5's ability, through ChatGPT Plus, to provide scientific explanations when solving direct current electric circuit problems. The analysis was conducted based on three aspects: claim, evidence, and reasoning. The research data were obtained from six test items representing three indicators of Ohm's law concepts, namely electric current, voltage, and electrical power (lamp brightness). The questions were presented in the form of images (Figures 1, 4, and 6) accompanied by a prompt (Figure 2) to ensure consistency in the responses generated. Each response produced by GPT-5 was then analyzed using the assessment indicators presented in Table 1, including claim, evidence, and reasoning. The assessment results showed that GPT-5 achieved a scientific explanation ability score of 100%, which falls into the high category, as presented in Table 3.

Table 3. GPT-5 scores across the six DC-circuit items

No	Maximal Score	Claim	Evidence	Reasoning	Total Score
1	5	1	2	2	5
2	5	1	2	2	5
3	5	1	2	2	5
4	5	1	2	2	5
5	5	1	2	2	5
6	5	1	2	2	5
Total Score					30

The findings indicate that GPT-5 demonstrates a high level of ability to construct scientific explanations when solving direct current electric circuit problems. To provide a more comprehensive understanding of GPT-5's scientific explanation ability, further analysis was conducted for each concept indicator. Each indicator was evaluated based on the aspects of claim, evidence, and reasoning, allowing the characteristics of GPT-5's responses to be examined in greater depth.

Performance on Electric-Current Items

The questions on the electric current comparison indicator were designed to assess GPT-5's ability to provide scientific explanations regarding the magnitude of electric current flowing through a circuit. The question used for this indicator is presented in Figure 1.

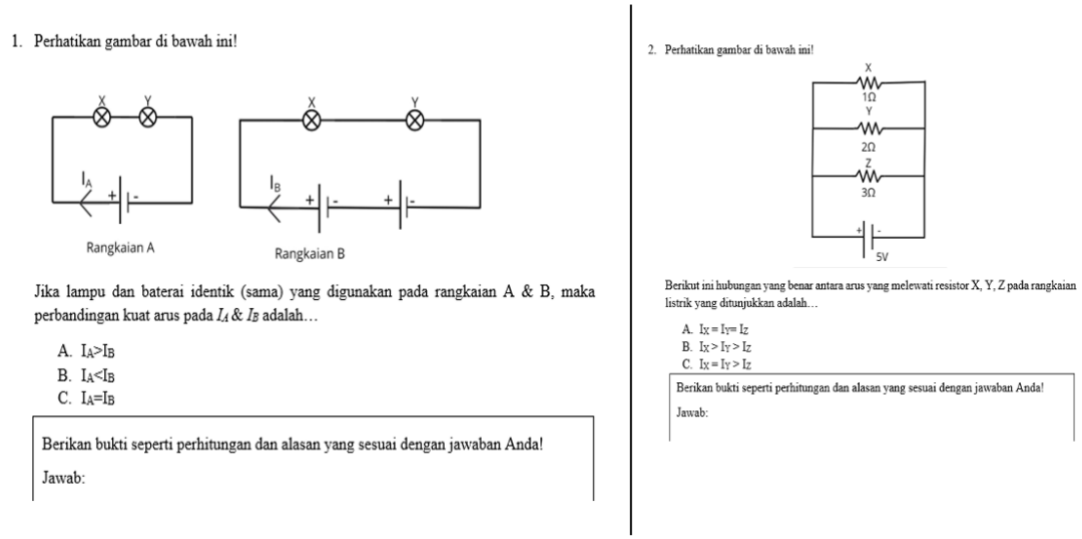


Figure 1. Question on the electric current comparison indicator

Next, the prompt used in this study was provided to GPT-5 for all questions as a structured instruction to guide the model in solving each problem systematically, as shown in Figure 2.

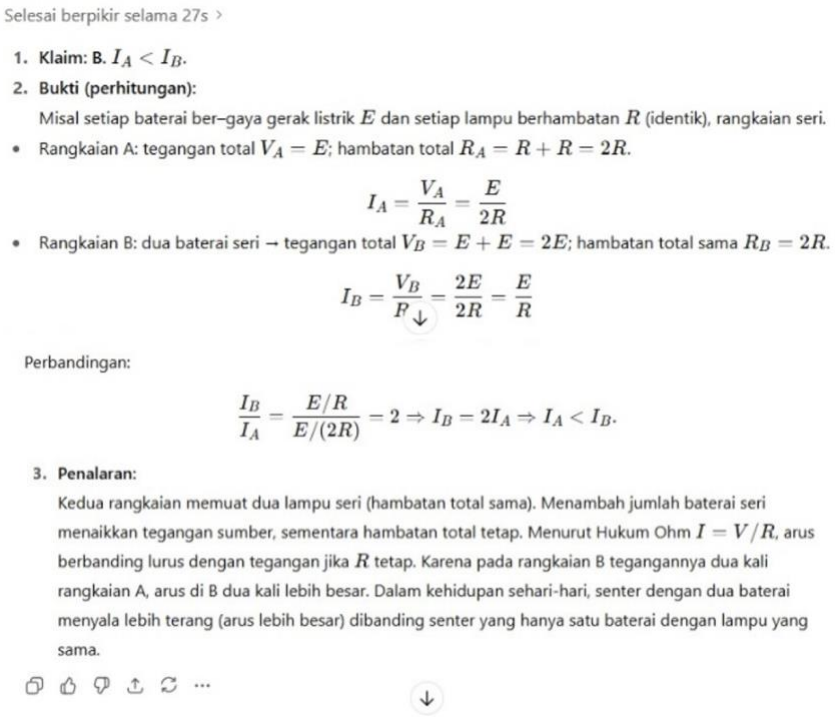
Bacalah soal berikut dengan cermat dan teliti.

Tugasmu adalah menjawab soal tersebut berdasarkan format:
1. Klaim berupa pilihlah jawaban yang paling tepat dari ketiga opsi tersebut meliputi A, B dan C
2. Memberikan bukti yang mendukung dari pilihan jawaban tersebut berupa perhitungan sesuai dengan konsep
3. Memberikan penalaran berupa alasan yang lengkap dan logis yang bisa dihubungkan dengan kehidupan sehari².

Tuliskan dengan bahasa yang jelas, sistematis dan sesuai dengan konsep rangkaian arus listrik searah. Tunjukan kemampuan menjelaskan secara ilmuah dan jangan menambahkan penjelasan lain diluar format tersebut

Figure 2. Prompt used for the electric current comparison indicator

After receiving the question and the prompt, GPT-5 generated the response shown in Figure 3.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1. **Klaim:** B. $I_A < I_B$.
2. **Bukti (perhitungan):**
   Misal setiap baterai ber–gaya gerak listrik E dan setiap lampu berhambatan R (identik), rangkaian seri.
   - Rangkaian A: tegangan total $V_A = E$; hambatan total $R_A = R + R = 2R$.

$$I_A = \frac{V_A}{R_A} = \frac{E}{2R}$$

   - Rangkaian B: dua baterai seri → tegangan total $V_B = E + E = 2E$; hambatan total sama $R_B = 2R$.

$$I_B = \frac{V_B}{R_B} = \frac{2E}{2R} = \frac{E}{R}$$

Perbandingan:

$$\frac{I_B}{I_A} = \frac{E/R}{E/(2R)} = 2 \Rightarrow I_B = 2I_A \Rightarrow I_A < I_B.$$

3. **Penalaran:**
   Kedua rangkaian memuat dua lampu seri (hambatan total sama). Menambah jumlah baterai seri menaikkan tegangan sumber, sementara hambatan total tetap. Menurut Hukum Ohm $I = V/R$, arus berbanding lurus dengan tegangan jika R tetap. Karena pada rangkaian B tegangannya dua kali rangkaian A, arus di B dua kali lebih besar. Dalam kehidupan sehari-hari, senter dengan dua baterai menyala lebih terang (arus lebih besar) dibanding senter yang hanya satu baterai dengan lampu yang sama.

Figure 3. GPT-5's response to the electric current comparison indicator

As shown in Figure 3, GPT-5 provided an accurate, clear, and comprehensive explanation. GPT-5 selected option B IA<IB as its claim. It explained that although the bulbs have identical resistance, the number of batteries differs between circuits A and B. Since the voltage in circuit B is greater than that in circuit A, the electric current in the circuit with two batteries is greater than that in the circuit with only one battery. This explanation is consistent with Ohm's law (I = V/R), which states that electric current is directly proportional to voltage (Giancoli, 2014). GPT-5 further strengthened its explanation by providing an example from everyday life, making the concept more contextual and easier to understand. The response received a score of 5 out of 5, indicating that GPT-5 provided accurate claims, evidence, and reasoning.

These findings indicate that GPT-5 is not only capable of generating appropriate responses but also of presenting them in a systematic structure while applying physics concepts logically and coherently. In addition to demonstrating a high level of scientific explanation ability and conceptual communication, GPT-5 provides in-depth and comprehensive explanations of scientific concepts (Azizah & Mansyur, 2024). This capability was also consistently observed in the second question, where GPT-5 again provided claims, evidence, and reasoning consistent with Ohm's law, explaining that electric current is inversely proportional to resistance and that the voltage across a parallel circuit remains the same (Halliday, Resnick, & Walker, 2014). Nevertheless, the quality of these responses should be interpreted within the scope and limitations of the present study.

Performance on Voltage Items

The questions on the voltage indicator were designed to assess GPT-5's ability to provide scientific explanations regarding the potential difference across an electric circuit. The question used for this indicator is presented in Figure 4, which was intended to examine how GPT-5 responded to the problem.

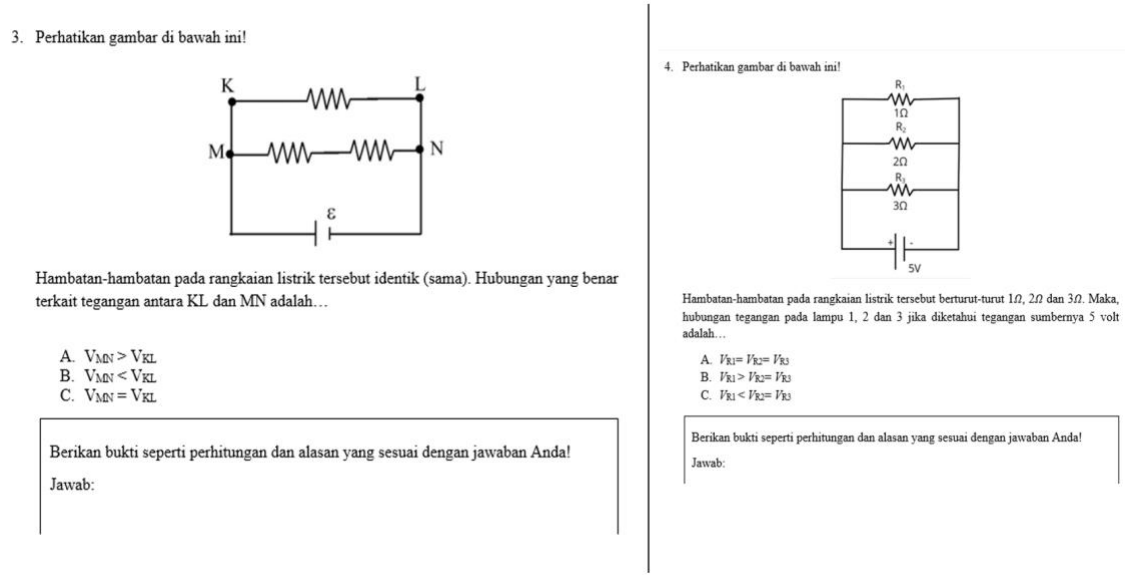
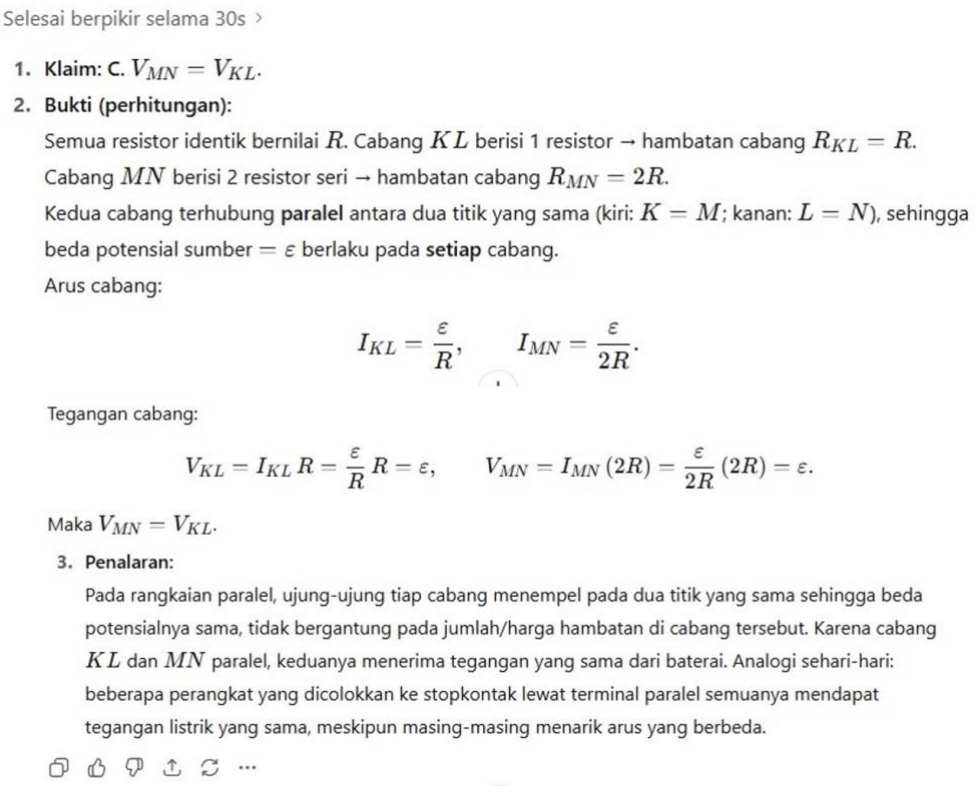


Figure 4. Question on the voltage indicator

The next analysis focused on the voltage indicator. The question presented in Figure 4 was accompanied by the same prompt used in the previous questions, as shown in Figure 2. GPT-5's response to this question is presented in Figure 5.



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1. **Klaim:** C. $V_{MN} = V_{KL}$.
2. **Bukti (perhitungan):**
   Semua resistor identik bernilai R. Cabang KL berisi 1 resistor → hambatan cabang $R_{KL} = R$.
   Cabang MN berisi 2 resistor seri → hambatan cabang $R_{MN} = 2R$.
   Kedua cabang terhubung **paralel** antara dua titik yang sama (kiri: $K = M$; kanan: $L = N$), sehingga beda potensial sumber $= \varepsilon$ berlaku pada **setiap** cabang.
   Arus cabang:

$$I_{KL} = \frac{\varepsilon}{R}, \qquad I_{MN} = \frac{\varepsilon}{2R}.$$

   Tegangan cabang:

$$V_{KL} = I_{KL}\,R = \frac{\varepsilon}{R}\,R = \varepsilon, \qquad V_{MN} = I_{MN}\,(2R) = \frac{\varepsilon}{2R}\,(2R) = \varepsilon.$$

   Maka $V_{MN} = V_{KL}$.
3. **Penalaran:**
   Pada rangkaian paralel, ujung-ujung tiap cabang menempel pada dua titik yang sama sehingga beda potensialnya sama, tidak bergantung pada jumlah/harga hambatan di cabang tersebut. Karena cabang KL dan MN paralel, keduanya menerima tegangan yang sama dari baterai. Analogi sehari-hari: beberapa perangkat yang dicolokkan ke stopkontak lewat terminal paralel semuanya mendapat tegangan listrik yang sama, meskipun masing-masing menarik arus yang berbeda.

Figure 5. GPT-5's response to the voltage indicator

As shown in Figure 5, GPT-5 provided an accurate, clear, and comprehensive explanation. GPT-5 selected option C MN= KL as its claim. It calculated the potential difference using Ohm's law and employed symbolic representations because the problem consisted only of symbols describing a parallel circuit. The calculations were supported by logical reasoning and reinforced with an example

from everyday life. GPT-5 explained that both branches are connected across the same potential difference; therefore, the voltage across each branch is equal, even though their resistances differ. This explanation was further illustrated by the example of household electrical outlets, where components connected in parallel receive the same voltage. The response to the third question received a score of 5 out of 5, indicating that GPT-5 provided accurate claims, evidence, and reasoning. GPT-5 was able to present explanations that established logical relationships between concepts while using language that was clear and contextually meaningful. This strong performance was not limited to the third question but was also observed in the fourth question, which received the same score.

These findings indicate that GPT-5 is not only capable of generating appropriate responses but also of constructing scientific explanations that satisfy the essential components of scientific explanation ability. It applies physics concepts accurately, follows a systematic problem-solving process, and explains scientific concepts in a clear and understandable manner.

Performance on the Electrical Power (Lamp Brightness) Items

The questions on the electrical power (lamp brightness) indicator were designed to assess GPT-5's ability to provide scientific explanations regarding electrical power, represented by the brightness of lamps in an electric circuit. The question for this indicator is presented in Figure 6 to evaluate GPT-5's response.

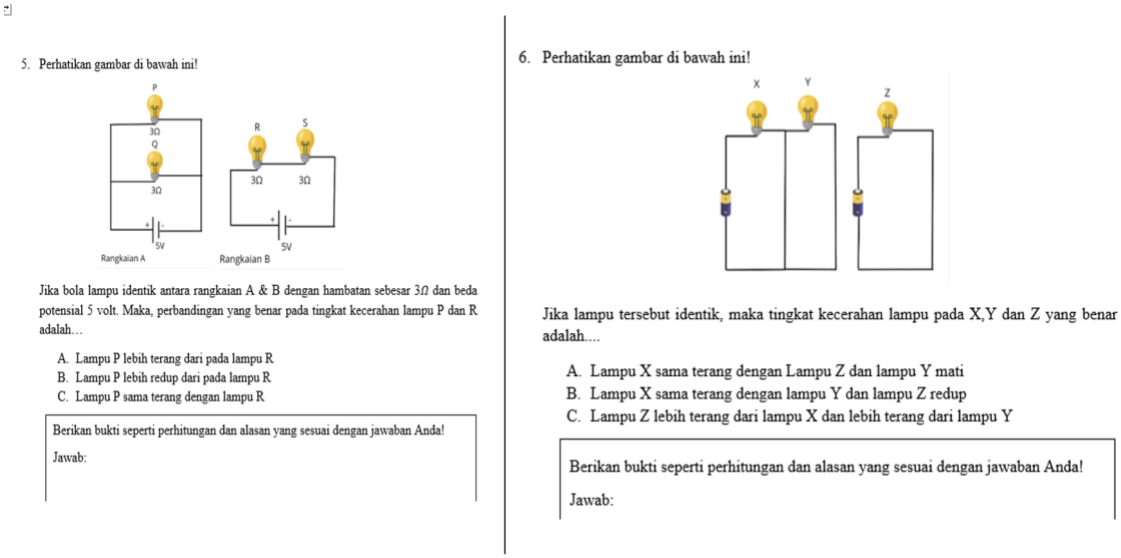
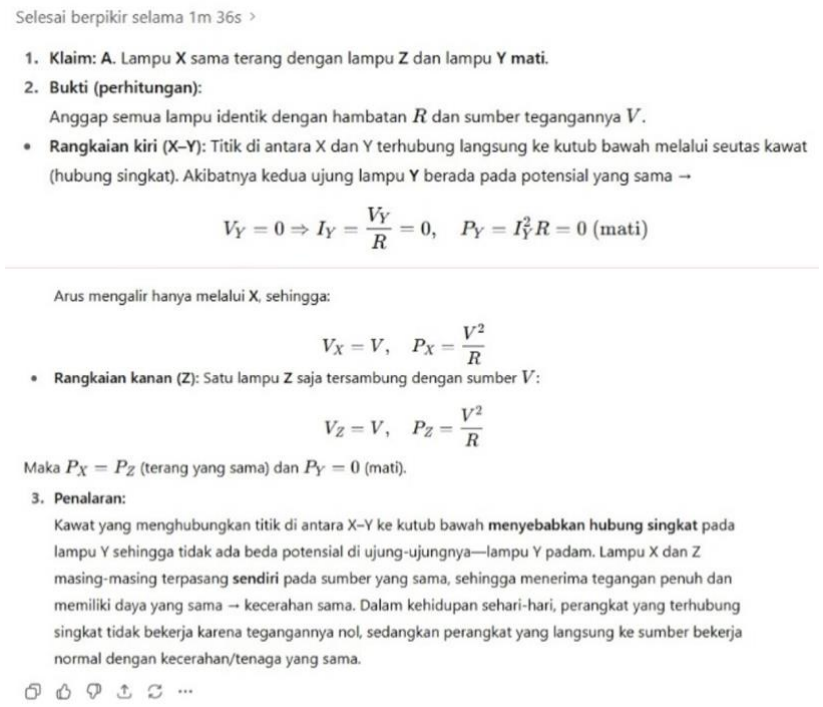


Figure 6. Question on the electrical power (lamp brightness) indicator

After the question shown in Figure 6 was presented, along with the same prompt shown in Figure 2, GPT-5 generated the response presented in Figure 7.



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1. **Klaim: A.** Lampu **X** sama terang dengan lampu **Z** dan lampu **Y mati.**
2. **Bukti (perhitungan):**

   Anggap semua lampu identik dengan hambatan R dan sumber tegangannya V.

- **Rangkaian kiri (X–Y):** Titik di antara X dan Y terhubung langsung ke kutub bawah melalui seutas kawat (hubung singkat). Akibatnya kedua ujung lampu **Y** berada pada potensial yang sama →

$$V_Y = 0 \Rightarrow I_Y = \frac{V_Y}{R} = 0, \quad P_Y = I_Y^2 R = 0 \text{ (mati)}$$

Arus mengalir hanya melalui **X**, sehingga:

$$V_X = V, \quad P_X = \frac{V^2}{R}$$

- **Rangkaian kanan (Z):** Satu lampu **Z** saja tersambung dengan sumber V:

$$V_Z = V, \quad P_Z = \frac{V^2}{R}$$

Maka $P_X = P_Z$ (terang yang sama) dan $P_Y = 0$ (mati).

3. **Penalaran:**

   Kawat yang menghubungkan titik di antara X–Y ke kutub bawah **menyebabkan hubung singkat** pada lampu Y sehingga tidak ada beda potensial di ujung-ujungnya—lampu Y padam. Lampu X dan Z masing-masing terpasang **sendiri** pada sumber yang sama, sehingga menerima tegangan penuh dan memiliki daya yang sama → kecerahan sama. Dalam kehidupan sehari-hari, perangkat yang terhubung singkat tidak bekerja karena tegangannya nol, sedangkan perangkat yang langsung ke sumber bekerja normal dengan kecerahan/tenaga yang sama.

Figure 7. GPT-5's response to the electrical power (lamp brightness) indicator

5 selected option A, stating that lamp X is as bright as lamp Z, while lamp Y is off. It performed calculations based on concepts consistent with Ohm's law, using the mathematical equation $P = \frac{V^2}{R}$ (Tipler & Mosca, 2008). The equation was correctly applied and aligned with the relevant physics concepts. The calculations were supported by logical and accurate reasoning and further reinforced with an example from everyday life. GPT-5 explained that lamps X and Z have the same brightness, whereas lamp Y does not light because it is bypassed by a short circuit, causing the electric current to flow through the path with lower resistance. Based on the assessment rubric, the response to the sixth question received a score of 5 out of 5, indicating that all three aspects of scientific explanation ability claim, evidence, and reasoning were demonstrated accurately.

These findings indicate that GPT-5 is not only capable of providing correct responses but also of constructing explanations that effectively integrate the concepts of electric current, voltage, electrical power, and short circuits. The use of contextual examples from everyday life, such as damaged electrical devices caused by short circuits, further strengthened the explanations. GPT-5 explained that a lamp that does not receive electrical energy from the battery will not light, while presenting the concept in language that is clear and easy to understand, thereby supporting conceptual understanding. A study by Kieser, Wulff, Kuhn, and Kuchemann (2023), as cited in Azizah and Mansyur (2024), also reported that ChatGPT provides logical and contextual explanations that can enhance users' confidence in scientific accuracy. GPT-5's performance on the electrical power (lamp brightness) indicator was consistently strong, as the fifth question also received accurate claims, evidence, and reasoning, with the same score as the sixth question. Nevertheless, the findings of this study are limited to the analysis of six questions representing Ohm's law and therefore cannot be generalized to GPT-5's ability to explain all concepts in physics.

Based on the analysis of all six questions, GPT-5 demonstrated a strong understanding of the fundamental principles of electricity based on Ohm's law, including the concepts of series and parallel circuits, electric current, voltage, and electrical power (lamp brightness). This was reflected in GPT-5's ability to construct scientific explanations by presenting appropriate claims, supported by evidence through the correct application of Ohm's law and accurate mathematical calculations. Furthermore,

the reasoning provided was logical and reinforced with contextual examples and analogies drawn from everyday life, such as lamps, batteries, and electrical outlets.

The findings of this study are consistent with those of Hwang, Chang, and Chen (2023), who reported that the integration of AI chatbots such as ChatGPT can enhance students' scientific thinking skills and support a deeper understanding of scientific concepts. Similarly, Demirci (2025) found that ChatGPT is capable of solving physics problems effectively. The responses generated by GPT-5 in this study therefore demonstrate its potential as a learning support tool, particularly in providing scientific explanations of physics concepts.

Nevertheless, these findings should be interpreted within the scope of the present study, which involved only six questions representing the concepts of Ohm's law and evaluated a single AI model, namely GPT-5. Consequently, the results cannot yet be generalized to all areas of physics or to different learning contexts. Future studies are recommended to include a wider range of physics topics, a larger number of questions, and comparisons of GPT-5's performance under different prompting strategies or with other AI models to obtain a more comprehensive understanding of AI's ability to construct scientific explanations in physics education.

CONCLUSION

Based on the findings of this study entitled Analysis of GPT-5's Ability to Construct Scientific Explanations in Solving Direct Current Electric Circuit Problems, GPT-5 demonstrated a high level of scientific explanation ability, achieving a total score of 30 out of 30, corresponding to 100%. Every response satisfied the three essential components of scientific explanation claim, evidence, and reasoning by providing complete, logical, and accurate explanations supported by the correct application of Ohm's law and contextual examples. These findings suggest that GPT-5 has the potential to support physics learning and promote a deeper understanding of physics concepts. However, the findings are limited to six questions representing three indicators of Ohm's law concepts. Therefore, future research should include a broader range of physics topics and a greater variety of questions to provide a more comprehensive evaluation of GPT-5's ability to construct scientific explanations.

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