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An Examination of Students' Critical Thinking Skills in the Context of the Digestive System

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Abstract: Critical thinking is vital in education, helping students analyze and evaluate information for better decision-making. However, research on fostering critical thinking in science education remains limited, particularly in topics like the digestive system. The digestive system topic is conceptually rich and closely related to students' daily lives, making it a suitable context to assess critical thinking. This study aims to reveal the essential thinking profiles of junior high school students in Bogor City on the topic of the digestive system, focusing on Ennis's indicators. A quantitative method was employed, involving 108 students who completed an essay test with five open-ended questions assessing critical thinking across five indicators: providing simple explanations, building basic support, making inferences, offering further explanations, and setting strategies. Participants were selected using purposive sampling, targeting students who had completed the digestive system topic. Semi-structured interviews with three science teachers supplemented the findings. The findings indicated that students demonstrated very low critical thinking abilities, with the lowest scores in providing further explanations (22.83%) and the highest in setting strategies (43.58%) among 108 junior high school students in Bogor. Based on teacher interviews, the current instructional approach predominantly employs lecture-based and textbook-oriented methods, which emphasize factual recall over critical analysis. This traditional approach significantly contributes to students' low performance in essential indicators of thinking. The study offers valuable insights into the challenges and opportunities for fostering critical thinking in science education, highlighting the importance of targeted interventions to address specific deficiencies.

Keywords: critical thinking, digestive system, Ennis indicators, science education.

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INTRODUCTION

Critical thinking is recognized as an essential 21st-century skill that empowers students to analyze information, draw conclusions, and make informed decisions. In science education, critical thinking allows students to connect concepts, evaluate evidence, and solve problems based on logical reasoning (Heard et al., 2020). In contemporary education, critical thinking is regarded as a key component of successful learning because it allows students to approach problems systematically and develop well-founded conclusions (Raj et al., 2022). In addition, critical thinking nurtures problem-solving abilities, encourages creative thinking, and enhances students' overall cognitive engagement with science topics (Bhuttah et al., 2024). Despite its significance, studies have shown that Indonesian students continue to perform poorly in this area (Chairatunnisa et al., 2023; Maulina et al., 2025; Umam & Fauziah, 2022; Wale & Bishaw, 2020). For instance, the results from the 2022 PISA assessment revealed that Indonesian students ranked in the bottom 10% globally, with substantial gaps in key cognitive areas, such as the ability to analyze, evaluate, and interpret information (OECD, 2023). This finding suggests that students often rely on rote memorization and are not equipped to engage in tasks requiring reasoning or argumentation (Alsaleh, 2020; Zohar & Dori, 2003). Studies in countries such as Vietnam and Thailand also highlight difficulties in fostering critical thinking in science due to similar reliance on traditional instruction (Ho et al., 2018; Kwangmuang et al., 2021).

Prior research indicates that the development of critical thinking in science is often hindered by conventional teaching approaches, such as lecture-based instruction and textbook dependency, which limit opportunities for students to actively construct knowledge (Velayati et al., 2017). Although the Indonesian curriculum has shifted toward emphasizing competencies and higher-order thinking skills, actual classroom practices remain dominated by teacher-centered methods (Maulana et al., 2022). Numerous efforts have been made to improve students' critical thinking through the implementation of various instructional models, such as inquiry-based learning (Qablan et al., 2024), problem-based learning (Maulana et al., 2022), and argumentation-based science teaching (Demircioglu et al., 2023). While these approaches have shown promise, few studies have focused on diagnosing the specific dimensions of students' critical thinking abilities, particularly within specific science topics.

One science topic that is both relevant and frequently misunderstood by students is the human digestive system. This topic is directly related to students' daily lives, health, and diet; yet, it also encompasses abstract concepts such as enzymatic activity and physiological interactions that require analytical reasoning. However, most studies on critical thinking in science education have focused on broader scientific competencies or on topics such as ecosystems (Septiany et al., 2024) and viruses (Sidabutar & Mercuriani, 2024), leaving a gap in understanding how students engage with physiological systems from a critical thinking perspective (Bustami et al., 2020). Students can analyze how dietary habits affect digestive health or evaluate claims about nutritional supplements (Rohani & Alimah, 2024). These real-life applications are crucial for developing critical thinking, as they encourage reflective, evidence-based reasoning (Astaifi, 2024).

Therefore, this study aims to reveal junior high school students' critical thinking skills based on Ennis's indicators (Ennis, 1985) through their written responses on the topic of the digestive system. This analysis is expected to provide insights into students' strengths and weaknesses across different dimensions of critical thinking, as well as guide the development of more effective learning strategies. The research question that guided this study is: How do junior high school students demonstrate critical thinking skills based on Ennis's indicators when learning about the digestive system?

METHOD

This study employed an explanatory sequential mixed-methods design. The quantitative phase involved an essay-based assessment of critical thinking, followed by qualitative interviews to explore and interpret the test results in greater depth. A total of 108 students from three public junior high schools in Bogor City participated in this study. The schools had implemented the Merdeka Curriculum, which emphasizes scientific literacy and critical thinking. However, based on teacher interviews, implementation remained limited, with instruction still largely teacher-centered and focused on textbook-based content delivery.

The primary instrument used in this study was an essay test comprising five open-ended questions designed to assess critical thinking skills based on Ennis's indicators: (1) providing simple explanations, (2) building basic support, (3) making inferences, (4) providing further explanations, and (5) setting strategies and tactics. A science education expert validated the essay test, and the results indicated strong content validity and alignment with both Ennis's critical thinking indicators and the digestive system topic as mandated by the Merdeka Curriculum's phase D learning objectives. Each question was scored using a rubric ranging from 0 (no response or incorrect) to 5 (comprehensive and accurate response). A semi-structured interview guide was developed to explore teachers' perspectives on the challenges and opportunities in fostering students' critical thinking skills. One sample item was: *"A student named Tiwi goes on a strict diet and experiences weight loss, but her appearance becomes unhealthy. Why might this happen? Explain the relationship between weight loss and nutritional needs."* This item was designed to assess inference and explanation skills in real-life contexts.

Data collection was conducted over two weeks during the second semester of the 2024/2025 academic year. Ethical approval was obtained from participating schools and relevant educational authorities. Informed consent was secured from all participants and their guardians to ensure ethical compliance. Participants were briefed on the research objectives and procedures to provide clarity and

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voluntary participation. The essay test was administered via Google Forms during a 60-minute session in a classroom setting.

To triangulate the quantitative data, semi-structured interviews were conducted with three science teachers to gather qualitative insights into teaching practices and students' critical thinking development. The teachers were interviewed individually in sessions lasting approximately 30 minutes each. The interviews included guiding questions related to students' tendencies in reasoning, questioning, interpreting, and strategizing. For example, one question asked: *"Do students often seek clarification or attempt to define unfamiliar terms during science lessons?"* Based on the semi-structured interviews with the science teachers, the instructional approach in the participating schools predominantly followed a traditional teaching method. Lessons were typically teacher-centered, focusing on textbook explanation and note-taking, with minimal use of inquiry, problem-solving, or discussion-based tasks.

The quantitative data from the essay tests were analyzed using descriptive statistics. Students' scores were classified, ranging from "very low" to "very high", based on the criteria established by Supriyati et al. (2018). The formula for determining the percentage of students in each category was:

$$\text{Grade} = \left(\frac{score\ obtained}{total\ score}\right)\times 100 \qquad (1)$$

The collected data were analyzed quantitatively using descriptive statistics. The students' scores were classified, ranging from "very low" to "very high," following Supriyati et al. (2018) criteria (Table 1).

Table 1. Critical Thinking Ability Criteria

Criteria	Intervals
Very high	$81.25 \leq x \leq 100$
High	$71.50 \leq x \leq 81.25$
Moderate	$62.50 \leq x \leq 71.50$
Low	$43.75 \leq x \leq 62.50$
Very low	$0 \leq x \leq 43.75$

Each indicator of critical thinking was analyzed individually to identify strengths and weaknesses in specific aspects of critical thinking. The mean score for each indicator was calculated, and the distribution of students across categories was presented in tabular and graphical formats. The total score was converted into a percentage scale (0–100) after the values had been interpreted, using the formula in Supriyati et al. (2018) as follows:

$$P\ (\%) = \left(\frac{\Sigma x}{n}\right)\times 100\% \qquad (2)$$

Remark:
P : percentage value
$\sum x$: percentage frequency to be searched for
n : number of frequencies

Each critical thinking indicator was analyzed individually to identify specific strengths and weaknesses. Results were presented in tables and graphical formats for clarity. Qualitative data from teacher interviews were analyzed using Sugiyono's (2019) interactive model, which consists of four stages: data collection, data reduction, data display, and conclusion drawing/verification. Interview responses and observational notes were transcribed and documented. Irrelevant information was filtered out to focus on themes related to the development of critical thinking, such as teaching approaches and student challenges. Thematic matrices were created to visualize relationships and patterns between the quantitative and qualitative findings. Synthesized findings were used to explain and contextualize the quantitative results, ensuring interpretations were well-supported by the data.

Ethical approval was secured from participating schools and educational authorities. Informed consent was obtained from both students and their guardians before data collection. Anonymity and

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confidentiality of all participants were maintained throughout the study to ensure compliance with the ethical standards of research.

RESULT AND DISCUSSION

The results presented in Table 2 indicate that students' critical thinking skills across all indicators are classified as "Very Low." Among the five indicators, the highest mean score was observed for "Setting strategies and tactics" (43.58%), while the lowest was for "Providing further explanations" (22.83%). This disparity in performance highlights the areas where students face the most significant challenges in developing critical thinking. The indicator "Setting strategies and tactics," which reflects students' ability to plan and approach problems methodically, is slightly stronger than others, but it still indicates significant room for improvement. However, the indicator "Providing further explanations" shows the most considerable deficiency, suggesting that students struggle to offer detailed, reasoned responses or justify their thinking beyond surface-level answers. This finding aligns with research conducted by Chairatunnisa et al. (2023), which highlights the underdevelopment of critical thinking skills in Indonesian junior high school students, particularly in the context of science education. Their study points to several key factors contributing to this issue, including limited exposure to teaching strategies that encourage deeper cognitive engagement. While students may grasp fundamental concepts, they often fail to engage with the material critically and analytically, which is essential for higher-order thinking. Surma et al. (2025) emphasize that knowledge is a crucial component of critical thinking, enabling individuals to process information and perform complex cognitive tasks efficiently. Without foundational knowledge, the ability to think critically about concepts or problems becomes significantly limited.

Table 2. Average Scores and Categories of Critical Thinking Indicators

Indicator	Mean Score (%)	Category
Providing a simple explanation	37.17	Very low
Building basic support	35.57	Very low
Making inferences	28.87	Very low
Providing further explanations	22.83	Very low
Setting strategies and tactics	43.58	Very low

Low critical thinking performance can be attributed, in part, to the lack of innovative teaching methods. Alsaleh (2020) notes that the traditional, teacher-centered instructional model predominates in many Indonesian classrooms, leaving little room for students to develop their strategies for analysis or evaluation. Furthermore, Velayati et al. (2017) emphasizes the struggle that students face when asked to engage in higher-order cognitive processes such as analysis, inference, and evaluation. These processes are essential for critical thinking, yet many students struggle to master them. The ability to analyze information, draw inferences from evidence, and evaluate arguments critically are foundational to scientific thinking, but they require both cognitive skills and an appropriate learning environment (Facione, 2015). Zohar & Dori (2003) highlight that while students may excel in recalling facts, they often struggle to apply this knowledge in new contexts, which is a hallmark of critical thinking

Providing Simple Explanations

The results show that 39.8% of students scored 2 on the “Providing Simple Explanations” indicator, meaning they could generate 1–2 questions based on a visual prompt about digestive disorders (Figure 1). However, most of these questions were surface-level and lacked depth in scientific reasoning. One teacher explained, *“Students often rely on what they’ve heard from social media, but they rarely probe deeper to ask critical questions.”* This aligns with research by Wale and Bishaw (2020), who emphasize the importance of classroom environments that promote student questioning as a gateway to critical inquiry.

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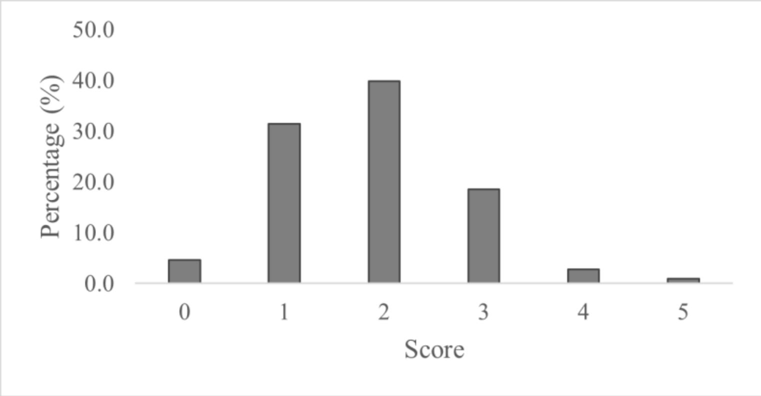

Figure 1. The Percentage Value of Students in Providing Simple Explanation

According to Bloom's revised taxonomy (Anderson et al., 2001) generating meaningful questions corresponds to the "analyze" level of cognition, which involves distinguishing relevant information from irrelevant information. Students' limited performance may be attributed to instructional practices that emphasize factual recall over inquiry. To address this issue, adopting inquiry-based learning (IBL) methods could significantly enhance students' questioning and reasoning abilities. Research by Qablan et al. (2024), Levy et al. (2013), and Firdaus & Wilujeng (2018) emphasizes that IBL fosters independent exploration and enables students to develop logical connections through guided questioning. Additionally, using question-generating frameworks and rubrics, as recommended by Ragupathi & Lee (2020), can help teachers scaffold students' skills by providing clear feedback and support.

Building Basic Support

Figure 2 illustrates that 51.9% of students scored 2 for the "Building Basic Support" indicator when asked to explain the effect of gastric enzyme deficiencies using data. Students could recognize that a lack of pepsin or HCl would disrupt digestion, but failed to elaborate on the enzymatic role or link it to the breakdown of macromolecules. A teacher stated, *"Students can mention gastric problems, but they rarely connect these to the specific roles of enzymes or stomach acids."* This suggests a disconnect between declarative knowledge and procedural understanding.

Ennis (2011) emphasizes the importance of supporting claims with evidence—a skill underdeveloped here. According to Vygotsky's Zone of Proximal Development (ZPD), learners benefit from scaffolding that bridges prior knowledge and abstract content. The absence of such support may explain why students struggle to contextualize biological concepts. These findings resonate with Duff et al. (2020), which highlights that many students find it challenging to transition from descriptive reasoning to more analytical and evidence-based reasoning. To address this, Kusumantoro et al. (2022) recommend case-based learning as an instructional strategy, where students engage with real-world biomedical problems that demand applied reasoning.

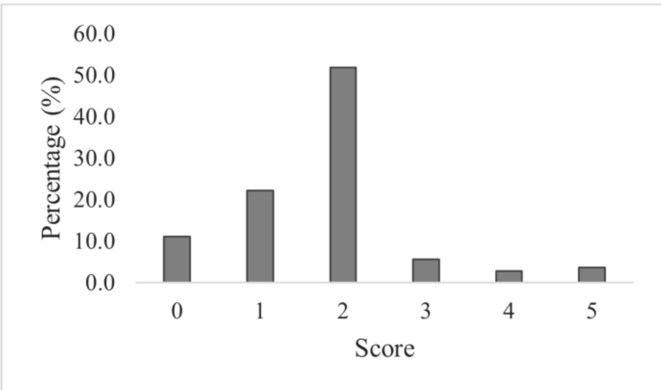

Figure 2. The Percentage Value of Students in Building Basic Support

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The underdevelopment of this skill may stem from instructional practices that do not emphasize critical thinking and problem-solving in science education. According to Hafeez (2021), traditional lecture-based teaching methods often fail to foster deeper scientific reasoning. To enhance this skill, implementing problem-based learning (PBL) could be highly effective. Research by Maulana et al. (2022), Aisy & Trisnowati (2024), and Nurhasanah et al. (2024) demonstrates that PBL promotes critical thinking and encourages students to apply scientific principles to solve real-world problems.

Making Inferences

Figure 3 shows that 80.5% of students scored between 0 and 2 on inference tasks. These tasks required analyzing data on enzymatic activity and making predictions. The high proportion of low scores indicates that students are having difficulty synthesizing information and drawing logical conclusions. Teachers noted that students were hesitant to answer inferential questions independently. *"They are afraid of being wrong, so they usually stay quiet,"* one teacher mentioned. *"But in group discussions, they're more confident and willing to share their ideas."* This highlights the value of collaborative learning, which, as Blake & Pope (2008) write, enhances students' inferential reasoning by encouraging peer interaction and exposure to diverse viewpoints. The low individual performance reflects a broader issue: students lack explicit instruction in how to construct inferences.

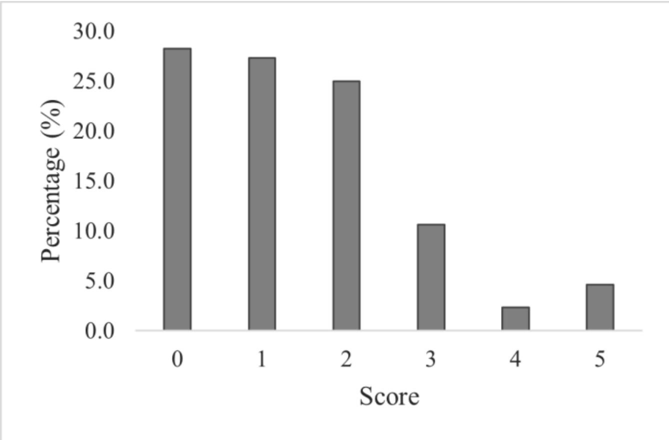

Figure 3. The Percentage Value of Students in Making Inferences

To address this issue, Morris (2025) propose explicit teaching of thinking skills, where inference-making is taught as a structured process. For example, scaffolding strategies, such as guiding students through data analysis using graphic organizers or structured prompts, can help them connect data to principles, like enzyme functionality in this case. Additionally, introducing metacognitive training, as suggested by Baird & White (2020), encourages students to reflect on their reasoning process, enhancing their ability to identify flaws in their logic and build stronger inferences.

Furthermore, the integration of argumentation-based learning has shown significant potential in improving inference skills. This approach, as highlighted by Demircioglu et al. (2023), encourages students to construct arguments supported by evidence, fostering deeper engagement with scientific data. For instance, asking students to justify the optimal temperature for enzymatic activity using experimental data can prompt them to critically evaluate and connect information. Argumentation not only strengthens inference-making but also promotes understanding of underlying scientific concepts (Yulianing et al., 2023).

Providing Further Explanations

Based on Figure 4, the results for the "Providing Further Explanations" indicator were particularly low, with 72.3% of students scoring between 0 and 1. This suggests a significant gap in students' ability to elaborate on their reasoning, even when prompted. A considerable number of students failed to justify their answers beyond stating facts or conclusions. One teacher remarked, *"They tend to give short answers and rarely explain why. Unless the topic is familiar, like nutrition, they guess or stay silent."*

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According to Bloom's taxonomy, explanation involves analysis and synthesis—levels that require students not only to recall but also to interrelate ideas and provide logical arguments (Main, 2021). This deficiency indicates a lack of cognitive engagement with the content. The tendency to avoid elaboration may stem from limited exposure to open-ended tasks and a classroom culture that prioritizes correctness over exploration and inquiry. These findings align El-Soufi & See (2019), who emphasized the need for explicit instruction in explanation skills rather than assuming students will develop them intuitively. Furthermore, cognitive load theory (Kennedy, 2021) explains that the complexity of tasks can overwhelm students' cognitive capacity, especially when they are not provided with adequate scaffolding or step-by-step guidance in analyzing data.

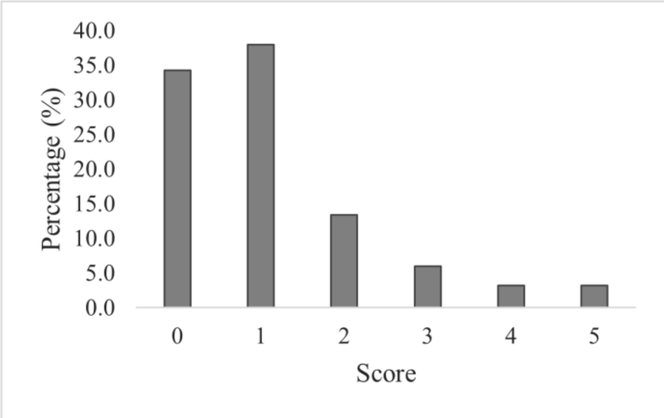

Figure 4. The Percentage Value of Students in Providing Further Explanation

To address these challenges, approaches such as Argumentation-Based Science Teaching (ABST) can be effective. This method encourages students to construct, justify, and defend arguments based on evidence, which has been shown to improve their analytical and explanatory skills (Uluçınar Sağır & Kılıç, 2012). Additionally, using reasoning models such as Toulmin's Argumentation Model provides a systematic framework for students to connect claims, evidence, and reasoning, as highlighted by Jumariati et al. (2021). Another effective strategy is implementing concept mapping, which helps students organize information and establish relationships between concepts. Utami & Yuliyanto (2020) found that concept maps enhance students' ability to provide more structured and comprehensive explanations.

Setting Strategies and Tactics

The results of the "Setting Strategies and Tactics" indicator in Figure 5 had the highest average score (43.58%), but performance remained in the "Very Low" category. Figure 5 reveals that many students identified only basic actions—such as naming healthy foods—without linking them to physiological reasoning or broader problem-solving strategies. A teacher observed, *"They can suggest strategies, but they don't always explain why or how it works. The answers are usually just lists."* This outcome indicates that while students may recall relevant concepts, they lack the metacognitive ability to apply them in planning or decision-making scenarios. This is a critical component of critical thinking, which, as Ennis (2011) defines, includes not only reasoning but also strategic decision-making and reflective judgment.

The limited performance in this area may stem from an insufficient understanding of how to approach complex problems in science. According to Suwono et al. (2023), embedding authentic health-related scenarios can improve students' ability to formulate well-structured strategies. This aligns with Bravo-Torija and Jiménez-Aleixandre's (2018) findings that structured decision-making tasks help students break down problems and make evidence-based choices over time.

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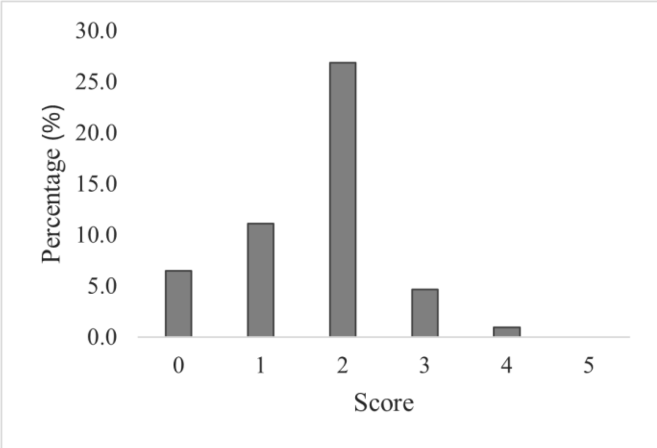

Figure 5. The Percentage Value of Students in Setting Strategies and Tactics

Moreover, teachers reported that most students rely on trial-and-error or peer advice when confronted with problem-solving tasks, especially outside of school. Embedding **reflective practices**, such as self-assessment and peer feedback (Daff et al., 2024), can empower students to evaluate the effectiveness of their strategies and improve them iteratively. Ultimately, while this indicator appears stronger relative to others, it still reflects a need for explicit instruction in planning, evaluating options, and justifying decisions—key skills that should be cultivated through project-based learning, guided inquiry, and structured reflection.

CONCLUSION

This study found that junior high school students demonstrated very low critical thinking skills across all of Ennis's indicators on the topic of the digestive system. The lowest scores were seen in *Providing Further Explanations* and *Making Inferences*, indicating difficulties in reasoning, justification, and connecting evidence. Even the highest-scoring indicator, *Setting Strategies and Tactics*, remained weak and lacked depth. These findings suggest a gap between the goals of Kurikulum Merdeka and current instructional practices, which remain largely teacher centered. While the curriculum emphasizes critical thinking and inquiry, classroom activities often rely on textbook recall and rote memorization of facts. Interview data supported this, revealing that students rarely ask questions or explain ideas in depth, especially in individual tasks. They performed better in group settings, where peer discussion stimulated thinking. This highlights the importance of collaborative and context-based instruction. To improve students' critical thinking, especially in science, teachers should integrate argumentation tasks, case-based learning, and scaffolded tools, such as concept maps. These approaches can make abstract content more relatable and encourage deeper reasoning. Limitations of this study include its focus on a single topic and region. Future research should explore broader content areas and assessment types. Teacher training in critical thinking pedagogy is also recommended to align instruction with curriculum aims.

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