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Analysis of Students' Critical Thinking Ability in Physics Learning at the High School Level

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Abstract

Analyzing the critical thinking ability of high school students in physics learning. The purpose of this survey study is to assess the critical thinking abilities of high school students studying physics in Jeneponto Regency during the 2024/2025 school year. The research sample consists of XII MIPA class students from three schools: SMAN 2 Jeneponto (32 students), SMAN 5 Jeneponto (28 students), and SMAN 11 Jeneponto (24 students). The analytical method employed was descriptive statistical analysis. The method of data collection utilized was a multiple-choice test on critical thinking ability. The instrument used is valid, and the reliability coefficient is 0,817. The indicators examined for critical thinking skills include providing simple explanations, developing basic skills, making inferences, and offering further explanations. According to the study's findings, the average score for students' critical thinking abilities in high school physics within the Jeneponto district is 6.48, with a percentage of 32%. 44%, falling into the low category, while the very high category comprises 30.95% with 26 students, the high category encompasses 40.47% with 34 students, the medium category includes 23.80% with 20 students, the low category represents 3.57% with three students, and the very low category denotes 1.19% with one student. The implications of this study are to enhance learning activities, for example, by utilizing innovative and interactive learning methods and evaluating students' critical thinking skills.

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INTRODUCTION

The 21st-century skill framework includes three main domains that have been adopted by Indonesia's Ministry of Education and its broader education sector: (1) life and career competencies, (2) learning and innovation abilities, and (3) information, media, and technology literacy. Learning and innovation focus on critical thinking, problem-solving, effective communication, teamwork, and creativity. Education prioritizes the development of students' critical thinking skills, particularly through subjects like physics, which require higher-order reasoning (Misbah et al., 2022; Sofiana et al., 2021; Yani et al., 2021).

Physics is a field of science that fosters the development of reasoning and analytical skills, equipping learners with the tools to comprehend a diverse range of natural phenomena. Therefore, strengthening students' conceptual mastery can be achieved by applying critical thinking abilities (Haryandi et al., 2019; Risnawati et al., 2018).

This aligns with 21st-century demands, in which students are expected to possess competencies in problem-solving, communication, collaboration, and critical thinking. Those who have such skills can assess the arguments of their peers and evaluate their

accuracy (Agnafia, 2019). As an internal factor influencing academic achievement, critical thinking has become a central goal across educational subjects, including physics. Thus, learning physics is expected to cultivate students' critical thinking skills (Asniar et al., 2022).

Quality education aims to provide students with higher-order thinking skills (Zubaidah et al., 2017), enabling them to generate ideas and solve problems throughout the learning process (Heong et al., 2012). These abilities are often embedded within academic content areas. Critical thinking is one of the key elements of higher-order thinking (King et al., 2010), involving the analysis, evaluation, and restructuring of information to make well-reasoned decisions (Haghparast et al., 2014). With these skills, students are better equipped to address real-life, scientific, and societal problems. Therefore, critical thinking should be practiced and nurtured through educational activities, such as simulation and problem-solving exercises (Colln-Appling & Giuliano, 2017). Additionally, it plays an important role in student academic success (Halpern et al., 2012).

In SMAN 2 Jeneponto, SMAN 5 Jeneponto, and SMAN 11 Jeneponto, physics is considered an abstract subject by many students. The ability to grasp physics concepts varies across students; some comprehend the material well, while others struggle, particularly with abstract content. Physics teachers in these schools generally use teaching methods such as lecturing, discussions, Q&A sessions, Problem-Based Learning (PBL), and Cooperative Learning. These strategies aim to encourage students to think critically, collaboratively, and reflectively as they learn physics.

Observational data from these schools suggest that student participation in learning remains limited, particularly in terms of asking questions, sharing opinions, contributing ideas, drawing conclusions, and applying critical thinking. Teacher interviews suggest that many students have not yet achieved satisfactory physics scores, often relying solely on the methods used by teachers to answer questions. Moreover, the tasks provided rarely stimulate critical thinking.

The purpose of teaching physics problem-solving is to help students tackle problems independently. However, many still face difficulties when problems are presented in different forms. While some are able to find answers by referring to textbooks or teacher explanations, they tend to struggle when confronted with unfamiliar question types (Nurlaila et al., 2015).

The subject matter itself also significantly affects the development of students' critical thinking skills. Physics is often perceived as difficult, leading many to see it merely as a subject of formulas rather than a platform for critical reasoning. This perception hinders students' ability to think critically about the material. Hence, educators have the responsibility to shift this mindset (Dhina & Mubaroq, 2017).

One of the teacher's roles is to foster students' critical thinking. Critical thinking is an exploratory mental process that aims to generate original ideas that diverge from conventional ones. This includes interpreting, analyzing, summarizing, and assessing information. Critical thinking yields advantages such as precision, relevance, logic, fairness, and depth. It involves organizing, prioritizing, and refining ideas (Treffinger & Isaksen, 2013). This skill enables students to make thoughtful judgments and solve everyday problems (Zubaidah et al., 2017).

Therefore, in the classroom, teachers should provide meaningful learning activities to help cultivate students' critical thinking skills. Nevertheless, this aim is not yet fully realized, as many learning processes still emphasize rote memorization and evaluation of factual recall. The present study aims to provide insight for physics educators by evaluating students' abilities and contributing to the development of learning strategies that actively promote critical thinking.

Based on these considerations, the researchers aim to analyze students' critical thinking abilities in Physics learning. Thus, this study is titled analysis of students' critical thinking ability in physics learning at the high school level.

METHODS

This study employed a survey method with a quantitative descriptive approach. The purpose of this research was to systematically describe students' critical thinking abilities in physics learning at the high school level in Jeneponto Regency. The study was conducted in class XII-MIPA at SMAN 2 Jeneponto, SMAN 5 Jeneponto, and SMAN 11 Jeneponto during the odd semester of the 2024/2025 academic year.

The population of this study consisted of all students in grade XII-MIPA at the three selected schools, totaling 330 students. The sampling technique used was disproportionate stratified random sampling, which involved selecting participants from each school not based on proportional representation but based on the researchers' consideration to obtain comprehensive and representative data. A total of 84 students were selected, comprising 32 from SMAN 2 Jeneponto, 28 from SMAN 5 Jeneponto, and 24 from SMAN 11 Jeneponto. This technique is aligned with Sugiyono (2017), who stated that this approach is appropriate when population sizes vary significantly across strata.

The primary method of data collection was through testing. The instrument used was a multiple-choice test designed to measure students' critical thinking skills in physics. The test consisted of 20 items, each aligned with one of four critical thinking indicators: (1) providing simple explanations, (2) building basic skills, (3) drawing conclusions, and (4) providing further explanation. Five questions assessed each indicator. Each item included five answer options (a, b, c, d, e), with one correct answer scored as one and incorrect answers scored as 0. Below are examples of the test questions used for each indicator:

1. Providing Simple Explanations: In a class discussion, a student claims that if the wavelength of a mechanical wave increases, its frequency decreases, provided the wave speed remains constant. Which of the following arguments best supports this statement?
2. Drawing Conclusions: Based on the graph showing the relationship between the wavelength and frequency of sound, what can be concluded from the data?
3. Building Basic Skills: On Monday, a father drives his car to the office. Along the way, he passes his friend Mr. Robi, and they greet each other by honking their horns. How is the sound of the horn perceived by both the father and Mr. Robi?
4. Providing Further Explanations: A wave traveling on a rope is described by the equation Y=0.03 sin π (2t - 0.1x), where y and x are in seconds. Based on this equation, what can be inferred about the wave's characteristics?

Before the test was administered in the main study, the instrument underwent both expert and empirical validation. Expert validation was conducted by two physics education lecturers, who evaluated the alignment of the questions with the intended indicators. Empirical validation was conducted by administering the test to a small sample group and analyzing the correlation between individual item scores and total scores. Items with a correlation coefficient (r count) greater than the critical value (r table) were considered valid.

Reliability testing was conducted using the Kuder-Richardson Formula 21 (KR-21), suitable for dichotomous (right/wrong) response items. The reliability coefficient obtained was 0.817, indicating a high level of internal consistency and reliability. The data collected were analyzed using descriptive statistical methods. After scoring students' responses on the critical thinking test, their abilities were categorized based on the following criteria in

Table 1 and 2.

Table 1 Score interpretation criteria

Interval Percentage Score	Interpretation Criteria
81 – 100	Very High
61 – 80	High
41 – 60	Medium
21 – 40	Low
0 – 20	Very Low

(Riduan, 2012)

Table 2 Score categorization

Interval Score	Category
17-20	Very High
13-16	High
9-12	Medium
5-8	Low
0-4	Very Low

RESULTS AND DISCUSSION

Based on the findings of the data analysis, the critical thinking ability of class XII MIPA students in learning.

Descriptive Analysis of Critical Thinking Ability Tests of Students in Physics Learning at High School Level in Jeneponto Regency

Based on the findings of the written test conducted, the analysis of students' critical thinking abilities in physics learning at the high school level is presented in Table 3.

Table 3 Descriptive statistical analysis of critical thinking ability of students in physics learning at high school level

Statistics	Statistical Value
Sample Size	84
Ideal Maximum Score	20
Ideal Minimum Score	0
Maximum Empirical Score	18
Minimum Empirical Score	1
Mean (average)	6.86

The following categorization presents the critical thinking abilities of students in physics learning at the high school level in Jeneponto Regency, as shown in Table 4.

Table 4 Categorization of critical thinking ability of students in physics learning at high school level

Interval Score	Category	Frequency	Percentage (%)
17-20	Very High	26	30.95
13-16	High	34	40.47
9-12	Medium	20	23.80
5-8	Low	3	3.57
0-4	Very Low	1	1.19
	Total	84	100%

Based on the data presented in Table 4, the majority of students fall into the high (40.47%) and very high (30.95%) categories, indicating that most of them have demonstrated strong critical thinking skills in understanding physics concepts. These skills involve the ability to analyze, evaluate, and draw conclusions from information. As defined by Ennis (2011), critical thinking is a reflective and reasoned process focused on deciding

what to believe or do.

These findings align with the study by Zubaidah et al. (2018), which emphasizes that science learning designed with problem-based approaches can significantly enhance students' critical thinking skills. The use of instructional methods such as lectures, discussions, question-and-answer sessions, and models like PBL and cooperative learning encourages students to be more actively involved in exploring and reflecting on physics material.

However, a small portion of students fall into the low (3.57%) and very low (1.19%) categories. This suggests a disparity in critical thinking abilities among students, which may stem from differences in learning styles, prior knowledge, or limited active participation in classroom activities. Some students may rely heavily on memorizing formulas without engaging in critical thinking or applying them to real-life situations.

Therefore, physics teachers need to employ differentiated instruction strategies to cater to the diverse needs of learners. Contextual and real-world problem-based activities that encourage idea exploration can provide students with greater opportunities to develop their cognitive potential. Brookhart (2010) highlights the importance of assessments designed to measure higher-order thinking skills, which are crucial for guiding teachers in creating more effective and inclusive instruction.

Descriptive Analysis of Critical Thinking Ability Test of SMAN 2 Jeneponto

Based on the results of the written test conducted, the analysis of the critical thinking ability of class XII MIPA students at SMAN 2 Jeneponto is presented in Table 5.

Table 5 Descriptive statistical analysis of critical thinking ability

Statistics	Statistical Value
Sample Size	32
Ideal Maximum Score	20
Ideal Minimum Score	0
Maximum Empirical Score	12
Minimum Empirical Score	1
Mean (average)	6.06
Standard Deviation	3.49

The following is a categorization of the critical thinking abilities of Class XII MIPA students at SMAN 2 Jeneponto, as shown in Table 6.

Table 6 Categorization of critical thinking ability of students

Interval Score	Kategory	Frequency	Percentage (%)
17-20	Very High	0	0
13-16	High	0	0
9-12	Medium	8	25
5-8	Low	11	34.37
0-4	Very Low	13	40.62
	Total	32	100%

Based on the data presented in Table 6, it is evident that none of the students at SMAN 2 Jeneponto fall into the very high or high categories of critical thinking ability. The majority of students are grouped in the low and very low categories, accounting for 34.37% and 40.62%, respectively. Meanwhile, about 25% of the students are classified as having a Moderate level of critical thinking skills. This situation suggests that most students in this school encounter substantial challenges in developing their critical thinking skills.

This condition suggests a gap in students' critical thinking skills, which several factors may cause. One key factor could be the teaching methods currently used, which may not

effectively encourage students to analyze and evaluate information in depth actively. Learning is often centered on memorizing facts and formulas without promoting reasoning skills and independent problem-solving. This aligns with Facione's (2015) assertion that critical thinking involves the ability to analyze, evaluate, and make rational and reflective decisions.

Furthermore, the low level of critical thinking stems from students' lack of active engagement in the learning process. Without opportunities for discussion, questioning, and connecting material to real-life contexts, students tend to be passive recipients of knowledge. Paul & Elder (2014) emphasize that effective learning environments encourage students to think critically and creatively through interaction and reflection.

In this context, teachers must design learning strategies that not only deliver content but also prioritize the development of higher-order thinking skills. For example, through Problem-Based Learning (PBL) and cooperative learning methods, teachers can encourage students to seek solutions and exchange ideas actively. Such approaches help students gradually sharpen their analytical and evaluative abilities. Additionally, assessments focused on critical thinking skills, such as formative assessments that measure understanding and application, can help teachers gain a realistic picture of students' abilities. Brookhart (2010) emphasizes the importance of assessments designed to measure higher-order thinking skills, enabling more effective and tailored instruction.

In summary, the data confirm that although some students at SMAN 2 Jeneponto possess moderate critical thinking abilities, most still require more intensive support to develop these skills. Therefore, systematic and ongoing efforts from schools and teachers are essential to create a learning environment that accommodates diverse learning needs and optimally stimulates critical thinking skills.

Descriptive Analysis of Critical Thinking Ability Test of SMAN 5 Jeneponto

Based on the results of the written test conducted, the analysis of the critical thinking abilities of class XII MIPA students at SMAN 5 Jeneponto is presented in Table 7.

Table 7 Descriptive statistical analysis of critical thinking ability

Statistics	Statistical Value
Sample Size	28
Ideal Maximum Score	20
Ideal Minimum Score	0
Maximum Empirical Score	11
Minimum Empirical Score	1
Mean (average)	5.5
Standard Deviation	2.5

The following is a categorization of the critical thinking Ability of class XII MIPA students at SMAN 5 Jeneponto, as shown in Table 8.

Table 8 Categorization of critical thinking ability scores

Interval Score	Kategory	Frequency	Percentage (%)
17-20	Very High	0	0
13-16	High	0	0
9-12	Medium	3	10.71
5-8	Low	14	50
0-4	Very Low	11	39.28
	Total	**28**	**100%**

The data in Table 8 show that most 12th-grade science students at SMAN 5 Jeneponto fall into the low and very low categories of critical thinking ability, with percentages of 50% and 39.28%, respectively. Only a small number of students (10.71%) reached the

medium category, and none were in the high or very high categories. This suggests that many students continue to struggle with critical thinking when learning physics.

Paul & Elder (2014) highlight the importance of learning approaches that encourage students to ask questions, evaluate evidence, and connect the concepts they study. Active and interactive teaching methods can help students gradually improve their critical thinking skills. Besides teaching methods, differences in students' learning styles and motivation may also affect these results. Some students may not have found the most effective way to learn or may have had fewer opportunities to practice critical thinking during lessons. Therefore, teachers should create supportive learning environments and provide various activities that encourage students to think more deeply and creatively. By paying attention to these factors, the critical thinking abilities of students at SMAN 5 Jeneponto will improve significantly, enabling them not only to memorize physics content but also to understand and apply the concepts in real life.

Descriptive Analysis of Critical Thinking Ability Test of SMAN 11 Jeneponto

Based on the results of the written test conducted, the analysis of the critical thinking abilities of class XII MIPA students at SMAN 11 Jeneponto is presented in Table 9.

Table 9 Descriptive statistical analysis of critical thinking ability

Statistics	Statistical Value
Sample Size	24
Ideal Maximum Score	20
Ideal Minimum Score	0
Maximum Empirical Score	18
Minimum Empirical Score	3
Mean (average)	9.54
Standard Deviation	3.82

The following is a categorization of the critical thinking abilities of Class XII MIPA students at SMAN 11 Jeneponto, as shown in Table 10.

Table 10 Categorization of critical thinking ability scores

Interval Score	Category	Frequency	Percentage (%)
17-20	Very High	1	4.16
13-16	High	3	12.5
9-12	Medium	9	37.5
5-8	Low	9	37.5
0-4	Very Low	2	8.33
	Total	**24**	**100%**

Based on the data in Table 10, most students in the XII MIPA class at SMAN 11 Jeneponto fall into the medium and low categories, each accounting for 37.5%. This suggests that the majority of students' critical thinking skills have not yet reached the expected level and require further improvement. Developing these skills is crucial for students to gain a deeper understanding of physics concepts. Furthermore, only a small portion of students are in the very high and high categories, with percentages of 4.16% and 12.5% respectively. This small percentage suggests that few students are truly capable of thinking critically at a deep level and can effectively analyze and evaluate information in the context of physics learning.

This situation shows that some students still struggle to apply critical thinking skills, such as drawing conclusions and providing further explanations related to the material studied. This difficulty might be caused by teaching methods that lack variety and do not actively involve students in the learning process. Therefore, teachers need to implement more interactive and challenging teaching strategies so that students are encouraged to

participate actively and develop their critical thinking abilities. With the right approach, students are expected to understand physics material more critically and connect their knowledge to real-world situations.

Based on the descriptive statistical analysis of the overall written test data of the critical thinking ability of students of XII MIPA in the three schools:

Senior High School in Jeneponto Regency

Among 84 students, 30.95% (26 students) demonstrated very high critical thinking skills, 40.47% (34 students) had high skills, 23.80% (20 students) had moderate skills, 3.57% (3 students) had low skills, and 1.19% (1 student) had very low skills. The average score was 6.48 (32.44%), indicating that, overall, students' critical thinking skills remain relatively underdeveloped. These results align with those of Asniar et al. (2022), whose study at SMAN 11 Makassar also found that the majority of students were classified in the low to very low categories of critical thinking. This suggests that teacher-centered learning approaches, such as lecturing, limit students' opportunities to engage in interpretive reasoning and draw logical conclusions.

SMAN 2 Jeneponto

Out of 32 students, none reached high or very high levels. Twenty-five percent (8 students) scored at a moderate level, 34.37% (11 students) low, and 40.62% (13 students) very low. The mean score of 5.67 placed this school in the low category. SMAN 2 Jeneponto showed the poorest overall performance, with a majority of students in the very low group. This may be due to the use of limited teaching strategies and insufficient practice with abstract and conceptual physics problems. This observation supports findings by Yuliati (2018), which highlights how difficulty in grasping abstract concepts obstructs the development of critical thinking. Additionally, the lack of contextualized and real-world physics questions also limits students' analytical engagement. Anggareni et al. (2013) emphasized that cultivating critical thinking requires regular exposure to analytical and reflective questioning.

SMAN 5 Jeneponto

Among 28 students, none achieved high or very high critical thinking scores. A modest 10.71% (3 students) were in the moderate range, while 50% (14 students) were low, and 39.28% (11 students) very low. The average score of 5.16 also falls into the low category. Although the average score resembles that of SMAN 2, the distribution shows a slightly larger percentage of students in the low category, rather than the very low category, indicating somewhat better performance. Research by Aini (2020) confirms that cooperative learning methods can enhance students' critical thinking. The continued dependence on traditional lectures at SMAN 5 likely contributes to the suboptimal learning outcomes, despite opportunities for improvement through active and collaborative teaching.

SMAN 11 Jeneponto

Of the 24 students assessed, 4.16% (1 student) scored very high, 12.5% (3 students) scored high, 37.5% (9 students) scored moderate, 37.5% (9 students) scored low, and 8.33% (2 students) scored very low. With an average score of 9.12, this school falls into the moderate category and shows the best performance among the three schools. It not only scored highest on average but also had a more balanced distribution, with many students in the moderate to high categories. These results suggest that SMAN 11 applies a more diverse range of teaching methods, has better access to learning resources, and benefits from more

active teacher involvement. Instructional approaches focused on Higher Order Thinking Skills (HOTS), as recommended by Rahmawati (2021), likely contribute to their superior development of critical thinking. This is consistent with Setyarini (2019), who noted the importance of instructional quality and supportive learning environments in fostering reasoning skills.

Comparison Among Schools and Influencing Factors

The differences observed across the three schools highlight SMAN 11 Jeneponto as more effective in promoting critical thinking, likely due to its use of more innovative pedagogical strategies and supportive learning conditions. Conversely, SMAN 2 and SMAN 5 predominantly rely on conventional lectures, limiting student engagement in analytical thinking. Other factors influencing these disparities may include teacher readiness, student academic backgrounds, availability of educational resources, and the emphasis placed on abstract physics concepts during instruction.

Research Contribution and Novelty

Unlike previous studies, such as Asniar et al. (2022), Yuliati (2018), and Kurniawan (2019) which typically focus on single schools or general recommendations, this study offers a novel comparative analysis of multiple schools within the same region. It provides contextual insights into how teaching practices, resource availability, and local education policies influence students' learning outcomes. These findings can serve as a foundation for context-specific interventions aimed at improving instructional quality and enhancing critical thinking skills at the senior high school level.

CONCLUSION

Based on the findings and discussion from the research outlined in the preceding chapter, it is concluded that the critical thinking abilities of students in physics education at the high school level in Jeneponto Regency fall within the low category. The implications of this study are to enhance learning activities, for example, by utilizing innovative and interactive learning methods and evaluating students' critical thinking skills.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

All authors' contributions to manuscript preparation are defined by the criteria: Conceptualization, methodology, formal analysis, and writing—preparation of the original draft, writing the manuscript, and others.

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