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Critical Thinking Skills in Physics Learning of Students at SMAN 8 Makassar

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Abstract

This research aims to analyze critical thinking skills in students' physics learning at SMAN 8 Makassar. It is descriptive research employing a survey method. The research subjects are 271 students from the 10th grade at SMAN 8 Makassar, distributed across nine classes. Students' critical thinking skills are measured using a multiple-choice test instrument with indicators such as interpretation, analysis, and inference. The data collection technique used is a critical thinking skills test consisting of multiple-choice questions covering critical thinking indicators. The researcher developed these questions and underwent validation by experts and empirical validation processes. The expert validation results show that the test instrument is valid with a score above 0.75. The research results are analyzed using descriptive statistical analysis, indicating that students' critical thinking skills are still in the low category. The critical thinking skills level for interpretation is 29.97%, for analysis is 31.30%, and for inference is 38.73%. This implies that teachers must strive for innovative teaching methods to empower students' critical thinking skills. The implications of this research are expected to provide support and opportunities for teachers to improve the quality of the learning process, enabling students to develop critical thinking skills in solving physics problems and producing high-achieving students.

Keywords: analysis; critical thinking; inference; interpretation

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INTRODUCTION

Education is an effort to nurture and develop the personality of individuals, both spiritually and physically. Education is a crucial component in realizing each individual's high-quality, intelligent, competitive, and improved well-being. It is expected to prepare individuals to face various changes and challenges of globalization affecting quality human resources (Changwong et al., 2018). Therefore, future education is expected to improve continually, influencing the development of science and technology (Saparuddin & Patongai, 2021).

A notable change in the 21st century is the rapid development of science and technology, leading to learning models

marked by curriculum and technological changes (Howelss, 2018). Effective learning media interpret abstract concepts into easily understandable ones. There are four competencies students should possess in the 21st century: critical thinking, creativity, communication skills, and collaborative abilities (Afida, 2023; Misbah et al., 2022; Suyidno et al., 2019; Yani et al., 2021).

Critical thinking skills are crucial for facing life's challenges, including critical thinking, creative thinking, and problem-solving skills (Kalelioğlu & Gülbahar, 2014; Saregar et al., 2021). Critical thinking involves reflective thinking, where individuals select knowledge stored in their memory to solve problems, achieve goals, and provide reasons for their beliefs (Agnafia, 2019; Haryandi et al., 2019).

Physics education aims to develop students' thinking skills to be competent and proficient in psychomotor and cognitive domains and to support systematic, objective, and creative thinking (Trúsiková & Velmovská, 2022). Physics learning processes that do not align with the essence of physics education do not allow students to actively participate in scientific processes, develop scientific process skills, or cultivate critical thinking skills (Pratama & Istiyono, 2015).

Physics learning processes can help students develop critical thinking skills. The demands of the 2014 curriculum state that physics subjects in schools should focus on students. Students are expected to be active, creative, and independent. Student-centered learning processes are useful for building their understanding without relying heavily on teachers. Therefore, the teacher's role in the learning process is to train the critical thinking skills of each individual (Lubis, 2015).

Everyone has different critical thinking skills, depending on how frequently they practice developing them (Sunarti et al., 2021). Practices include asking questions, making assumptions, identifying information, and more. Students still struggle with high-order thinking skills (HOTS) questions requiring analytical, creative, and critical thinking. Physics learning in schools is still dominated by the teacher's role, hindering students' critical thinking skills (Holmes et al., 2015).

Over the years, Indonesia has not shown significant improvement in science. According to the results of the Programme for International Student Assessment (PISA), this is due to various factors, one of which is that Indonesian students still have low critical thinking skills in solving high-order thinking skill (HOTS) problems (Pratiwi, 2019). PISA study questions consist of contextual problems in daily life to measure high-level thinking skills (Zikrina et al., 2021). Students are required to think critically in answering these PISA questions (Suprayitno, 2019).

Based on observations at SMAN 8 Makassar, students' learning outcomes are not considered successful, as seen from the physics test scores on the quantity and unit material for the 10th grade. Due to low academic achievements in physics, the average student is below the minimum passing grade criteria. Previous research shows that physics learning outcomes in one high school in Makassar, for instance, had participants with scores ranging from 34-54, with a percentage of 7.69%, where the standard KKM for Physics in the 11th grade in high school is 75. One factor contributing to the low academic performance in physics learning is that many students cannot think critically in the learning process. Research (Alemda & Desniata, 2023) shows that empowering students' critical thinking skills improves learning outcomes.

Given the above reality, Indonesian students lag behind those in other developing countries. Therefore, the

question raised in this research is how critical thinking skills are in physics learning for students at SMAN 8 Makassar. The research aims to analyze critical thinking skills in physics learning for students at SMAN 8 Makassar.

METHOD

This study is a descriptive research of the survey type. It is descriptive because the researcher needs to provide an overview of students' critical thinking skills. This overview is presented by analyzing students' critical thinking abilities in physics subjects (Asniar et al., 2022).

The research was conducted at SMAN 8 Makassar during the second semester of the 2022/2023 academic year. The subjects of this study were 271 students from the 10th grade at SMAN 8 Makassar in the academic year 2022/2023, distributed across nine classes.

The data collection technique used in this research involved providing a critical thinking skills test instrument distributed online to the predetermined research samples through a Google Form link. The instrument consisted of multiple-choice questions covering quantity and unit materials with a grid developed based on critical thinking skill indicators, totaling 15 questions that include interpretation, analysis, and inference indicators. The researcher developed these questions and underwent expert and empirical validation processes. Expert validation aimed to assess the content and construction of the critical thinking instrument, with each question structured based on the intended indicators. The expert validation results indicated that the test instrument was valid with a score above 0.75. For empirical validation results, the critical value (r-table) was 0.3882, with 12 questions valid and three not. The reliability score was above the alpha coefficient at 0.486.

Based on the critical thinking skills test data, students were grouped according to the critical thinking classification criteria. Statistical analysis was employed to analyze students' critical thinking skills in solving physics problems. The analysis described students' critical thinking abilities by presenting highest scores, lowest scores, average scores, and standard deviations.

The scores obtained by students were calculated, and critical thinking skills were categorized based on the critical thinking classification criteria, as shown in Table 1.

Table 1 Critical thinking classification criteria

Percentage	Category
81-100	Very High
61-80	High
41-60	Medium
21-40	Low
0-20	Very Low

(Riduwan, 2013)

RESULTS AND DISCUSSION

This research describes the scores of students' critical thinking skills at SMAN 8 Makassar, presented in Table 2.

Table 2 Descriptive analysis of critical thinking skills of 10th-grade students at SMAN 8

Statistics	Statistics Score
Research Subjects	271
Highest Score	12
Lowest Score	0
Average	4.431
Mode	3
Standard Deviation	2.59

The analysis results in Table 2 show an average score of critical thinking skills achieved by 271 students as the research sample, which is 4.431, with a standard deviation of 2.59. The lowest score obtained by students is 0, and the highest score is 12. The most frequently occurring score is 3, indicating that many students fall into the low category based on the criteria used.

Based on the indicators of critical thinking skills, the level of critical thinking skills of 10th-grade students at

SMAN 8 Makassar can be seen in Table 3.

Table 3 Frequency distribution of critical thinking skills scores of 10th-grade students at SMAN 8 Makassar

Category	Frequency	Percentage
Very High	14	5.17
High	22	8.12
Medium	79	29.15
Low	97	35.79
Very Low	59	21.77
Total	271	100%

Table 3 shows that the level of critical thinking skills is still relatively low, and a histogram of critical thinking skills can be observed in Figure 1.

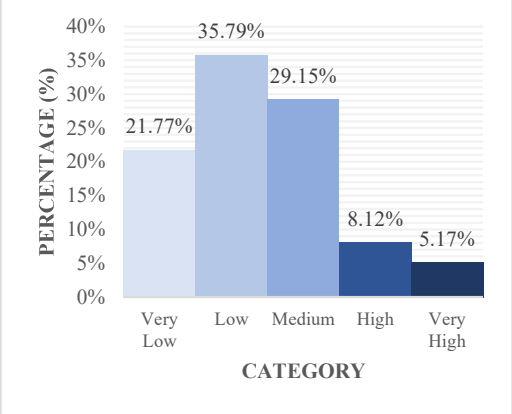

Figure 1 Diagram of critical thinking skills of 10th-grade students at SMAN 8 Makassar

Interpretation

The results of descriptive statistical calculations of the scores of students' critical thinking skills at SMAN 8 Makassar in the interpretation indicator can be seen in Table 4.

Table 4 Descriptive analysis of critical thinking skills in the interpretation indicator

Statistics	Statistics Score
Research Subjects	271
Highest Score	4
Lowest Score	0
Average	1.32
Mode	1
Standard Deviation	0.997

The analysis results in Table 4 show an average score of critical thinking skills in the interpretation indicator, 1.32, with a standard deviation of 0.997. The lowest score obtained by students is 0, and the highest score is 4. The frequency distribution of critical thinking skills scores in the interpretation indicator for 10th-grade students at SMAN 8 Makassar is presented in Table 5.

Table 5 Frequency distribution of critical thinking skills scores of students on the interpretation indicator

Category	Frequency	Percentage
Very High	4	1.48
High	35	12.92
Medium	65	23.99
Low	109	40.22
Very Low	58	21.40
Total	271	100%

When looking at the average score of 1.32, students' critical thinking skills on the interpretation indicator are categorized as low, as shown in the histogram of critical thinking skills levels in Figure 2.

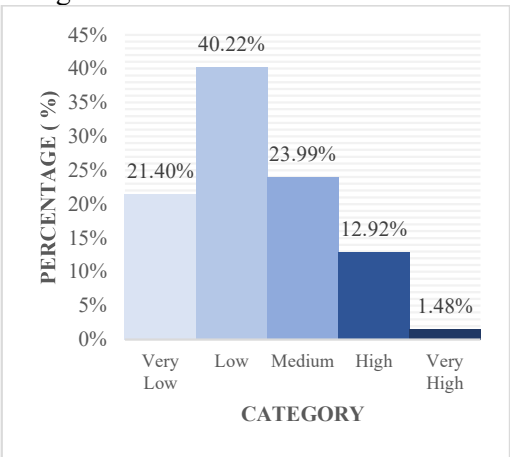

Figure 2 Histogram of critical thinking skills on the interpretation indicator

Figure 2 shows that students' ability to comprehend and express the meaning of questions/statements in the given physics problems is relatively low. The interpretation indicator, with achievement

in the low category, is attributed to many students still having difficulty understanding the questions or failing to articulate what is known and asked in the problems. This can be observed from the students' test results. In line with the statement by (Maslakhatunni'mah et al., 2019) that students are expected to explain events by connecting related causes and effects from the problems, most students still struggle with problems related to the material. According to (Zhou et al., 2013), interpretation is the ability to sort out a problem and clarify the meaning thoroughly. Orlich suggests that one crucial aspect of critical thinking is interpretation. It can train students to interpret observed objects and explain and understand situations, procedures, or rules (Agnafia, 2019).

Analysis

The results of descriptive statistical calculations of the students' critical thinking skills scores at SMAN 8 Makassar in the analysis indicator are reviewed in Table 6.

Table 6 Descriptive analysis of critical thinking skills of 10th-grade students at SMAN 8 Makassar on the analysis indicator

Statistics	Statistics Score
Research Subjects	271
Highest Score	4
Lowest Score	0
Average	1,38
Mode	1
Standard Deviation	1,218

The analysis results presented in Table 6 show an average score of critical thinking skills on the analysis indicator, which is 1.38, with a standard deviation of 1.218. The lowest score obtained by students is 0, and the highest score is 4. The frequency distribution of critical thinking skills scores on the analysis indicator for 10th-grade students at SMAN 8 Makassar is presented in Table 7.

Table 7 Frequency distribution of critical thinking skills scores of 10th-grade students on the analysis indicator

Category	Frequency	Percentage
Very High	19	7.01
High	34	12.55
Medium	58	21.40
Low	82	30.26
Very Low	78	28.78
Total	271	100%

Table 7 presents the distribution of student frequencies in each category of critical thinking skills on the analysis indicator. The categories include very high, with a percentage of 7.01%; high, with a percentage of 12.55%; moderate, with a percentage of 21.40%; low, with a percentage of 30.26%; and very low, with a percentage of 28.78%. When looking at the average score of 1.38 indicates that students' critical thinking skills on the analysis indicator are in the low category. The histogram depicting the level of critical thinking skills on the analysis indicator is shown in Figure 3.

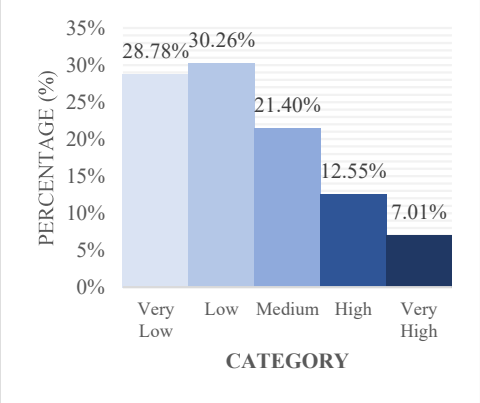

Figure 3 Diagram of critical thinking skills on the analysis indicator

The level of students' critical thinking skills on the analysis indicator can be interpreted as the ability to differentiate the correct relationship between questions and ideas in the given physics problems. Figure 3 suggests that students cannot distinguish the appropriate relationships between explanations, questions, and ideas in the given material science

problems. It is categorized as low in the analysis indicator because most students can use logical data and understand explanations. However, many still cannot connect data from questions to answer and receive responses. This aligns with the statements made by Selviana et al. (2016) that students with strong critical thinking and thorough investigation skills facing a problem are individuals with good critical thinking skills (Rodzalan & Saat, 2015). Students still struggle to recognize known variables, what is being asked, and efforts in solving the given problems (Bell & Loon, 2015), resulting in low analytical skills (Haryandi et al., 2013). There are various ways to improve critical thinking, including enhancing analytical skills in a discussion and finding suitable solutions while analyzing the worst impacts of the problem (Susilowati et al., 2017).

Inference

The descriptive statistical calculation results of students' critical thinking skills scores at SMAN 8 Makassar in the inference indicator are reviewed in Table 8.

Table 8 Descriptive analysis of critical thinking skills of 10th-grade students at SMAN 8 Makassar on the inference indicator

Statistics	Statistics Score
Research Subjects	271
Highest Score	4
Lowest Score	0
Average	1.716
Mode	1
Standard Deviation	1.186

The analysis results in Table 8 show an average score of critical thinking skills on the inference indicator, 1.716, with a standard deviation of 1.186. The lowest score obtained by students is 0, and the highest score is 4. The frequency distribution of critical thinking skills scores on the inference indicator for 10th-grade students at SMAN 8 Makassar is presented in Table 9.

Table 9 Frequency distribution of critical thinking skills scores of 10th-grade students on the inference indicator

Category	Frequency	Percentage
Very High	28	10.33
High	39	14.39
Medium	72	26.57
Low	92	33.95
Very Low	40	14.76
Total	271	100%

Table 9 shows the distribution of student frequencies in each category of critical thinking skills on the inference indicator. Categories include very high, with a percentage of 10.33% high with a percentage of 14.39%, with a percentage of 26.57%; low, with a percentage of 33.95%; and very low, with a percentage of 14.76%. When looking at the average score of 1.716 indicates that students' critical thinking skills on the inference indicator are in the low category. The histogram depicting the level of critical thinking skills on the inference indicator based on the percentage of students' scores is shown in Figure 4.

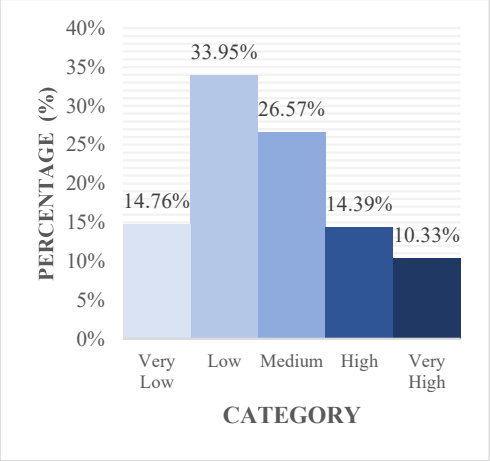

Figure 4 Diagram of critical thinking skills on the inference indicator

The level of students' critical thinking skills on the inference indicator can be interpreted as recognizing and obtaining the expected elements to make a sensible

decision by considering statements, standards, evidence, feelings, beliefs, and various types of representations. Given the information in Figure 4, it can be assumed that students cannot recognize and obtain the components needed to make decisions about specific physics issues. It is categorized as low in the inference indicator because students cannot recognize and obtain the expected components to make a sensible solution, and many students usually provide results beyond the topic. As indicated by Nuraini (2017) one variable affecting the low ability of students' inference is that students are not directly involved during the developing experience through conversation and exploratory learning strategies, so students do not have the opportunity to directly respond to a problem they are experiencing (Vong & Kaewurai, 2017). This aligns with the findings of Parappilly et al. (2013) stating that experimental learning techniques can foster students' applied understanding and reasoning skills. Critical students can identify a problem, leading to a conclusion. Concluding aims to interpret what has been observed (Koasih, 2014).

The critical thinking skills of students still in the low category are due to students being accustomed to memorization, having a limited grasp of concepts, and being untrained in critical thinking. Students also lack basic knowledge, leading to difficulties in solving problems and finding alternative solutions (Wenno et al., 2022). This is consistent with the findings of Patonah (2014) and Ruggiero (2012) that the learning process is still dominated by educators, prioritizing memory or rote learning over developing thinking skills, causing weak learners to analyze and express their ideas. Meanwhile, critical thinking skills that are still in the moderate category are due to a lack of practice in various scientific problems, limited learning sources, biased perceptions, and limited learning time hindering the development of students' thinking (Ebosele, 2012).

Efforts to empower critical thinking skills can be shaped and honed through well-organized and directed learning processes, where every physics learning requires critical thinking skills. As explained by Kurniawati et al. (2016) and Yunita et al. (2019), critical thinking can be taught and requires practice to possess it. Critical thinking skills must be trained in students because critical thinking allows them to analyze their thoughts when making choices and intelligently draw conclusions. Furthermore, students' critical thinking skills can be developed by applying appropriate learning strategies (Palennari, 2016).

The learning process should include critical thinking skills that students must have (Fang, 2012). Students must be able to interpret, analyze, infer a problem, and make decisions. Lack of practice in evaluation can result in low critical thinking skills in students (Chukwuyenum, 2013; Švecová et al., 2014)Click or tap here to enter text.. The learning experience gained by students greatly influences critical thinking skills. Learning activities that train critical thinking skills will significantly affect the development and improvement of students' critical thinking skills.

CONCLUSION

Based on the conducted research, it can be concluded that the critical thinking skills of physics learning for students at SMAN 8 Makassar in the interpretation, analysis, and inference indicators are categorized as low. It can be classified as low, with an average score of 4.431. This is evident from the data analysis results, indicating that the level of critical thinking skills for students in the interpretation indicator is only 29.97%; for the analysis indicator, it is only 31.30%, and the remaining 38.73% for the inference category.

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