

Students' Critical Thinking Ability on Global Warming Material at Pariaman High School

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ABSTRACT

21st century learning in the era of globalization requires students to have abilities that can help them face the demands of contemporary developments. Of the various abilities demanded in the 21st century, students must possess critical thinking skills in order to navigate life's challenges and competition. Practicing this ability is certainly carried out by all subjects including physics. One of the materials in physics subjects is global warming. Different initiatives have been undertaken to cultivate a generation equipped with abilities relevant to the 21st century, particularly emphasizing critical thinking to address everyday challenges, primarily through the utilization of an independent curriculum. However, in reality, learning physics is often considered a difficult lesson, students tend to learn by memorizing topics rather than investigating, analyzing and solving real world problems, so critical thinking abilities are less developed. This study aims to outline students' critical thinking abilities in relation to global warming content. Descriptive research is the method of research that was utilized. The research was conducted at three high schools in Pariaman. A total of 79 students were given a critical thinking ability test with the instrument used in the form of a 10-question essay. Overall, the research results show that the average critical thinking ability of students is still very low with a score of 39.16. Based on the results of the analysis, the highest score was obtained for the aspect of providing simple clarification. This is followed by aspects of strategy and tactics, aspects of building basic skills, concluding and making further clarifications in the very low category.

Keywords : critical thinking skills; physics learning; global warming.



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I. INTRODUCTION

21st century learning in the era of globalization requires students to have abilities that can help them face the demands of contemporary developments. The aim of education in today's times is to create a cohort of graduates who are proficient not just in information technology, but also demonstrate strong critical thinking abilities, literacy, problem-solving skills, communication, collaborative skills, and possess positive character traits. [1]. Of the various abilities demanded in the 21st century, students must possess critical thinking abilities in order to navigate life's challenges and competition. [2,3]. A person who can think critically will have the skills to locate pertinent information through logic, draw accurate conclusions, and apply it effectively in real-life situations. [4]. Critical thinking skills can help someone to verify the truth of information and distinguish whether the information is worthy of being accepted [5]

Critical thinking is an essential ability where the learning process that involves this ability encourages students to participate actively and be able to make wise, critical decisions. [6]. Critical thinking means focusing on what is believed by involving standard and reasonable thinking [7]. Critical thinking is an essential aspect of education, and it is a crucial cognitive skill that should be developed in schools [8]. Proper learning not only enhances comprehension of the content but also enhances critical thinking and other abilities.[9]. Teachers have a crucial impact on enhancing students' critical thinking abilities. The development of these abilities can be trained by implementing appropriate learning so that students become accustomed to applying and practicing thinking skills. It is envisaged that if this ability is developed, excellent human resources with strong

competitiveness will be able to compete in the workforce in a healthy way. Increasing these abilities is of course carried out by all subjects including physics.

Physics, as a field of science, is intricately linked to the natural world and the various phenomena that take place in our surroundings. The focus of physics research involves exploring natural occurrences, understanding the workings of nature, examining natural interactions, and observing the transformations that take place within it. [10,11,12]. Studying physics helps to cultivate critical thinking abilities that can be applied to solving practical problems in daily life. Studying physics not only teaches students theoretical principles, but also includes hands-on experiments and serves as a platform for fostering critical thinking abilities that can be applied to real-life situations. The goal of studying physics is to gain insight into the fundamental physical laws that govern the universe and to enhance abilities in quantitative reasoning and critical thinking.[13].

Different initiatives have been undertaken to cultivate a generation equipped with abilities relevant to the 21st century, particularly emphasizing critical thinking to address everyday challenges, primarily through the utilization of an independent curriculum. Independent curriculum learning focuses on the skills necessary to be cultivated in the 21st century, such as critical thinking abilities, cooperation, communication, creativity and problem solving [14]. Focusing on these abilities can prepare students to meet the demands and changes of a complex and ever-evolving world.

However, in reality, learning physics is often considered a difficult lesson, so students dislike learning it [15]. Students tend to learn by memorizing topics rather than investigating, analyzing, and solving real-world problems, so critical thinking abilities are underdeveloped [16]. Physics learning is also still teacher-centered in its implementation [17]. This indicates that it has not helped students in developing critical thinking abilities. [18]. This causes students' critical thinking abilities to remain low [12,13,20]. In the learning process, critical thinking plays an important role in developing potential, carrying out tasks and solving problems, as well as drawing conclusions on the material being taught [21]. Concepts from physics lessons, such as global warming material, can help students practice critical thinking abilities. The core topic in global warming material includes questions that ask students to think about and decide on a problem so that they can develop critical thinking abilities [22].

According to this explanation, it is important to assess students' critical thinking abilities so that teachers can prioritize implementing suitable policies to enhance these abilities. Hence, it is crucial to conduct a study focusing on students' critical thinking abilities when it comes to understanding global warming concepts in physics learning

II. METHOD

Researchers utilize descriptive research methods to analyze and interpret symptoms or phenomenon without providing any treatment to the variables studied [23]. The research subjects were 79 students from three high schools in Pariaman, namely SMAN 5 Pariaman, SMAN 1 V Koto Timur and SMAN 2 Pariaman. This study aims to outline students' critical thinking abilities in relation to global warming content

The research utilized a critical thinking assessment tool consisting of 10 essay questions. The questions presented are packaged according to aspects of Ennis' critical thinking abilities, namely providing simple clarifications, building basic skills, concluding, making further clarifications as well as strategies and tactics.[24]. Each aspect of critical thinking skills consists of two questions. The questions given as tests to students are sourced from research by Syafaun Nada (2021) and have been tested for validity and reliability by experts. Each answer to the question is assessed using a rubric that has been developed according to the keywords contained in the answer. The distribution of questions according to aspects of critical thinking abilities is presented in Table 1.

Table 1. Distribution of questions according to aspects of critical thinking abilities

Aspect	Question Number
Provide Simple Clarification	1, 7
Building Basic Skills	2, 5
Conclude	3, 9
Making Further Clarifications	4, 8
Strategy and Tactics	6, 10

The data obtained was analyzed by checking students' answers. The assessment will be adjusted to the criteria contained in the critical thinking assessment rubric developed. To obtain student grades, use the equation formula (1).

$$Value = \frac{total\ score}{maximum\ total\ score} \times 100 \quad (1)$$

The scores obtained from student tests are analyzed descriptively and classified according to the critical thinking ability category. Table 2 presents the different levels of critical thinking abilities among students.

Table 2. Categories of Students' Critical Thinking Ability Level

Percentage	Category
$0 < \text{value} \leq 43,75$	Very low
$43,75 < \text{value} \leq 62,50$	Low
$62,50 < \text{value} \leq 71,50$	Enough
$71,50 < \text{value} \leq 81,25$	High
$81,25 < \text{value} \leq 100,00$	Very high

(Sumber: [15])

III. RESULTS AND DISCUSSION

Students' critical thinking abilities are measured through test results in the form of essay type questions. This question was given to 79 high school students who had studied global warming material. Scores are given based on the assessment guidelines that have been created. The results of students' critical thinking ability tests are divided into five aspects mentioned in the method, then the results obtained are analyzed based on the critical thinking ability aspects presented in Table 3.

Table 3. Student critical thinking ability test results

Aspect	Percentage	Category
Provide Simple Clarification	45,79	Low
Building Basic Skills	40,53	Very low
Conclude	35,52	Very low
Making Further Clarifications	31,41	Very low
Strategy and Tactics	42,54	Very low
Average	39,16	Very low

According to Table 3, the average score of students' critical thinking abilities remains quite low, at 39.16. Judging from aspects, students' ability to provide simple clarifications is included in the low category. Meanwhile, building basic skills, concluding, making further clarifications as well as strategies and tactics are included in the very low category. These results are in line with the findings of researchers Putri et al (2023) who stated that the average percentage of critical thinking abilities is still in the low category of the scores obtained [22]. The following is an explanation of five aspects of students' critical thinking abilities in global warming material.

1. Provide simple clarification

Question number 7 relates to the aspect of the ability to provide simple clarification. In this question, a table of the differences between LED and incandescent lamps is presented in order to ask and answer questions regarding the efficiency of using these two lamps as a solution to reducing the impact of global warming. According to the findings from analyzing the responses of students to question 7, 30 students answered correctly, 16 students answered incorrectly and 33 students answered incorrectly. The average score obtained by students was 48.67 in the low category. An example of a student's answer to number 7 is presented in Figure 1.

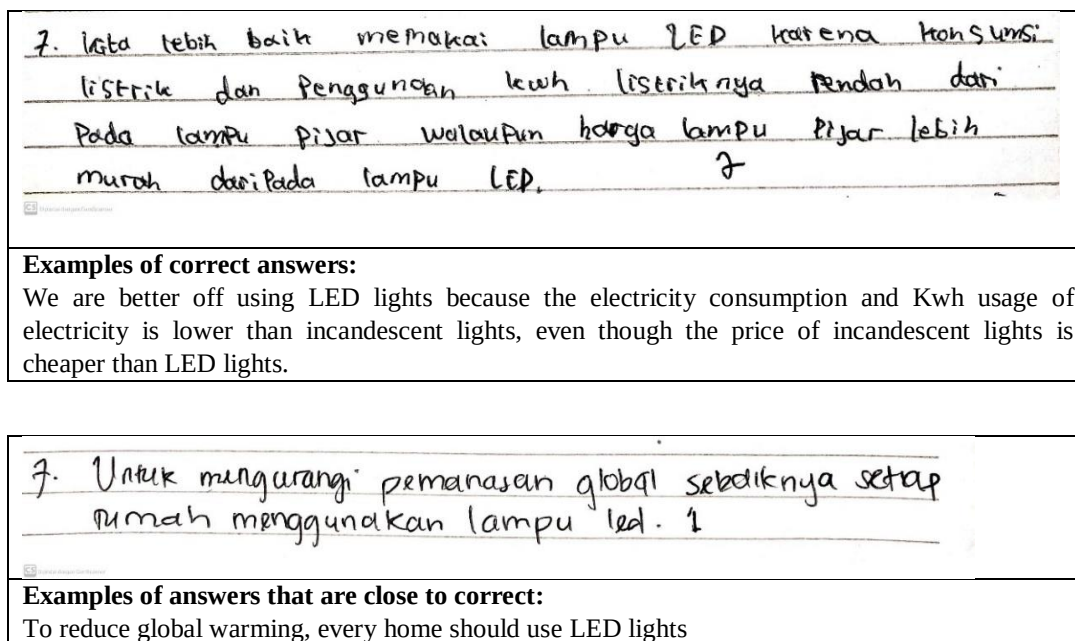


Fig 1. Example of student answer to question number 7

On this question, there were still many students who gave inaccurate answers. Students only answered by choosing to use one of the two types of lamps without providing clarification or reasons for choosing that lamp. This is because students do not focus on what is asked of the question so they do not provide the simple explanation that should be given. Students should answer by choosing to use LED lights with the considerations outlined in the table where electricity consumption and Kwh of electricity are lower than incandescent lights even though the price of LED lights is more expensive.

Overall, this aspect of ability is in the low category with an average score of 45.79. The ability to provide simple clarification is a basic ability for students to be able to think critically which they should already have. However, there are still many students who give inaccurate answers to questions about this aspect of ability. The aspect of the ability to provide simple clarification is related to the ability to focus one's thoughts on a problem and efforts to overcome or resolve it [18]. To provide an explanation, students must be able to utilize existing knowledge and relate it to the context of the problem they face.

2. Build basic skills

Question number 2 relates to critical thinking abilities in the aspect of building basic skills. The phenomenon presented is related to the greenhouse effect phenomenon. In this question, a graph of greenhouse gas concentrations and a graph of sectors contributing to greenhouse gases are presented. Students should be able to analyze graphs and critically assess arguments about how the agricultural industry contributes to greenhouse gas emissions. The example provided in Figure 2 is a student's response.

2. Pada 1 sisi pendapat adi juga ada benarnya, karena dampak dari gas rumah kaca bisa membuat tanaman yang sudah seharusnya bisa dipanen malah gagal panen karena pemanasan global. dan pada sisi lainnya juga ada beberapa pertanian yang menggunakan pestisida sehingga membuat gas rumah kaca meningkat, jadi bisa sesuai dengan pendapat Adi. 2

Examples of correct answers:
On the one hand, Adi's opinion is also correct, because the impact of greenhouse gases can cause crops that should be harvestable to fail due to global warming. And on the other hand, there are also some farms that use pesticides, thereby increasing greenhouse gases, so this could be in line with Adi's opinion

2. Kesimpulan adi ~~tidak~~ tepat karena pertanian juga berpengaruh pada rumah kaca, disebabkan karena pemakaian pupuk. 1

Examples of answers that are close to correct:
Adi's conclusion is correct because agriculture also affects greenhouses due to the use of fertilizer

Fig 2. Example of student answer to question number 2

Based on the findings of the analysis of responses to question 2, 14 students answered correctly, 30 students answered incorrectly and 35 students answered incorrectly. The average score obtained by students was 39.80 in the very low category. Based on the answers to questions regarding aspects of building basic skills, students still have difficulty considering existing arguments and connecting them with the graphs presented. The ability to build basic skills depends on how someone thinks in connecting related variables in a problem [21]. Some of the students' answers did not explain the impact of greenhouse gases on the agricultural sector, only agreeing with existing arguments without connecting them with the results of observations in the graph. Overall, the results of the analysis on this ability, students obtained an average score of 40.53 in the very low category.

3. Conclude

Question number 3 relates to the ability to make conclusions. The problem presented is information regarding the area of coral reefs identified as experiencing damage and is reinforced with two pictures of coral reefs in different years. Students are asked to explain the causes and impacts of this phenomenon. The following is an example of the answer given by students to question number 3 in Figure 3.

3. penyebab nya seperti pengambilan karang secara ilegal, penggunaan bom, penangkapan ikan, pembangunan jangkar dan perubahan iklim. Dampaknya penurunan parameter kondisi terumbu karang dan hupan karang mahi meningkat. 2

Examples of answers that are close to correct:
The causes include illegal coral harvesting, use of bombs, fishing, anchor construction and climate change. The impact is a decrease in coral reef condition parameters and

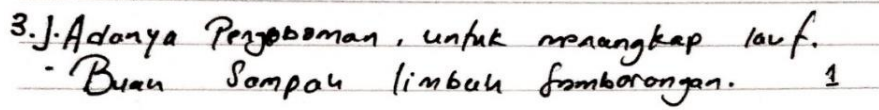
increased dead coral cover

Examples of answers that are close to correct: -There is bombing to capture at sea, -Littering

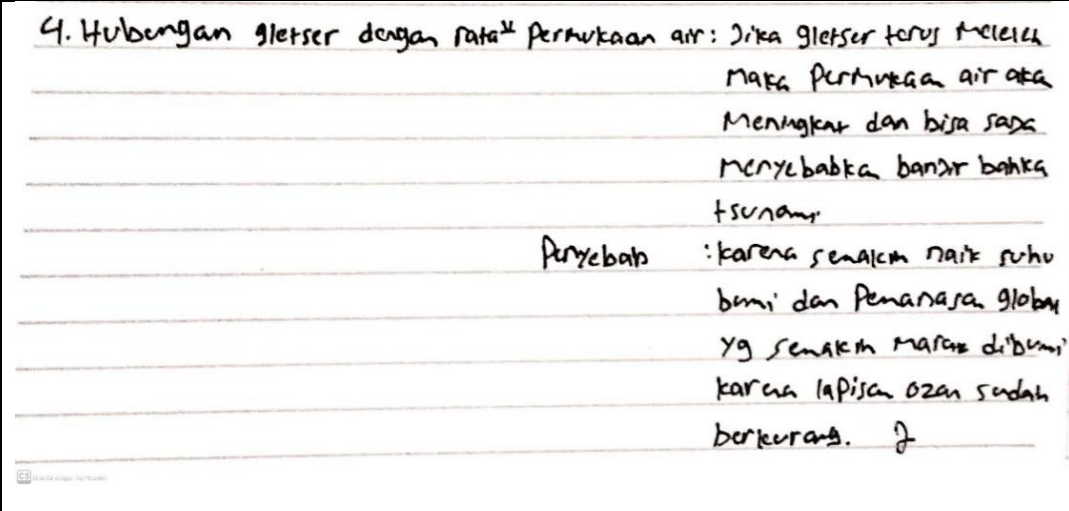
Fig 3. Example of student answer to question number 3

Based on the findings of the analysis of responses to question 3, there were no students who could give the correct answer, as many as 75 students gave inaccurate answers and as many as 4 students answered the questions incorrectly. The average student ability in this aspect is 41.20 in the very low category. The main reason students fail to solve questions correctly is because they do not read the information contained in the questions carefully. Students only explain the causes of coral reef damage and do not consider the symptoms of carbon emissions that have an impact on coral reef life. Most students believed that only human activity caused the damage.

In this concluding aspect, the overall score falls within the very low category, with an average of 35.52. From the questions given, it was found that students were unable to draw conclusions correctly because students did not read the information presented carefully. To draw rational conclusions, we need relevant information related to the problem at hand.

4. Make further clarification

Question number 4 relates to the ability to make further clarifications. The things presented in this question relate to graphs of glaciers and changes in water levels in the world. In this situation, students must connect the two graphs and identify the terms referenced in the problem. The following is an example of the answer given by students to question number 4 in Figure 4.


Examples of correct answers: Relationship of glaciers to average water levels ; If the glacier continues to melt, the water level will rise and could cause flooding Reason ; Because the earth's temperature is increasing and global warming is becoming more prevalent on earth, the ozone layer is decreasing

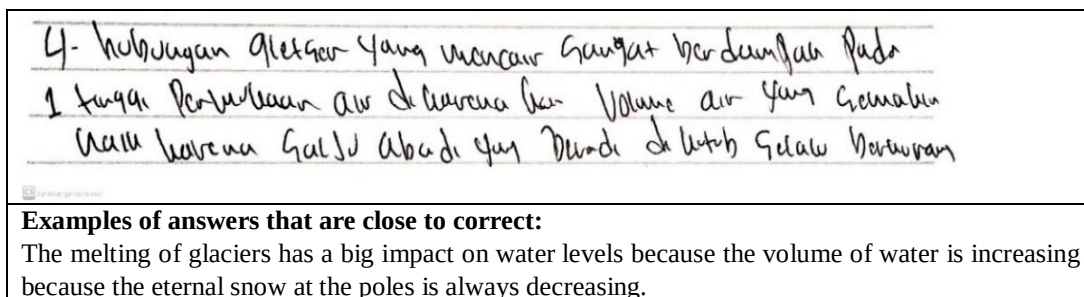


Fig 4. Example of student answer to question number 4

The analysis of students' responses to this question revealed that the students' abilities were ranked in the low category, with an average score of 45.80. A total of 27 students answered correctly, 15 students gave inaccurate answers and 37 students answered incorrectly. Some students gave answers without making a connection between the graphs presented, students should identify the relationship between the glacier graph and changes in water level and then explain the causes of this relationship.

On questions regarding the ability to make further clarifications, the overall average score obtained by students was 31.41 in the very low ability category. With this ability, students should be able to identify and relate the relationships between the assumptions given. However, in this aspect, students who already have critical thinking skills in making further clarifications do not accept and think about assumptions when solving problems [25].

5. Strategy and tactics

The next question number 6 relates to the ability to create strategies and tactics. This question presents a graph of the carbon footprint of consuming frequently consumed foods. In this case, students are able to propose an action regarding solutions or efforts that can be made to reduce global warming caused by carbon footprints. The following is an example of the answer given by students to question number 6 in Figure 5.

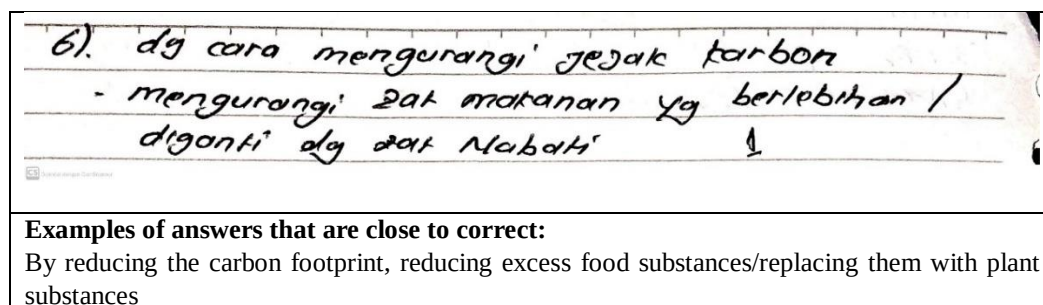
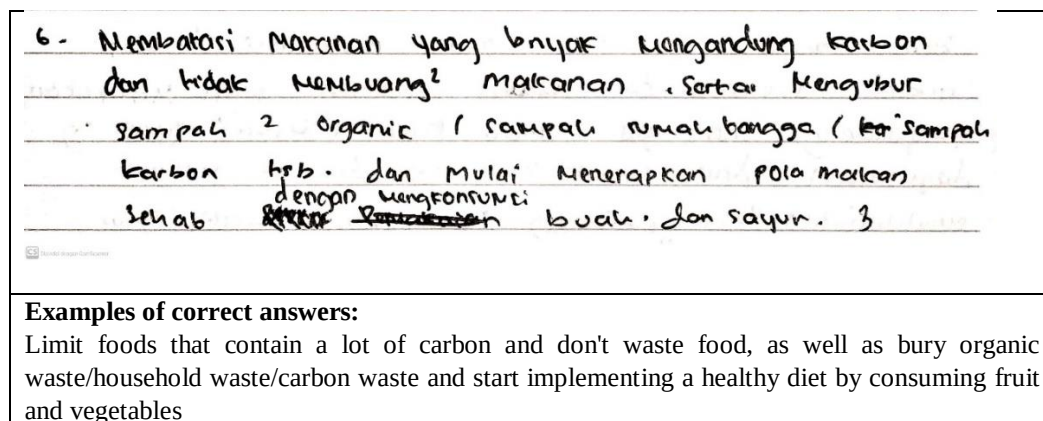


Fig 5. Example of student answer to question number 4

The analysis of students' responses to this question revealed that only 6 students provided correct answers, 47 students gave inaccurate answers and 26 students answered the questions incorrectly. The average obtained by students in this question was 33.47 in the very low category. Students did not mention efforts that could reduce global warming based on the information from the carbon footprint graph presented. For example, students only give the answer that to reduce their carbon footprint they must adopt a healthy lifestyle, without mentioning what actions/strategies can be taken.

Overall, the analysis of students' abilities in developing strategies and tactics revealed an average score of 42.54. This means that the capabilities possessed are still in the low category. Critical thinking abilities will emerge when you encounter a problem. That's when someone is required to use the right strategy needed to overcome the problem. However, in reality students are not able to provide effort in the form of action to solve problems. The ability to create strategies and tactics is related to students' ability to take action in solving problems [26]. In learning, teachers who use guiding questions have been shown to positively influence students as they work through solving a problem [25].

In general, the five aspects of students' critical thinking abilities on global warming material are still in the very low category when viewed from the scores obtained. Students' low critical thinking abilities can be seen from the way students formulate things, provide arguments, consider decisions and provide solutions to existing problems. Therefore, teachers have an important role in developing this ability, such as designing appropriate learning processes to overcome students' difficulties in understanding the concept of global warming. Critical thinking ability is not an ability that can develop naturally along with a person's physical growth. This ability must be trained through stimuli that involve critical thinking [27]. Developing critical thinking is very necessary in education, because to process the information received students must not only swallow what they have received, but also analyze the authenticity of the information and evaluate it critically. Based on this research, the follow-up action that can be taken is to examine the causes of students' low critical thinking abilities by using appropriate learning approaches and models and consistently using questions that promote critical thinking.

IV. CONCLUSION

Based on an analysis of students' critical thinking ability on global warming material carried out at 3 high schools in Pariaman, the highest score was obtained in the aspect of providing simple clarification with a score of 45.79 (low category). This was followed by aspects of strategy and tactics with a score of 42.54 (very low category). Then in the aspect of building basic skills, concluding and making further clarifications with respective scores of 40.53 (very low category), 35.53 (very low category) and 31.41 (very low category). Overall, it can be concluded that students' critical thinking abilities are in the very low category (score 39.16). The low level of critical thinking abilities possessed by students is a challenge for teachers in implementing physics learning at school. Critical thinking abilities need to be trained through stimuli that involve critical thinking because this ability does not develop alone along with a person's physical growth. Utilizing various techniques, approaches, and models can help enhance students' critical thinking abilities through education. Using appropriate teaching materials can also develop the abilities that students have in learning physics.

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