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Analysis of the Comparison of Science Literacy Skills of Students at MTS Nurul Huda Situbondo in Solving PISA Science Problems

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ABSTRACT

PISA (Program for International Student Assessment) is an international assessment designed to measure students' literacy abilities in various disciplines, including science. This research aims to analyze the scientific literacy abilities of students at MTS Nurul Huda Situbondo in solving PISA Science questions. The research method used is data analysis from the results of the PISA Science test given to students. The data described includes test results based on problem-solving and reasoning assessment rubrics. The research results show that most students need help solving these questions, such as understanding questions well, misinterpreting images, applying scientific knowledge, and relating them to real life. The results of the analysis also show that there is significant variation in abilities among students. The results of the Kruskal Wallis-H test show a p-value <0.05, which means there is a substantial difference between the 3 dependent variables. Some students demonstrate scientific literacy in analyzing and solving PISA science questions, while others still need further assistance. The research results will provide insight into the challenges in solving PISA Science questions by students and improving science education at MTS Nurul Huda Situbondo. Understanding and overcoming these obstacles can prepare students to compete globally, especially in science.

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1. INTRODUCTION

The 21st century is a century of globalization, marked by the rapid growth of technology and science (Mursyidah dan Saputra 2022). Therefore, later, society will be required to adapt and compete to become a quality human resource (Delfi dan Hudaidah 2021). In the 21st century, 16 skills are needed and have been identified by the WEF (World Economic Forum). One part of these skills is scientific literacy (WEFUSA, 2015). Thinking skills, problem-solving, reasoning, using scientific thinking, and responding to social issues can be seen through scientific literacy skills (Asyhari dan Hartati 2015). Five components of a scientific or scientific approach can be obtained through scientific thinking, namely observing, asking, gathering information, associating, and communicating (Budiono 2022). Scientific literacy is urgent for students to understand technology, environment, economics, modern society, health, etc (Dwisetiarezi dan Fitria 2021). This ability can be measured through assessments; one example is the PISA (Program for International Student Assessment) (Yusmar dan Fadilah 2023).

PISA is an international assessment initiative by the OECD (Organization for Economic Cooperation and Development). This program is designed to measure the literacy skills of students worldwide in various disciplines, including science (Yusmar dan Fadilah 2023). Based on the 2018 PISA assessment results by the OECD, Indonesia ranks 70th out of 78 countries in PISA science with a score below the average, 389 out of 489 OECD average scores(Coffin dkk. 2003). PISA provides a comprehensive picture of how students in different countries can apply knowledge and skills relevant to everyday life, making it a valuable benchmark in comparing and assessing the effectiveness of global education systems (Firdausia, Novianti, dan Kurnia 2020). Participation and better PISA science results have significant implications for the reputation of Indonesian education at the global level (Azzahra 2017).

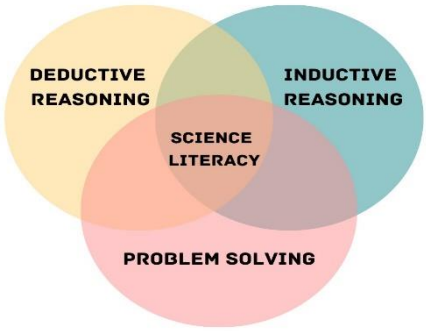

Figure 1. Attached Self-Made Figure

PISA science success can improve Indonesian education and provide more excellent opportunities for students to compete internationally (Annisa Widi Pratiwi 2021). MTS Nurul Huda Situbondo, Indonesia, needs help implementing PISA Science questions to evaluate students' abilities. These problems may include limited resources, curricula that not aligned with PISA requirements or other challenges related to the lack of testing facilities to international standards (Syarqawi dkk. 2022). Studying these constraints is essential to identify areas where improvement is needed. Research related to applying PISA Science questions in Situbondo, especially at MTS Nurul Huda, is currently restricted. Therefore, this research will be helpful as a basis for filling knowledge gaps and providing helpful insight into the challenges experienced by students and schools when facing the PISA science exam (Simatupang dkk. 2023).

PISA science questions can be applied to measure students' abilities to analyze information, evaluate arguments, and apply their knowledge in relevant scientific contexts. As a result, it can improve the problem-solving abilities of students (Sa'adah, Suryaningsih, dan Muslim 2020).The table below shows a problem-solving ability assessment rubric that can be used as a reference.

Table 1. Problem-Solving Skills Assessment Rubric (Anggraini & Musyarofah, 2023)

Score	Understanding and Presenting the Problem	Planning a solution for a settlement	Implement the plan	Evaluate the results and draw conclusions
0	Misinterpreting the problem / no answer	There is no planning in a solution	There is no resolution plan at all	No description
1	Misinterpreting questions / misinterpreting several questions	The planned settlement solution is irrelevant	The procedure performed is correct, but the solution is incomplete	The conclusions given are incomplete
2	Understand the problem well	The planned solution needs to be more relevant and can be implemented perfectly	Correct implementation procedures and solutions	The conclusions given are correct and complete
3		The settlement plan created is excellent but needs to be completed		
4		The settlement plan made is correct and complete		

Science skills also include inductive and deductive reasoning abilities. Inductive reasoning involves the process of looking for patterns and identifying possible relationships based on the information that has been provided. This thinking process produces general conclusions from specific data (Anggraini 2022; Agusantia dan Juandi 2022). On the other hand, deductive reasoning involves the process of thinking to draw definite conclusions from existing premises or rules. It is the process of applying existing knowledge to a specific situation (Mukhibat 2023).

These skills are essential in science because science often involves testing hypotheses and applying existing principles to new situations (Habibatul Izzah dan Azizah 2019). Inductive and deductive reasoning abilities can help students solve PISA Science questions that test their ability to apply scientific concepts taught to new situations (Zulanwari et al., 2023). These questions can also assist students in strengthening their abilities in the context of problem-solving and reasoning (N. Rokhima, D. Pamungkas, dan R.C.I. Prahmana 2023). The table below illustrates a reasoning ability assessment rubric that can be used as a reference in assessing students' PISA science test results.

Table 2. Reasoning skills assessment rubric (Zulfa, 2019)

Reasoning Assessment Indicators	Response	Score
Inductive Reasoning	No answer	0
	Identify the relationship between processes/concepts in a particular case and determine the name of the process/concept in question	0-3
	Select/determine the relationship between similar processes/concepts in both cases, accompanied by reasons and the name of the idea concerned	0-3

	Identify science processes/concepts and trends from specific situations	0-2
	Develop a general form of the process/concept in question, along with the reasons/explanations	0-3
	Arranging patterns based on the relationships between scientific rules/concepts that have been obtained	0-2
Deductive Reasoning	No answer	0
	Identify science processes/concepts in specific situations/problems, ask questions, and check the adequacy of elements	0-3
	Develop a scientific model/pattern of the problem	0-3
	Solving scientific model problems accompanied by reasons or stating the scientific processes/concepts/rules used	0-3
	Identify the steps along with an explanation of the processes/concepts/science rules used	0-2
	Determine relevant solutions	0-2
	Check the correctness of the main problem solution	0-2

2. METHODS

This research uses a mixed method, a combination of quantitative and qualitative research methods (Pluye et al, 2018, Nadirah et al., 2022). The research stages are presenting the data, analyzing it, then integrating it as findings and determining conclusions (Subagyo dan Fithroni 2022)(Subagyo, 2020, p. 101). Quantitative research aims to determine the comparative results of student test scores on problem-solving and reasoning abilities. The test scores of MTS Nurul Huda Mangaran students were measured for each type of question. Meanwhile, for qualitative research, researchers described students' reasoning and problem-solving abilities in solving PISA Science questions.

There are 3 components in PISA questions, namely content components, process components, and context components (OECD, 2019b; Santia & Tyaningsih, 2018). The topics in this research are the earth's atmosphere, reproductive system, ecosystem, biodiversity, force and motion, energy transformation, and earth rotation. One of the criteria used in this research is MTS Nurul Huda Mangaran Situbondo students aged 15 years, where these students need to gain experience in adapting PISA questions. This criterion was met by 45 students at the school. Written tests and observations were used in this study as research instruments. The written test consists of 13 PISA 2012 questions with several types used: Open-Constructed Response, Traditional Multiple Choice, Short Response, Complex Multiple Choice, and Closed-Constructed Response. Each question is assessed based on the rubric in each assessment category based on the reference journal. Data analysis used in this research is data presentation, verification, Kruskal Wallis-H comparative SPSS analysis, and conclusion (Sugiyono 2012).

3. FINDINGS AND DISCUSSION

Comparative Test Results

Based on the scores obtained by 45 students, it can be used as a basis for calculating problem-solving abilities, inductive reasoning, and deductive reasoning. If students can answer correctly and include relevant scientific reasons and solutions, they will score 10 on each question. However, the total score in each aspect is different: problem-solving ability (130), inductive reasoning (60), and deductive reasoning ability (70). The data to be presented and analyzed in SPSS consists of results from the

calculation of (N/130x100) in problem solving ability, (N/60x100) in inductive reasoning, (N/70x100) in deductive Reasoning. The table of average student scores is shown in Table 3.

Table 3. Average Student Scores on Problem Solving Ability, Inductive Reasoning, and Deductive Reasoning

N	Problem Solving		Inductive Reasoning		Deductive Reasoning	
45	Total	N/130x100	Total	N/60x100	Total	N/70x100
	71.36	54.89	40.56	67.59	30.80	44.00

Afterward, the data is presented by dividing the dependent variables into 3 groups and analyzing the data in SPSS. This research uses the Kruskal-Wallis H comparison test. Based on the results of the value test, it can be seen that the mean problem-solving (106.82) is greater than the mean inductive reasoning value (64.50) and the mean deductive reasoning value (32.68). The mean value for each aspect of the assessment is in Table 4.

Tabel 4. Mean Rank on Problem Solving, Inductive and Deductive Reasoning Scores

Test	Category	N	Mean Rank
Score	Problem Solving	45	106.82
	Inductive Reasoning	45	64.50
	Deductive Reasoning	45	32.68

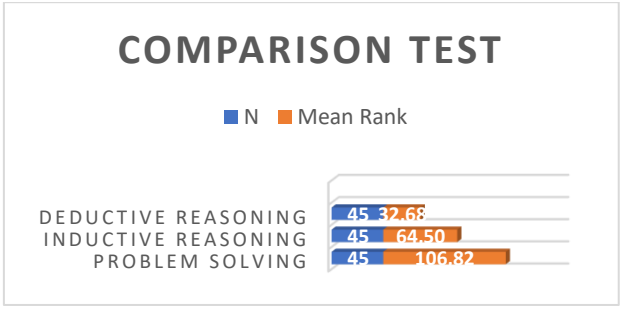

Figure 2. Mean Rank Comparative Test

The hypothesis used in this research can be formulated as follows:
H_0: There is no significant difference in student literacy (problem-solving abilities, inductive reasoning, and deductive reasoning)
H_a: There are substantial differences in student literacy (problem-solving abilities, inductive reasoning, and deductive reasoning)

The results of the comparison test can be seen in Table 5. Based on these results, it was found that the p-value (0.000) < 0.05, which means that H_0 was rejected and H_a was accepted (Corder & Foreman, 2014). Significant differences exist in student literacy (problem-solving abilities, inductive reasoning, and deductive reasoning).

Tabel 5. Comparative Test With Kruskal-Wallis H

	Score
Kruskal-Wallis H	81.721
Df	2
Asymp. Sig	0.000

a. Kruskal-Wallis H
b. Grouping Test Variables

Based on these results, the abilities of each student are significantly different in every aspect, as shown by their problem-solving skills, which are pretty high. However, students still need help reasoning, identifying, and determining relationship patterns between questions or statements and the right solution.

Reasoning Ability Analysis

Based on the analysis of student's answers, their analytical reasoning abilities can be seen as follows:

a. Analysis Question 1. The questions are in the deductive reasoning category, including the Earth's Atmosphere chapter, specifically regarding Ozone, categorized as an Open Constructed Response question type. Based on the results of the analysis of answer sheets from 45 students, 26 students could not formulate and communicate the answer conclusions in writing, and 14 could answer correctly. Still, they needed to write down the appropriate reasoning steps, and 5 students responded correctly and could formulate and communicate their findings' results.
b. Analysis Number 2. This question is an inductive reasoning question in the Complex Multiple Choice category regarding material regarding the Earth's Atmosphere. A total of 29 students answered correctly, identifying the solution steps and determining relevant solutions. Meanwhile, 14 other students were able to answer correctly. Still, they had yet to provide solutions to complex problems in the questions precisely, and there were only 2 students who could not solve tough PISA science questions.
c. Analysis Number 3. Questions in the deductive reasoning category include a chapter on the Earth's Atmosphere, specifically Ozone, in the Short Response question type category. The results of the analysis of answer sheets from 45 students show that all students can connect the concept of the problem and find appropriate and relevant solutions.
d. Analysis Number 4. This deductive reasoning question uses a Closed-Constructed Response type regarding the chapter on animal reproduction, specifically cloning. These questions train students' reasoning skills to look for relationships between statements and answers. A total of 41 students could interpret complex situations and provide appropriate solutions, and 4 other students answered several views incorrectly.
e. Analysis Number 5. This inductive reasoning question uses the Traditional multiple-choice query regarding the ecosystem chapter. Based on the analysis of students' answers, it was found that all 45 students had answered correctly. Students have been able to represent descriptive questions and relate them to the real world to draw the correct conclusions.
f. Analysis Number 6. Deductive reasoning questions use the Traditional multiple-choice question type regarding biodiversity. Based on the analysis of student's answers, it was found that 14 students could connect and determine the right solution to the problem given—a total of 31 other students needed to answer the question correctly.
g. Analysis Number 7. Inductive reasoning questions use the Traditional multiple-choice question type. The material of this question is force and motion. A total of 35 students could interpret the picture, relate the event to real life, and give the correct answer. Meanwhile, 10 students needed help to answer correctly.
h. Analysis Number 8. Deductive reasoning questions use the Open-Constructed Response question type. All students struggled and needed help understanding the meaning of the PISA Science questions in the Energy Transformation chapter.
i. Analysis Number 9. This inductive reasoning question uses the Traditional multiple-choice question type in cloned material. A total of 21 students could understand complex reading and determine conclusions. However, the other 24 students still needed help providing correcting answers and reasons.

j. Analysis Number 10. This question is a continuation of question number 9. A total of 26 students answered correctly based on their reasoning. Meanwhile, 19 students needed help to analyze the problem and answer correctly.
k. Analysis Number 11. This deductive reasoning question uses the Complex multiple-choice question type in cloned material. There were only 4 students who were able to connect the statement with the solution provided, but they needed complete reasons. Meanwhile, 41 others still answered incorrectly.
l. Analysis Number 12. This inductive reasoning question uses the Traditional Multiple Choice question on Earth Rotation material. 42 students could analyze and provide correct and complete answers, while 3 other students still needed to be corrected.
m. Analysis Number 13. This deductive reasoning question uses the Traditional multiple-choice question type in the Biodiversity chapter. A total of 43 students were unable to answer the question correctly, and 2 students were able to interpret the meaning of the question so they could draw relevant conclusions.

Problem Solving Analysis

Based on the analysis of student's answers, problem-solving abilities can be identified, namely as follows:

a. Analysis Number 1. Based on their problem-solving abilities, there were only 5 students who answered correctly and precisely and were able to present relevant solutions; 26 students were not able to answer correctly and precisely, and 14 students could identify images accurately but did not provide reasons for solving the problem.
b. Analysis Number 2. Based on their problem-solving abilities, there were only 2 students who answered incorrectly, 14 students were able to respond without providing an appropriate solution, and 29 students were able to answer correctly and provided reasons for solving the problem.
c. Analysis Number 3. All students understood this question very well and were able to identify the problem presented and find the right solution.
d. Analysis Number 4. 41 students could present and determine the correct and relevant solution to all the statements given in the questions, and 4 other students could only answer 2 of the 3 questions correctly. Students' problem-solving abilities on this question are outstanding.
e. Analysis Number 5. In this question, all students could solve the problems given very precisely.
f. Analysis Number 6. Total of 14 students could solve complex problems and provide the correct answers, while 31 other students were still having difficulties.
g. Analysis Number 7. Based on the results of the students' answers, 10 students answered incorrectly, while 35 other students could solve the problem and provide the correct solution.
h. Analysis Number 8. It was found that none of the students could solve the problem in this question and could not answer correctly.
i. Analysis Number 9. In this question, 21 students solved the problem in this material, while the other 24 still needed to give the correct answer.
j. Analysis Number 10. In this question, 26 students were able to solve the problem in the question given, while 19 other students were still experiencing difficulties.
k. Analysis Number 11. 41 students answered incorrectly in this question, and 4 others gave correct scientific answers without complete reasons.
l. Analysis Number 12. In this question, 42 students answered correctly and could draw the correct conclusions. Meanwhile, the other 4 students needed help with the problem precisely.
m. Analysis Number 13. Only 2 students were able to solve this problem, and 43 other students still needed help.

Based on the analysis of answers from 45 MTS Nurul Huda Mangaran students in the assessment of problem solving and reasoning in solving PISA 2012 questions, students still need to improve in interpreting problems linking, linking, and forming scientific patterns. It is also reinforced by research

conducted by Umaroh and Pujiastuti (2020), which found that students generally struggle with interpreting text and image-based questions in PISA assessments. Most students could identify and answer correctly in material regarding the Earth's atmosphere. However, many still needed help when asked to describe and interpret the picture entirely according to the stages and categories of statements. In reproduction material, students could only solve problems by answering questions correctly. Still, most others needed help analyzing the meaning of the questions and providing correct reasons. All students answered the questions in the ecosystem chapter correctly. Students can accurately identify organisms in the food chain and relate them to the real world to provide relevant solutions.

In biodiversity, many people still have difficulty selecting, defining, and determining patterns of relationships between processes and concepts that are similar in both cases. Most students still answered incorrectly, and the reasons given needed to be completed. In the force and motion material, most students were able to understand the context of the questions and were able to solve problems, and were able to relate them to everyday life. In the energy transformation chapter, all students needed help to solve the issues in the questions. In the chapter on the rotation of the Earth, almost all students answered correctly, were able to integrate their knowledge to solve the problem in this question, and their reasoning skills were good.

Based on the results of the comparative tests and qualitative analysis above, the scientific literacy obstacles experienced by students can be seen. Teachers can take further action by implementing PISA questions in schools to improve problem-solving and reasoning abilities, such as developing teachers' capabilities (Patabang dan Murniarti 2021), enhancing students' interests and potentials (Irawan 1997) and training and improving problem solving skills (Sari at al., 2020). Apart from that, it is essential to review and increase the portion of explanation for material that still needs to be understood. This is because teachers are required not only to transfer knowledge but also to be able to encourage and stimulate their reasoning abilities so that students are trained to learn to construct their knowledge independently.

4. CONCLUSION

Based on the results of the research that has been carried out, students are still weak in the Essay (Open and Closed Constructed Response) and Complex Multiple Choice question categories. Still, most students have good abilities in the Short Response and Traditional Multiple Choice question categories. Among the 7 materials, students experienced quite a difficulty answering the material on the earth's atmosphere, reproductive system, biodiversity, and energy transformation, so it required repetition. Students understand enough about ecosystems, energy transformation, and earth rotation.

The results of the Kruskal Wallis-H test show a p-value <0.05, which means there is a significant difference between the 3 dependent variables. Applying PISA questions is perfect for encouraging and improving problem-solving, deductive reasoning, and inductive reasoning abilities. This is because the PISA questions include a reasonably complex introduction. Some students have demonstrated scientific literacy in analyzing and solving PISA science questions, while others still need further help.

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