
Analysis of Science Misconceptions Using Four Tier Diagnostic Test Assisted by Certainty of Response Index (CRI)

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Abstract: Misconceptions are a common problem that still often occurs in students both at elementary school, high school, and even in college students. Especially science learning with many abstract concepts has a large chance of misconception. Therefore, it is necessary to detect student misconceptions early on. There are several ways to detect misconceptions, one of which is a multilevel diagnostic test that has developed into two tiers, three tiers, and four tiers. This diagnostic test can detect student misconceptions so that later teachers can set the right learning strategy to correct misconceptions and slowly improve student learning outcomes. The type of research used is descriptive research with a quantitative approach. The location of the research is SMP NWDI Pancor with a sample of 27 students. The data analysis technique uses the Certainty of Response Index (CRI) analysis. The results of the analysis show that the number of students who experience misconceptions in science lessons is more than 70% of the total students. Misconceptions occur most in the material of Work and Energy.

Keywords: Certainty of Response Index; Four Tier Diagnostic Test; Misconceptions; Science.

INTRODUCTION

Science learning should be carried out to develop competencies such as 21st-century learning competencies related to 4C abilities. Science learning in schools is expected to be able to solve everyday problems by utilizing the scientific concepts obtained. The science learning process often experiences problems and hinders students from learning to develop their thinking skills to the next stage. One of the problems that still often occurs is that students often experience misconceptions in this science learning. Misconceptions in science lessons occur from elementary school to college (Pulu & Amahoru, 2023). This condition of misconception cannot be allowed to continue because it will be an obstacle to the acceptance of further material or concepts. Misconceptions become obstacles in the process of accepting and assimilating new knowledge in students, it will damage student development and have an impact on poor student learning outcomes (Izza et al., 2021). So there needs to be quick action to be able to detect this misconception so that learning methods can be arranged that can remediate or even eliminate student misconceptions (Yuliati, 2017). Misconceptions

in students still need to be reviewed to find out how much inaccurate conceptual knowledge is still experienced by students after learning and to find out the effectiveness of learning experienced by students in overcoming misconceptions, if this is left unchecked it will have an impact on the material afterward and will experience increasingly complex misconceptions (Afifah et al., 2021).

Misconception is a mismatch between students' understanding and scientific concepts that have been recognized by experts in the field. This misconception is caused by several factors such as students' preconceptions, wrong learning methods, conceptual errors, and even difficulty understanding textbooks are some of the causes (Ariyastuti & Yuliawati, 2017; Haerunnisa et al., 2022; Irianti, 2021). Differences in experiences experienced by students allow students to have a wrong understanding of a concept and can lead to the formation of misconceptions. The construction of students' knowledge is not only carried out by the students themselves but is assisted by their surroundings. Students do not come to class like blank paper. They have preconceptions that are obtained from experience or even from the environment. This requires that learning should

be able to synchronize students' preconceptions with correct scientific concepts. Several things cause misconceptions to arise, including students, teachers, textbooks, teaching methods, and so on. Misconceptions from students are usually caused by students' preconceptions, experiences, ways of thinking, environment, and interests and abilities of the students themselves (Yuliati, 2017). Therefore, it is important to detect students' misconceptions early so that teachers can prepare for better learning to reduce or even improve students' misconceptions.

There are several methods commonly used to detect misconceptions in students such as diagnostic tests through written tests and giving reasons, clinical interviews, and presentation of concept maps. In the use of diagnostic tests, students' answers and arguments/reasons can be used as a reference to determine students' misconceptions and their backgrounds (Yuliati, 2017). Misconceptions can be detected with multilevel multiple-choice diagnostic tests (Lestari et al., 2020). Diagnostic tests usually use multiple-choice tests that are equipped with reasons. Diagnostic tests are used to determine which parts of a subject have weaknesses and provide tools to find the causes of these deficiencies and are used to determine students' strengths and weaknesses in learning (Mubarak et al., 2016). Diagnostic tests can make it easier for a teacher to classify students who experience misconceptions and students who do not know the concept. The use of diagnostic tests before and after learning can help teachers diagnose misconceptions experienced by students in the learning process (Putri & Subekti, 2021). This diagnostic test has several levels such as two-tier, three-tier, and four-tier diagnostic tests. The four-tier diagnostic test is equipped with an assessment of the level of confidence and reasons for each answer given. This causes the test results obtained to be more accurate compared to other test instruments in identifying student misconceptions. The four-tier diagnostic test can identify students who have a good understanding of concepts, misconceptions and do not understand the concept (Nur et al., 2023). The second and fourth levels of the four-tier diagnostic test contain the level of confidence

which will later be used for analysis in the CRI (Certainty of Response Index). CRI is a method used to measure students' misconceptions about a concept in a lesson by paying attention to the level of student's confidence in their answers. The CRI technique is simple and effective in measuring misconceptions that occur because this technique can distinguish students who understand the concept, do not know the concept, and those who experience misconceptions (Atiqoh & Hafiz, 2021). Based on the description of the problem, it is necessary to conduct research on misconceptions and how to analyze them. This study aims to detect student misconceptions using a four-tier diagnostic test assisted by CRI analysis.

METHODS

This research is a descriptive study with a quantitative approach. This research was conducted through three stages, namely one pre-field stage, this stage is the stage of compiling, planning, and preparing all forms of materials needed as basic materials for the next stage. Field stage, at this stage the data collection process is carried out, and researchers use research tools that have been prepared in advance. The next post-field stage is to conduct further data analysis, draw conclusions, and confirm and compile reports. The location of the research is at the FMIPA, Hamzanwadi University as the location for compiling the four-tier diagnostic test and SMP NWDI Pancor. Data collection techniques by providing diagnostic tests and documentation. The research sample collection used a saturated sampling technique, meaning that all populations were sampled. The data collection instrument used in the study was the four-tier diagnostic test instrument consisting of 10 questions. Each question item consists of four levels as follows: 1) tier-1 in the form of questions with several answer choices; 2) Tier-2 in the form of a level of confidence in the answer in tier-1; 3) tier-3 in the form of reasons for choosing an answer in tier-1; 4) tier-4 is the level of confidence in choosing a reason in tier-3. Next, the misconception analysis with CRI is categorized in the following Table 1.

Table 1. Misconception Categories Based on CRI Analysis for the Four-Tier Test

Category	Answer Combination		Rating	Reason	Confidence Reason	Rating
	Answer	Confidence Answer				
Misconceptions	Understand the Concept	Correct	Sure	Correct	Sure	
	Not Understand the Concept	Correct	Sure	Correct	Not Sure	
		Correct	Sure	Wrong	Not Sure	
		Correct	Not Sure	Correct	Sure	
		Correct	Not Sure	Correct	Not Sure	
		Correct	Not Sure	Wrong	Not Sure	
		Wrong	Sure	Correct	Not Sure	
		Wrong	Sure	Wrong	Not Sure	
		Wrong	Not Sure	Correct	Not Sure	
		Wrong	Not Sure	Wrong	Not Sure	
		Correct	Sure	Wrong	Sure	
		Correct	Not Sure	Wrong	Sure	
		Wrong	Sure	Wrong	Sure	
		Wrong	Not Sure	Wrong	Sure	
Error	Wrong	Sure	Correct	Sure		
	Wrong	Not Sure	Correct	Sure		

FINDINGS AND DISCUSSION

Findings

The research conducted asked students to work on a four-tier diagnostic test. This test consists of multiple-choice questions, confidence levels, students' reasons for answering, and confidence levels in the reasons

for the answers. The test was given to 7th-grade students of SMP NWDI Pancor. In the early stages of planning, the four-tier diagnostic test was compiled by considering the science material at the 7th-grade level. After that, 10 four-tier diagnostic test questions were compiled. The following is an example of a test that has been compiled.

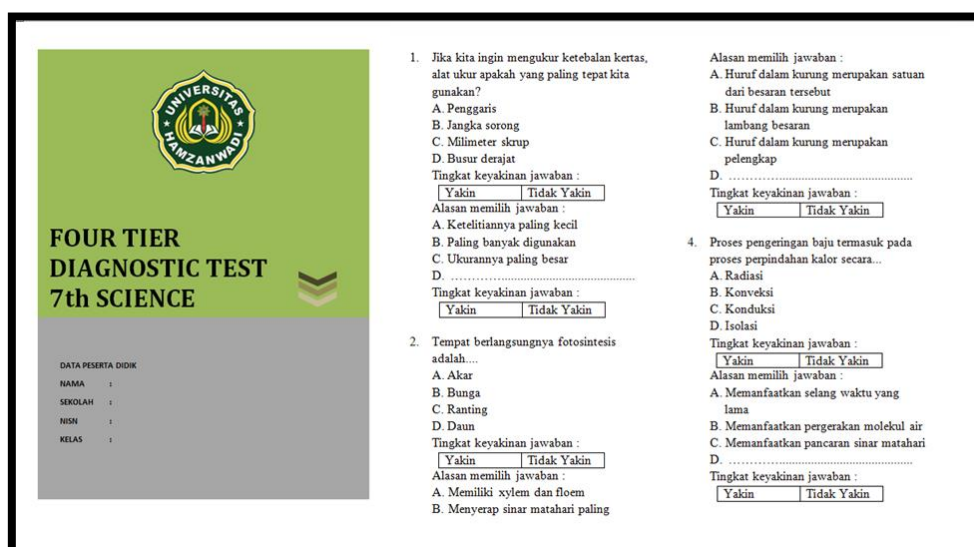


Figure 1. Example of a Four Tier Diagnostic Test Instrument

Furthermore, data collection was conducted at SMP NWDI Pancor by giving four-tier diagnostic test questions to 7th-grade students. The results of the students' tests were used as a reference to analyze the students' conceptions. The four-tier diagnostic test that was developed consisted of 10 question items.

Question item number 1 is related to quantities and units. In this concept, many students still experience misconceptions. 77.78% of students experienced misconceptions and did not understand the concept out of a total of 27 students who took the test. Only one person was categorized as understanding the concept. This

indicates that the material on quantities and units needs to be explained in more detail and better so that students do not experience misconceptions. Furthermore, in question item number 2 related to plant photosynthesis, all students experienced misconceptions. Most students assume that photosynthesis occurs in the roots and flowers. This misconception is quite fatal so teachers need to explain photosynthesis more carefully and if possible use interesting learning videos or animations. In question item number 3 related to temperature and heat, 2 students understood the concept and the rest did not understand the concept or had misconceptions or even answered randomly. Next, in question item number 4, many students did not understand the concept because they could not differentiate between convection, conduction, and radiation events. Question item number 5 was better than the other questions, 8 people understood the concept because this question was related to the concept of animal

adaptation so they could understand it because they found many in their environment that were by the question narrative. However, misconceptions and not understanding the concepts in this material are still quite a lot. Item number 6 with the number of students who experienced the most misconceptions, namely 22 students (81.48%). This question is related to effort and energy. While questions number 7 and 8 related to celestial bodies and the solar system, students experienced misconceptions as many as 20 students in question number 7 and 18 students in question number 8. Question number 9 related to networks and question number 10 related to Newton's laws, but many students still experienced misconceptions. Based on this, in the 7th-grade science lesson, many students still experience misconceptions because of the environment or lessons learned at the previous level. More details can be seen in Figure 2.

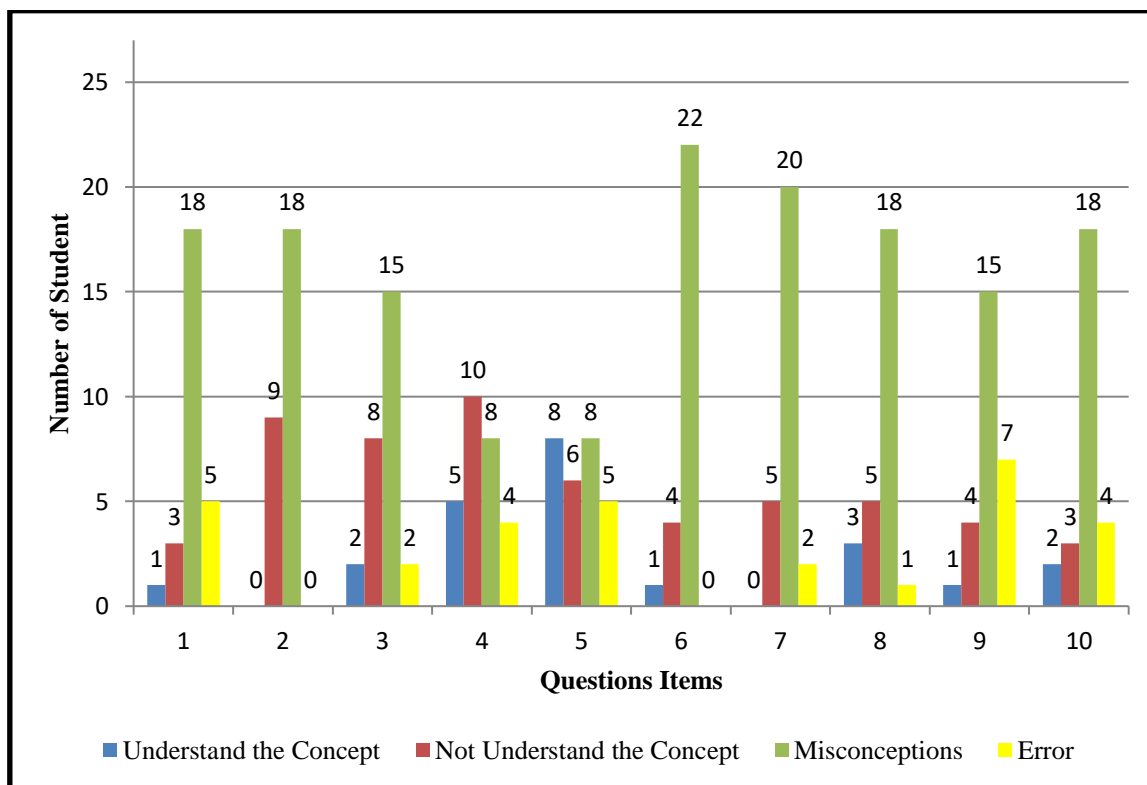


Figure 2. Results of Student Concept Analysis

Based on these results, it is known that most students still experience misconceptions in science lessons. The sub-materials that experience the most misconceptions are effort and energy. Meanwhile, only a few students understand the concept. This shows that

students' conceptual understanding brought from elementary school is still largely wrong or experience misconceptions. This is an important concern in science learning at the secondary or elementary school level. High misconceptions will have an impact on low learning outcomes

so students' thinking skills will be difficult to develop.

Discussion

Analysis of the results of the four-tier diagnostic test using CRI is used to group students into categories: understand the concept, not understand the concept, misconceptions, and errors. that currently grouping someone's conceptual understanding is important, most people equate the understanding of not understanding the concept with misconceptions. Educators need to distinguish students who can understand the concept well, do not understand at all, and experience misconceptions, to handle students properly so that they can correct the misconceptions they experience (Fariyani, et al., 2017).

Misconceptions are obstacles to student learning. Students who experience misconceptions will be hampered in their thinking process so their thinking ability does not improve. Indirectly, this has an impact on student learning outcomes. Especially in science lessons that have many abstract concepts, the opportunity for misconceptions is very large. This can be seen from the results of the analysis which shows that 7th grade students at SMP NWDI Pancor experience many misconceptions, even most students experience misconceptions and only a small number understand the concept. Misconceptions experienced by students will interfere with them in receiving new knowledge. Wrong concepts that are already firmly embedded will be considered correct and overlap with the correct scientific concept (Mubarak et al., 2016). Misconceptions become a problem because students feel that the concepts they have are always correct. Students will be disturbed and reject the correct scientific concept if their misconceptions are not resolved and these misconceptions can be permanent which can have an impact on low learning outcomes (Makhrus & Hidayatullah, 2021).

Many factors cause misconceptions in students such as learning methods, and environment, and sometimes teachers are the cause of misconceptions due to incomplete delivery of material or students' failure to understand the explanation from their teachers. Students' learning experiences at previous levels are one of the factors in the formation of student concepts. Initial erroneous concepts are often carried over to the next level of education and

become misconceptions that remain embedded in students' knowledge (Wulandari, et al., 2021). Detecting misconceptions early on is an important asset so that later the right learning solution can be known so that students can understand the concept correctly.

The use of certainty of response index (CRI) to analyze the four-tier diagnostic test is appropriate. The four-tier method with CRI can provide accurate results related to student misconceptions. This type of question format makes students provide more assertive answers in accordance with their level of confidence so that misconceptions that occur in students can be identified (Fakhrudin et al., 2024).

CONCLUSION

The results of the analysis using CRI on the four-tier diagnostic test showed that most students of NWDI Pancor Middle School still experience misconceptions and do not understand the concepts in science lessons. The most misconceptions occur in the material of Work and Energy. Students who understand the concept are only a small number, even in each material, students who understand the concept are no more than 3 students. The percentage of students who experience misconceptions and do not understand the concept, as well as errors exceeds 70% of the total 7th grade students junior high school at NWDI Pancor.

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