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IDENTIFICATION OF MISCONCEPTIONS ON THE MATERIAL OF SOUND WAVES USING THE FOUR TIER DIAGNOSTIC TEST IN TOLITOLI REGENCY

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Abstract :
This research aims to describe the misconceptions that occur in sound wave material in Class VIII Public Middle School Tolitoli Regency by using a four-tier diagnostic test. This type of research is descriptive qualitative. The subjects in this study were 60 students from class VIII of Public Middle School 2 Tolitoli, junior high school Negeri 5 Tolitoli, and Public Middle School 8 Tolitoli. Determination of respondents using a purposive sampling technique, namely by taking respondents who experienced the highest misconceptions as many as 10 students. The results showed that the misconceptions that occurred in students of Public Middle Schools in Tolitoli Regency with low misconception criteria, namely at 27%, The identification results showed that students of Public Middle Schools in Tolitoli had understood the concept of sound waves well so that the results achieved were based on the misconception criteria, namely low.

Keywords: Four Tier Diagnostic Test, Identification Misconceptions, Sound Waves

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INTRODUCTION

Physics is a branch of science that discusses natural phenomena with all its physical dynamics (Pertiwi & Setyarsih, 2015; Astalini et al., 2023; Samijo & Romadona, 2023). Learning physics requires a good understanding of concepts, this is in line with the opinion of (Amnirullah, 2015; Winda & Shofiardin, 2023; Yusra et al., 2023) who say that physics is learning that prioritizes mastery of concepts. Physics concepts that deviate from existing physics concepts can affect students' learning processes continuously. If this wrong concept is allowed to continue, students will experience misconceptions. Misconception is a concept that does not correspond to the concept recognized by experts (Suparno, 2005; Purwanti & Heldalia, 2023; Irmayanti et al., 2023). Based on literature studies, quite a lot of students experience misconceptions in physics learning, such as in the concept of mechanics (Saehana and Kasim, 2011; Astalini et al., 2022; Wulandari, 2023), as well as optics and waves (Sheftyawan et al., 2018; Nurulwati, Veloo & Ruslan, 2014), indicating that quite a lot of students at public senior high school 1 Turi have misunderstandings about the concept of sound waves, one of which is students' understanding of the concept of sound waves. Other misconceptions related to the concept of sound

waves were also found by Sofia and Wiwin (2022) which were conducted at MTs Rukoh, where students experienced misunderstandings in several concepts including the concept of vibration and waves. With several studies that have been conducted previously, it can be concluded that there are still many students who experience misconceptions in the material of sound waves.

The physics material used in this study is sound wave material. The choice of sound wave material in this study is because this material is one of the materials where students often have difficulty in understanding the concept of the material. One effort that can be made to find out students' misconceptions in a subject matter is to use a diagnostic test. This diagnostic test usually consists of several questions or requests in a particular matter (Rusilowati, 2015; Irawati & Ningsih, 2021; Hendriyani, 2023).

One way to find out misconceptions is by giving a test to identify misconceptions experienced by students (Andriani et al., 2021; Ekasari & Maulidinah, 2023) using the Four-tier diagnostic test. This test has the advantage of distinguishing students who lack knowledge and those who do not understand (Pesman, 2005; Rohmahtika & Wirayuda, 2023). Some of the advantages of the four-tier diagnostic test method are that it can distinguish the belief in answers and the belief in the reasons given by students, understand the misconceptions that occur more deeply, and make it easier for teachers to plan learning better than before. From the explanation above, the study entitled "Identification of Student Misconceptions Using the Four Tier Diagnostic Test on Sound Wave Material for Junior High Schools Class VIII Tolitoli Regency" as an effort to find out the misconceptions that occur in students, especially in the Sound Wave material.

Previous research that is in line with this research is a study conducted by Sheftyawan et al., (2018) regarding the identification of student misconceptions using a four-tier diagnostic test. The current research has significant differences with previous research that focused on Geometric Optics material. The GAP in this study lies in the differences in the topics of the material studied, where sound waves have different physics concepts and may be more abstract for students compared to geometric optics. In addition, the geographical context is also a differentiating factor, because the current research was conducted in Tolitoli Regency, which may have different student characteristics and educational resources than previous research. This provides an opportunity to examine how these differences in topics and contexts affect the level of student misconceptions and the effectiveness of the Four-Tier Diagnostic Test in identifying misconceptions on different materials.

This study presents significant novelty by applying the Four-Tier Diagnostic Test to identify student misconceptions on sound wave material, a topic that has not been widely explored in the context of physics education at the junior high school level, especially in Tolitoli Regency. Previously, the use of the Four-Tier Diagnostic Test was more often applied to other materials such as geometric optics, but there has been no in-depth study examining misconceptions in sound wave material with this method. In addition, this study also offers a new contribution to the understanding of how the local geographic and cultural context in Tolitoli can affect students' understanding of abstract physics concepts. Thus, this study not only enriches the literature on the use of the Four-Tier Diagnostic Test but also provides new insights that are relevant to the development of more effective learning strategies in overcoming students' misconceptions.

RESEARCH METHOD

Types of research

This study is a qualitative descriptive study. This study uses a descriptive research design with a qualitative approach (Asnia et al., 2023; Sahban et al., 2024). This study describes misconceptions on sound wave material that occur in grade VIII students in three schools.

Research Subject

The subjects of this study were selected using purposive sampling techniques (Permatasari, 2023; Setiawan et al., 2024), involving 60 students from three junior high schools in Tolitoli Regency, namely state junior high school 2, state junior high school 5, and state junior high school 8. The selection of these schools was based on certain considerations relevant to the research objectives, such as the diversity of student backgrounds and representation of various levels of academic achievement. This

purposive sampling technique allows researchers to strategically select subjects who are believed to have high potential to provide rich and in-depth data related to the identification of misconceptions in sound wave material, so that the research results can be more accurate and representative in the context studied (Karmina et al., 2023; Kharis et al., 2023; Jana et al., 2024).

Data Collection Techniques and Research Instruments

Through this study, researchers try to describe the misconceptions experienced by students on the material of sound waves with multiple-choice objective tests accompanied by the level of confidence and reasons of students according to the criteria of the Four-tier Diagnostic Test. In addition, as supporting data, researchers conducted documentation and interviews to obtain answers that could not be written in the four-tier diagnostic test objective test. The multiple-choice question grid and interview grid can be seen in the table below:

Table 1. Multiple Choice Question Grid

No	Grid
1	Students can understand and apply the law of sound reflection in the context of physics..
2	Students can analyze the relationship between sound volume and the speed of sound heard, and determine the factors that influence the speed of sound received.

Table 2. Interview Grid

No	Grid
1	Students' basic knowledge of sound waves
2	Examples of applications of sound waves in everyday life and how students apply the concept
3	Questions that lead students to express their understanding, including potential misconceptions.
4	The reasons behind their answer choices in the Four-Tier Diagnostic Test

Data Analysis Techniques

The data analysis technique used in calculating the value of multiple-choice questions uses descriptive statistics while the interview results are analyzed using Miles and Huberman (Anwar, 2021; Bastari, 2021; Nofri, 2021). The formula used in calculating the value of multiple-choice questions is as follows:

$$P = \frac{f}{n}\ x\ 100\%.$$

RESULTS AND DISCUSSION

The research results are described qualitatively in percentages presented in Table 3.

Table 3. Analysis of students' conceptual understanding with the four tier diagnostic test on each question item.

SC	LK	MSC	FP	FN	E
29%	33%	27%	6%	3%	1%

The data in the table above shows that the average percentage of students who understand the concept (SC) is 29% which is included in the low criteria, the average percentage of students who lack knowledge (LK) is 33% which is included in the medium criteria, the average percentage of students who experience misconceptions (MSC) is 27% which is included in the low criteria, the average percentage of students who experience false positives (FP) is 6% which is included in the low criteria, the average percentage of students who experience false negatives (FN) is 3% which is included in the low category and the average percentage of student answers that cannot be identified or errors is 1% which is included in the low category.

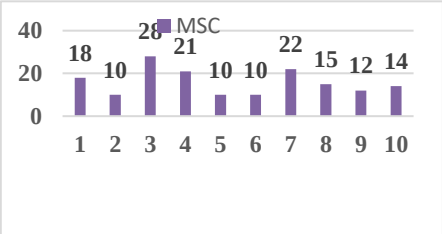

Figure 1. Analysis of Misconception Distribution for Each Question Item

In the diagram above, it can be seen that the most misconceptions occur in question number 3 where the number of students experiencing misconceptions is 28 students. And the least misconceptions occur in questions 2, 5 and 6 where the number of students experiencing misconceptions is the same, 10 students. Students have varying understandings of the concept of the law of reflection. Based on the questions in table 2. Students who answered correctly and had correct reasons were then sure of their answers and reasons (SC) by 31%. Students who experienced a lack of knowledge (LK) by 18%. Students who experienced misconceptions (MSC) by answering incorrectly and having wrong reasons but were sure by 30%. Students who experienced false positives (FP) with correct answers and wrong reasons by 5%. Students who experienced false negatives (FN) by answering incorrectly but having correct reasons by 12%. Students whose answers were not identified or errors by 3%.

Table 4. Questions on the Law of Reflection Type 1

Question	Answer	Reason
The correct statement regarding the law of sound reflection is ...	a. The incident sound, normal line, and reflected sound lie in the same plane, the angle of incidence is smaller than the angle of reflection b. The incident sound, normal line, and reflected sound lie on one line, the angle of incidence is the same as the angle of reflection c. The incident sound, normal line, and reflected sound lie in one plane, the angle of incidence is the same as the angle of reflection d. The incident sound, normal line, and reflected sound lie in the same plane, the angle of incidence is not the same as the angle of reflection	a. The incident wave, reflected wave and normal line lie in one plane, the angle of incidence is the same as the angle of reflection. b. Incident wave, reflected wave and normal line, the angle of incidence is not the same as the angle of reflection. c. Reflected wave, the incoming wave and the normal line lie on one line, the angle of incidence is the same as the angle of reflection. d. The incident wave, reflected wave, and normal line lie on one line, the angle of incidence is not the same as the angle of reflection.

From the question it has been shown about the law of sound reflection, just choose which of the multiple choices is the right answer. Many students answered correctly on question number one, but there were some students who chose the wrong answer. Where the answer should be the incoming sound, the normal line and the reflected sound lie in one plane, the angle of incidence is the same as the angle of reflection. In addition to that answer, many students were wrong in choosing the reason. Where the incoming wave, the reflected wave and the normal line should lie in one plane and the angle of incidence is the same as the angle of reflection. The students' answers and the reasons they chose for number one show that many students have misconceptions about the material on sound waves. This shows that some students are still wrong in answering questions, statements related to students' errors in answering the questions above are strengthened by the existence of interview activities. In line with research conducted by Sutopo (2016) that the law of sound reflection is much.

Table 5. Questions on the Law of Reflection Type 2

Question	Answer	Level of Confidence in Answers	Reason
In a room there are two loudspeakers playing songs at different volumes. The first loudspeaker plays a song at a high volume while the second loudspeaker plays a song at a low volume. If both loudspeakers play sound at the same time, which loudspeaker's song is heard first? 	a. High volume speaker b. Low volume speaker c. Both speakers d. No speakers	1. Sure 2. Not Sure	a. The higher the volume, the higher the frequency of the sound, so the speed of sound is greater b. The higher the volume, the greater the energy it has, so it can propagate faster c. The lower the volume, the smaller the sound particles produced, so it can easily propagate through the medium d. The speed of sound is not affected by the amplitude of the wave

In the question of the law of reflection type 2 above, students who answered correctly and the reason was correct and then were sure of their answer and reason (SC) were 18%. Students who experienced a lack of knowledge (LK) were 37%. Students who experienced misconceptions (MSC) by answering incorrectly and the reason was wrong but they were sure were 35%. Students who experienced false positive (FP) with the correct answer and the wrong reason were 8%. Students who experienced false negative (FN) by answering incorrectly but the reason was correct were 2%. Students whose answers were not identified or errors were 0%.

From the question explaining about sound reflection on a loudspeaker. In this question, many students answered that the sound that is heard first is a loudspeaker with a high volume. Not only is the answer wrong, the reason chosen is also wrong where the speed of sound propagation should not be affected by the amplitude of the wave so that the sound heard is both. The students' answers and choices of reasons cause them to experience misconceptions. In addition, there are some students who answer correctly and the reasons chosen are correct so that it can be seen that they understand the concept well. However, there are also those whose answers are correct but the choice of reasons is still not quite right or wrong. Likewise, the answer is wrong but the reason chosen is correct. This identifies them with answers like that understand some of the concepts of sound material.

The concept of sound has the highest percentage of misconceptions compared to other concepts. This is because many students still do not understand the effect of medium density on sound propagation, the differences in sound frequencies, and the effect of sound frequency on pitch. This is in line with research conducted by Aulia et al. (2018) which states that there are still many and high misconceptions experienced by students in the material of vibrations, waves, and sound. Student misconceptions are shown when the answers and reasons given by students are wrong, but students are sure of the answers and reasons.

The condition of misconceptions that occur in students if left unchecked will have an impact on the acceptance of subsequent concepts and cause students to experience continuous conceptual errors (Yuliati, 2017; Syahputra et al., 2024). Misconceptions experienced by students can be different with different causes. Therefore, it is very important for teachers to know the misconceptions experienced by students and the causes of misconceptions.

Misconceptions in students can be caused by various things. Misconceptions can also be formed by students themselves and influenced by experiences and environments that cause frequent errors in students in understanding a concept, students' preconceptions are wrong, students' reasoning is incomplete, understanding ability is still low, and can be caused by student handbooks (Hasanti, 2021; Anggita et al., 2024). Apart from student factors, the occurrence of misconceptions is also influenced by other things such as learning carried out by teachers, teaching materials used, or teachers' inadequate understanding of a concept that causes students to experience misconceptions (Sholihat et al., 2017; Abidin et al., 2024).

Previous research conducted by Triastutik (2021), the current research is significantly different from previous research in terms of the focus of the material and the context of the research. Although both studies used the same tool, namely the Four Tier Diagnostic Test, the identified material was very different, namely Sound Waves versus Straight Motion. In addition, the different geographical contexts and student populations between Tolitoli Regency and the previous research location also provide different backgrounds in identifying student misconceptions. The main GAP that emerged was the lack of study of student misconceptions on the Sound Wave material, which has its own characteristics and challenges compared to the Straight Motion material, so this study has the potential to provide new contributions in developing a deeper understanding of the conceptual difficulties experienced by students on different physics topics.

This study has a novel value because it specifically explores student misconceptions on the Sound Wave material using the Four Tier Diagnostic Test, which has not been widely carried out at the junior high school level, especially in Tolitoli Regency. Most previous studies have focused more on physics topics such as Straight Motion or other basic concepts, so studies on misconceptions on the Sound Wave material are still limited. The use of the Four Tier Diagnostic Test, a comprehensive and in-depth evaluation tool, allows this study to identify students' misconceptions more accurately and in detail compared to traditional diagnostic methods. In addition, the local context of the study in Tolitoli Regency adds a new dimension to the understanding of the influence of the learning environment and student characteristics on the emergence of misconceptions on this material, which can contribute to the development of more effective teaching strategies in addressing similar misconceptions in other areas with similar characteristics.

This study has important implications for the world of education, especially in teaching physics at the junior high school level. The results of this study can provide teachers with in-depth insights into the concepts of Sound Waves that are often misunderstood by students, thus enabling the development of more effective and targeted learning strategies to overcome these misconceptions. In addition, the findings of this study can be the basis for the development of teaching materials that are more contextual and in accordance with the characteristics of students in Tolitoli Regency, which can ultimately improve students' understanding of complex physics concepts. Thus, this study not only contributes to improving the quality of learning in the classroom, but also has the potential to support the improvement of overall student learning outcomes in the field of physics.

CONCLUSION

Based on the results of the study, it is known that the total number of grade VIII students from State Junior High School 2 Tolitoli, State Junior High School 5 Tolitoli, and State Junior High School 8 Tolitoli who were identified as having misconceptions using the four-tier diagnostic test on sound wave material was 27% which is included in the low criteria. The causes of misconceptions in students at State Junior High School 2 Tolitoli, State Junior High School 5 Tolitoli, and State Junior High School 8 Tolitoli include students' initial conceptions, wrong intuition, student interests, lack of literacy in students, teacher explanations, lack of teaching materials used, monotonous teacher teaching methods, limited teacher time in teaching especially during the Covid-19 pandemic.

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