
PROFILE OF JUNIOR HIGH SCHOOL STUDENTS' CONCEPTUAL UNDERSTANDING OF VIBRATION, WAVES, AND LIGHT

Azhar Husnun Mawaddah

Pendidikan IPA, Universitas Trunojoyo Madura, Bangkalan. 69162, Indonesia

Email: azharhusnun98@gmail.com

Abstract

This research aims to analyze the level of junior high school students' understanding of concepts related to vibration, waves, and light. The method used in this research is a mixed-methods approach, employing a sequential explanatory research design conducted at a state junior high school in Kamal sub-district. The population of this study includes all Grade VIII students during the odd semester of the 2023/2024 academic year. A purposive sampling technique was used to select a sample of 30 students. Data were collected using tests and interviews. The data collection involved a two-tier diagnostic test to assess students' conceptual understanding. The indicators used in this concept understanding test include explaining, classifying, interpreting, exemplifying, and concluding. Based on the research results, it can be concluded that: (1) students' overall conceptual understanding is moderate, (2) the two-tier diagnostic test results showed that the highest score was on the interpreting indicator, with 29%, and the lowest was on the classifying indicator, with 8%, (3) the analysis of student responses revealed that question number 4 had the highest percentage of correct answers at 80%, while question number 2 had the lowest percentage at 20%.

Keywords: *Conceptual Understanding, Vibrations, Waves, Light*

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INTRODUCTION

Natural Science (IPA) is a discipline that systematically gathers information about nature in the form of principles, facts, and concepts related to life (Candra et al., 2019). The application of science education begins with natural phenomena, developed through scientific methods such as observation and experimentation. Science education is closely related to the systematic analysis of phenomena, involving students in active interaction to perform tasks. The implementation of science education provides opportunities for students to identify events, ask questions, analyze phenomena, and communicate them to others (Martiasari, 2021). The instillation of scientific concepts has a broad impact on human life. Conceptual understanding in science can be cultivated through science education to enhance students' knowledge, skills, and quality as human resources.

According to Bruner, the discovery process actively sought by students independently can yield better results, emphasizing the need for active involvement in understanding concepts and principles to gain learning experiences that promote the discovery of these concepts and principles (Haryono, 2019). In agreement with Bruner, Piaget also suggested that in understanding science, students need to use concepts to organize and interpret the information obtained from learning experiences. Learning experiences that construct students' conceptual understanding align with Ausubel's view, which posits that meaningful learning is a process of acquiring new information that is connected to an individual's existing understanding structure (Haryono, 2019).

Conceptual understanding is the ability of students to delve into various subject materials, absorbed through events, objects, or other phenomena that share similarities and can be expressed through definitions, laws, and theories (Azizah et al., 2020). Conceptual understanding is not just the ability of students to know, recall, and memorize the topics they study; it also involves expressing those topics in their own words, making them easier to comprehend. Additionally, students must be able to interpret data and apply concepts in line with their cognitive abilities (Candra et al., 2019).

Conceptual understanding forms a crucial foundation for students, enabling them to address problems in science learning, both theoretically and practically. Students with a high level of conceptual understanding tend to communicate more interactively and logically, capable of conveying ideas based on phenomena they encounter in life (Safitri et al., 2021). This understanding can develop independently and instinctively; it cannot be achieved solely through the transmission of knowledge (Wardani, 2020). Instead, it must be nurtured and

sharpened by providing students with ample opportunities to construct their understanding of scientific concepts based on their individual learning experiences (Nurani et al., 2021).

The level of students' conceptual understanding in science can be assessed through evaluations or assessments. One effective method is diagnostic testing, which serves to analyze students' difficulties by identifying their weaknesses in understanding scientific concepts, thereby addressing these issues (Febriyana et al., 2021). Evaluating students' understanding can be conducted at the end of a learning cycle to gauge the extent of their comprehension of the learning process. Teachers can use various methods to measure students' conceptual understanding, one of which is the two-tier test. The two-tier test is a diagnostic assessment tool that can be used to reveal students' understanding based on their reasoning (Ananda et al., 2021). This test consists of two levels: the first level presents the concept being tested, and the second level explains the reasoning behind the answer provided (Sundari et al., 2021). The two-tier test can be structured as multiple-choice questions, supplemented by reasoning that supports the chosen answer (Safitri et al., 2021).

Every student has unique characteristics in processing knowledge. These unique characteristics can create a tendency towards specific learning styles for each student. Learning style refers to the way an individual absorbs, organizes, and processes the information received (Khoirunnisa & Soro, 2021). According to De Porter and Hernacki, learning styles are categorized into three types: visual, auditory, and kinesthetic (Suci et al., 2020). Visual learning style is characterized by a preference for learning through seeing. Generally, individuals with a visual learning style tend to absorb information predominantly through visual strategies, such as images or visually descriptive expressions. Auditory learning style refers to learning through listening; individuals with this style are usually adept at acquiring, understanding, and remembering information through strong auditory strategies, including sounds and verbal cues. Kinesthetic learning style involves learning through movement, doing, and touching. Individuals with a kinesthetic learning style typically absorb information by applying physical strategies and expressions with a physical component (Sufianti, 2022).

Research on identifying junior high school students' conceptual understanding using the two-tier test method has been rarely reported. Therefore, this study aims to further analyze the level of junior high school students' conceptual understanding of the topics of vibration, waves, and light. These topics were chosen because they align with the implementation of the odd semester PLP in Grade VIII, where the curriculum has reached these topics. Additionally, the subject matter is closely related to the students' daily lives, necessitating a deep understanding to support successful learning.

METHODS

This study employs a mixed-methods approach, combining quantitative and qualitative research. The research design used is a mixed design with an explanatory sequential technique. Quantitative data serves as the primary data, while qualitative data supports it. The study was conducted in the village of Banyu Ajuh, Kamal sub-district, Bangkalan district, with Grade VIII students from the 2023/2024 academic year. The sample consisted of 30 students who had received instruction on vibration, waves, and light.

The research instruments included a multiple-choice two-tier test on the topics of vibration, waves, and light, aligned with indicators of students' conceptual understanding, and interviews. Data collection involved both test and non-test methods. The test data comprised five two-tier questions on vibration, waves, and light, with closed-answer choices and reasons, while the non-test data consisted of interviews conducted with teachers. The diagnostic test results were analyzed using the following formula:

$$PK = \frac{\text{Student's score}}{\text{Maximum score}} \times 100\% \tag{1}$$

(source: Zulkarnain & Sari (2014))

After analyzing students' conceptual understanding, their answers were categorized and assessed. The scoring and categorization of conceptual understanding are presented in Tables 1 and 2.

Tabel 1. Scoring Instrument for Conceptual Understanding Test

| Question Distribution | | Score |
|-----------------------|-----------|-------|
| Question | Reason | |
| Correct | Correct | 1 |
| Correct | Incorrect | 0 |
| Incorrect | Correct | 0 |
| Incorrect | Incorrect | 0 |

(Source: modified from Nabilah et al., (2013))

Tabel 2. Conceptual Understanding Score Categories

| Understanding Score (%) | Category |
|-------------------------|-----------|
| $80 < PK \leq 100$ | Very High |
| $60 < PK \leq 80$ | High |
| $40 < PK \leq 60$ | Moderate |
| $20 < PK \leq 40$ | Low |
| $0 \leq PK \leq 100$ | Very Low |

(Source: modified from Zulkarnain & Sari (2014))

Following the analysis, conceptual understanding is classified into five categories: very high, high, moderate, low, and very low.

RESULT AND DISCUSSION

The students' conceptual understanding test maps out the difficulties students face and their mastery of the material that has been taught. A two-tier diagnostic test was administered to Grade VIII students at SMPN 1 Kamal. A total of 30 students, consisting of 14 male students and 16 female students, participated in the lessons on vibration, waves, and light. This was a prerequisite for conducting the diagnostic test. The two-tier diagnostic test was conducted as a summative test at the end of the lessons, consisting of five questions that represent the five indicators of conceptual understanding in the topics of vibration, waves, and light. The results of this test reveal the level of students' conceptual understanding, as shown in Table 3.

Tabel 3. Results of the Two-Tier Diagnostic Test

| No | Student Name | Score | Maximum Score | (%) | Category |
|----|--------------|-------|---------------|-----|-----------|
| 1 | AANQ | 5 | 5 | 100 | Very High |
| 2 | RMAR | 5 | 5 | 100 | Very High |
| 3 | AM | 4 | 5 | 80 | High |
| 4 | PNA | 4 | 5 | 80 | High |
| 5 | RA | 4 | 5 | 80 | High |
| 6 | ZEN | 4 | 5 | 80 | High |
| 7 | AF | 3 | 5 | 60 | Moderate |
| 8 | BLS | 3 | 5 | 60 | Moderate |
| 9 | H | 3 | 5 | 60 | Moderate |
| 10 | HQ | 3 | 5 | 60 | Moderate |
| 11 | MNAJA | 3 | 5 | 60 | Moderate |
| 12 | NAS | 3 | 5 | 60 | Moderate |
| 13 | NCB | 3 | 5 | 60 | Moderate |
| 14 | NA | 3 | 5 | 60 | Moderate |
| 15 | OASP | 3 | 5 | 60 | Moderate |
| 16 | RAP | 3 | 5 | 60 | Moderate |
| 17 | RSNS | 3 | 5 | 60 | Moderate |
| 18 | SBH | 3 | 5 | 60 | Moderate |
| 19 | SA | 3 | 5 | 60 | Moderate |
| 20 | AJS | 2 | 5 | 40 | Low |
| 21 | AAS | 2 | 5 | 40 | Low |
| 22 | F | 2 | 5 | 40 | Low |
| 23 | M | 2 | 5 | 40 | Low |

| | | | | | |
|----------------|------|---|---|------|----------|
| 24 | NAS | 2 | 5 | 40 | Low |
| 25 | SW | 2 | 5 | 40 | Low |
| 26 | AHLJ | 1 | 5 | 20 | Very Low |
| 27 | ARB | 1 | 5 | 20 | Very Low |
| 28 | AS | 1 | 5 | 20 | Very Low |
| 29 | AVP | 1 | 5 | 20 | Very Low |
| 30 | SAR | 1 | 5 | 20 | Very Low |
| Average | | | | 54,6 | Moderate |

The distribution of students' conceptual understanding is divided into five categories: very high, high, moderate, low, and very low, as presented in Figure 1.

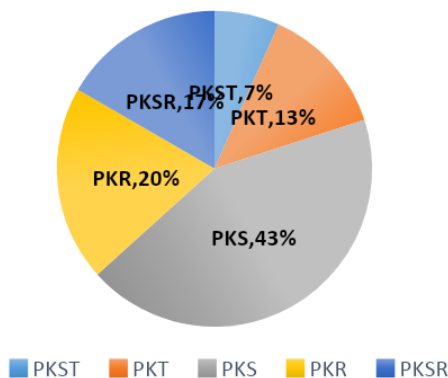


Figure 1 Percentage Distribution of Students' Conceptual Understanding Categories

Table 4 below provides the details of students' conceptual understanding for each indicator.

Table 4 Percentage of Students' Conceptual Understanding for Each Indicator

| Topic | Indicator | Question Number | Total Student Score | % |
|----------------------------|--------------|-----------------|---------------------|----|
| Vibration | Explaining | 1 | 18 | 22 |
| Types of Waves | Classifying | 2 | 6 | 8 |
| Speed of Sound Waves | Interpreting | 4 | 24 | 29 |
| Application of Sound Waves | Exemplifying | 3 | 20 | 24 |
| Light | Concluding | 5 | 14 | 17 |
| Total | | | 82 | |

Based on the data on students' conceptual understanding for each indicator, it is evident that the highest level of conceptual understanding is found in the indicator "interpreting," with 24 correct answers (29%). In contrast, the lowest level of conceptual understanding is in the indicator "classifying," with only 6 correct answers (8%). Figure 2 below presents the percentage of students' conceptual understanding for each question.

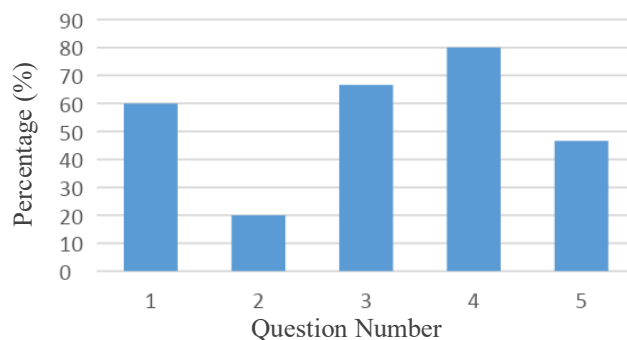


Figure 2 Percentage of Students' Conceptual Understanding for Each Question

Based on the data in Table 3, the analysis of students' conceptual understanding reveals the following distribution: two students fall into the very high understanding category, four students into the high category, 13 students into the moderate category, six students into the low category, and five students into the very low category. The majority of students fall into the moderate to very low conceptual understanding categories. From these results, two samples from each category of conceptual understanding were selected for interviews.

Table 5 List of Interview Subjects

| Conceptual Understanding Level | Subject |
|--------------------------------|---------------|
| Very High | AANQ and RMAR |
| High | AM and PNA |
| Moderate | ZEN and BLS |
| Low | F and M |
| Very Low | HS and HVP |

The students' conceptual understanding in science was measured using a two-tier diagnostic test, aligned with Piaget's theory. After the Grade VIII students completed the two-tier diagnostic test, which consisted of five multiple-choice questions accompanied by supporting reasons, the results were analyzed quantitatively. The test results were processed based on the scoring guidelines in Table 1 to determine the students' conceptual understanding scores. Students who answered correctly with a correct supporting reason received a score of 1. Students who answered correctly but provided an incorrect reason or answered incorrectly with a correct reason, as well as those who answered incorrectly with an incorrect reason, received a score of 0. The scores from the two-tier diagnostic test were then calculated using the conceptual understanding formula and categorized based on the students' conceptual understanding levels. There are five categories of conceptual understanding: very high, high, moderate, low, and very low. The results were further grouped into three categories: high, moderate, and low. The distribution of students' conceptual understanding was found to be 65% in the high category, 21% in the moderate category, and 14% in the low category.

Table 4 presents data on students' conceptual understanding abilities based on the conceptual understanding indicators. The highest percentage was observed in the interpreting indicator, with a result of 29%, while the lowest percentage was in the classifying indicator, at 8%. This suggests that students' conceptual understanding is relatively weak in the classification indicator related to vibrations, waves, and light. Students struggled to analyze and differentiate the characteristics of the objects presented. The question related to the classifying indicator was question number 2, which covered the topic of wave types. Only six students answered this question correctly, while 24 students answered it incorrectly. In contrast, the interpreting indicator, represented by question number 4, achieved the highest percentage, with 29% of students answering correctly. This question focused on the speed of sound waves, and 24 out of 30 students answered it correctly. The analysis of students' conceptual understanding indicates that the majority of students find it easier to apply formulas learned in class compared to understanding the fundamental concepts of the material.

The highest score percentage for conceptual understanding was observed in question number 4, related to the interpreting indicator, where 80% of students answered correctly. The lowest percentage was in question number 2, related to the classifying indicator, where only 20% of students answered correctly. For question number 4, the majority of students (24 out of 30) were able to answer correctly. This can be attributed to the fact that students found it easier to apply the formula for the speed of sound waves based on their classroom learning. On the other hand, for question number 2, which involved the classifying indicator, only a small portion of students (6 out of 30) were able to answer correctly. This demonstrates that students' conceptual understanding is still weak, making it difficult for them to identify questions related to wave classification. Students struggled to differentiate between transverse and longitudinal waves, indicating an incomplete understanding of the concepts of vibration, waves, and light.

The results of student interviews reveal that students with high conceptual understanding tend to have a visual learning style. According to the interviews, students with the initials AANQ and RMAR prefer learning with clear illustrations. During the interviews, AANQ displayed a calm demeanor and was not easily distracted by surrounding noise, while RMAR was more active. Both students mentioned that they found classroom learning easier to understand because the teacher presented material through picture-based games, making the questions easier to grasp. Interviews with students with high conceptual understanding indicated that both had an auditory learning style. They both admitted to having difficulty focusing in a less conducive learning

environment. During the learning process, the student with the initials PNA frequently asked the teacher for clarification on the material and information provided.

Interviews with students in the moderate category revealed that the student with the initials AF had an auditory learning style. AF found it difficult to focus in a noisy classroom and struggled with picture-based learning. Meanwhile, the student with the initials BLS had a visual learning style but often got distracted by things around them during class, causing their focus to shift. Interviews with students in the low conceptual understanding category showed that both had an auditory learning style. The students with the initials F and M were active in class but were easily distracted by conversations around them. During the learning process, they frequently left the classroom, leading to incomplete learning experiences. Interviews with students in the very low conceptual understanding category revealed that the student with the initials HS had an auditory learning style, while HVP had a kinesthetic learning style. During the interviews, HS expressed difficulty hearing the teacher's explanations due to the noisy classroom environment, while HVP seemed uncomfortable during the interview and mentioned having trouble understanding the teacher's explanations during class but was too shy to ask questions.

Based on the data analysis and interviews conducted, it was found that the low conceptual understanding among students can be influenced by their learning styles. Each student has a different learning style, with varying characteristics. Students with a visual learning style tend to find it easier to understand questions accompanied by images. These students are more observant and can better construct their memory based on observed phenomena. The second learning style is auditory. Students with an auditory learning style are sensitive to surrounding sounds and prefer learning through discussion and interaction. The third learning style is kinesthetic. Students with a kinesthetic learning style prefer learning that involves physical activities. Typically, learning models that involve hands-on experiences, such as experiments, are easier for kinesthetic learners to grasp. The learning model also influences students' conceptual understanding. In the Grade VIII class on vibrations, waves, and light, the teacher employed various learning models that supported the students' learning styles, such as discovery learning through experiments on the topic of vibrations, think-pair-share through discussions on the topic of waves, and problem-based learning through demonstrations on the topic of light. Another factor that contributed to the low conceptual understanding among students was their low motivation to learn. This was observed during the learning process when some students left the classroom, indicating low engagement. The short learning time also played a role in the less-than-optimal classroom learning process. The time available for teaching the material on vibrations, waves, and light was relatively short—about 25 minutes per lesson—due to school infrastructure rehabilitation, which resulted in a reduction of classroom teaching time.

CONCLUSION AND SUGGESTIONS

A. Conclusion

The conceptual understanding of Grade VIII students at one of the public junior high schools in Kamal District is still relatively low. The results of the two-tier diagnostic test indicate that only 6 students (37%) achieved a high and very high level of conceptual understanding, while 24 students (63%) remain in the moderate and low categories. Based on the indicators, the highest score was on the interpreting indicator at 29%, while the lowest score was on the classifying indicator at 8%. Furthermore, the analysis of student responses shows that the question most frequently answered correctly was question number 4, with 80% of correct answers, whereas the question with the lowest correct response rate was question number 2, with only 20% correct answers.

B. Suggestions

Based on the research conducted, the following suggestions can be made for future studies: The test questions used to assess students' conceptual understanding can be further developed into multiple-choice questions with higher levels of complexity to more accurately measure students' conceptual understanding.

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