Measuring students’ conceptions of light waves: A survey in Central Java

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Abstract. Students’ conceptions an important role in achieving learning goals, especially in the concept of light waves in physics. The aim of this research is to measure students’ conceptions of light waves. This research is a survey with 519 respondents (K-11 students with an age of about 17 years old consisting of 399 females named “Mba’e” and 120 Males named “Le” calling in Central Java). The instrument used is the seven questions from MOLWI that have been developed. The research results are categorized based on six conception categories: Sound Understanding (SU); Partial Positive (PP); Partial Negative (PN); Misconception (MC); No Understanding (NU); and No Coding (NC). The results show that the concept of students in Central Java on the concept of light waves is in the category SU = 29%, PP = 3%, PN = 26%, NU = 4%, MC = 27%, and NC = 0%.

1. Introduction

Students' understanding of a concept in physics can vary. If students' understanding is in accordance with scientific conceptions, it can be said that they have the correct conception [1-3]. However, if their understanding is not in accordance with the understanding of experts, then they can be said to have a wrong conception or commonly known as a misconception [4-6]. Misconceptions can happen to anyone, whether children, adults, students, students, teachers, even lecturers. This is because there are many causes of misconceptions, including books, wrong guides, social media, friends, even learning outcomes in class can also be the cause of misconceptions [7-9]. In addition, everyone's experiences are different, thus, this also has the potential for misconceptions [10].

Misconceptions in physics can occur in various concepts [11-13], one of which is the concept of light waves [14-16]. Research conducted [16] states that Sundanese scholars still have misconceptions about the concept of light waves. For example, in the concept of fast propagation of light in a certain medium, it turns out that there are still students who experience misconceptions. In fact, based on the conception in accordance with experts say that when light passes through a certain medium, its speed will change according to the refractive index of the medium, according to Equation 1 [17].

\[ v = \frac{c}{n} \] (1)
Note: \( v \) = The velocity of light in a medium (m/s)
\( c \) = The velocity of light in vacuum (\(3 \times 10^8\) m/s)
\( n \) = refractive index

In this case, each region in Indonesia can be a research subject to identify its level of conception, considering that Indonesia is a country with different ethnicities and cultures. This diversity can also be a factor in the occurrence of misconceptions because every tribe or culture must have its own legend. When it comes to physics concepts, sometimes the students understand it completely. Thus, it must be handled immediately. However, before that, we must identify the conceptions of students in each area, for example, the concept of light waves, thus, that we have a map of the diversity of conceptions for each area. Thus, the purpose of this study is to measure students' conceptions of light waves in Central Java.

2. Research Method

2.1. Respondents
Respondents in this study were K-11 students aged around 17 years old consisting of 399 females named “Mba’e” and 120 Males named “Le” calling in Central Java. Central Java is one of the provinces in Indonesia with Semarang as its capital city. The map of Central Java can be seen in Figure 1.

![Figure 1. The map of Central Java (Source by Google Maps)](image)

2.2. Design
This research is a survey research conducted in Central Java. Survey research is a research where the main source of data and information is obtained from respondents as research samples using a questionnaire as a data collection instrument. Survey research generally refers to selecting a relatively large sample of people from a predetermined population [18]. Thus, it is hoped that the results of this study can provide an overview of the conditions of the conception of students in Central Java on the concept of light waves.
2.3. Instrument
The instrument used is the seven questions from MOLWI that have been developed by [16]. The instruments used were questions from numbers one to seven which were taken sequentially. The instrument is a type of four-tier test with a close-ended category. This means that all answers for each tier are available. An example of the instrument used is shown in Figure 2.

![Figure 2. The sample of MOLWI developed questions](image)

2.4. Data Analysis
Data analysis was performed for each category of conceptions used. There are six categories of conceptions, including: Sound Understanding (SU); Partial Positive (PP); Partial Negative (PN); Misconception (MC); No Understanding (NU); and No Coding (NC). The category is adjusted to the student's answer when answering the questions given. Details of the categories of conceptions used can be seen in Table 1.
Table 1. Conceptions Categories

| Tier | SU | PP | PN | MC | NU | NC |
|------|----|----|----|----|----|----|
| 1    | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| 2    | S  | U  | S  | U  | S  | U  |
| 3    | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| 4    | S  | S  | U  | S  | U  | S  |

*✓: Correct, ✖: Incorrect, S: Sure, U: Unsure, IA: Incomplete Answer

After the students' answers are entered based on the conception category in Table 1, then each category will be analyzed based on Equation 2.

\[
\text{Conception category} = \frac{\sum \text{Number of students per category} \times \text{score for each category}}{\sum \text{Number of students}} \times 100
\]

(2)

After all conception categories have been analyzed, then all the questions used will be formulated. The aim is to see a comprehensive picture of the conceptions of Central Javanese students on the concept of light waves.

3. Result and Discussion

After conducting the research, we got an overview of the conceptions of students in Central Java about the concept of light waves. The distribution of student conceptions can be seen in Table 2.

Table 2. Value of Critical Thinking Skills.

| Category Conception | Number of Question |
|---------------------|--------------------|
|                     | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
| SU                  | 413| 80 | 170| 33 | 73 | 14 | 25 |
| PP                  | 10 | 2  | 82 | 16 | 8  | 2  | 6  |
| PN                  | 53 | 10 | 181| 35 | 123| 24 | 306|
| NU                  | 4  | 1  | 6  | 37 | 8  | 27 | 5  |
| MC                  | 39 | 8  | 80 | 15 | 277| 53 | 155|
| NC                  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

Based on Table 2, the number of students in question number 1 is in the SU category as many as 413 students (80%). While in question number 2 the most students were in the PN category with 181 students (35%). In question number 3, most students are in the MC category with 277 students (53%). As for question number 4, it is the same as question number 2 which is the most in the PN category with 306 students (59%). In question number 5, like question number 3 where most people are in the MC category with 240 students (46%). Whereas for questions number 6 and 7 the most was in the PN category with 359 (69%) and 204 (39%) students respectively, the same as questions number 2 and 4. And the smallest number of students for all categories is in the NC category with 0 students (0%). After the data is obtained, the percentage description for each category of conception can be seen in Figure 3.
Figure 3. Percentages for each category of conception

Figure 3 shows the percentages for each category of conception. Furthermore, to find an overview of the conceptions of Central Javanese students on the concept of light waves, it can be seen in Figure 4.

Figure 4. Central Javanese students' conception of the concept of light waves

Figure 4 illustrates that the conceptions of Central Javanese students on the concept of light waves are greatest in the PN category with a percentage of 36%. Meanwhile, the smallest category of conception is in the NC category with a percentage of 0%. However, there are also categories of conception that stand out apart from the PN category, namely the SU category with a percentage of 29% and the MC category of 27%. What should be noted from this result is that the concept of Central Javanese students is still wrong on the concept of light waves. This can be seen in the MC category whose percentage is not far from the PN and SU categories. These results are in line with research [16]
which states that Sundanese scholars still have misconceptions on the concept of light waves. Thus, there needs to be a handler to reduce the misconceptions that Central Java students have.

Dealing with misconceptions can be done in a number of ways. Existing research can serve as a guide such as:[19] who in this study use visual multimedia as an aid to changing conceptions; [20] where, the use of learning models is carried out as a treatment in changing students' conceptions; [21] which in research uses activities in the lab. Thus, Central Javanese students' misconceptions about the concept of light waves are expected to be derived, or converted into a concept that is in accordance with scientific or expert concepts.

4. Conclusion
The conceptions that Central Javanese students have on light waves are still diverse. Based on the results of the study, as many as 29% of students were in the SU category, 3% of students were in the PP category, 26% of students were in the PN category, 4% of students were in the NU category, 27% of students were in the NC category. These results can be a support in identifying students' conceptions of light waves in other areas, given that Indonesia has a diverse ethnicity and culture. Thus, this step can be used for other physics concepts with samples from different regions in Indonesia.

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