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FOUR-TIER DIAGNOSTIC TEST TO IDENTIFY MISCONCEPTIONS IN *GEOMETRICAL OPTICS*

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Abstract

The purpose of this research was to identify student misconceptions in Geometrical Optics. Four-tier multiple choice diagnostic test can be used to identify student misconseptions. The data of this research were obtained by interview, questionnaire, and test. This research used random sampling to 107 X grade students who already got Geometrical Optics materials. The data of this research were analyzed and interpreted to distinguish students who understand the concept, not understand, and misconceptions. Result of the research showed that on each item of test, there are some students who have misconceptions. Students had misconceptions in low category with details of 31% of all test item, 53% in medium category, and 16% in high category.

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INTRODUCTION

Learning process is an activity led by teacher to bring students into bettermen. A learning process will be considered success if there is a change to learner's behavior. Effective learning is not only related to explanation, but also avoiding learner to have misconception (Styer, 1996).

One of students' learning problems is misconception. Kose (2008) defines misconception as an unscientifically acceptable concept understood by students. It happens to everyone, whether children or adults.

It can happen due to internal or external factors. Internally, students may have understoond wrong thing before the class. A simple example of misconception is elementary students who believe that sun evolves the Earth, since they see the sun rises on the east and sets on the west. This wrong understanding will ruin the learning process (Tayubi, 2005). Thus, teacher and students should do remediation to solve the problem.

The recurring test done by teachers only objected to know students' cognitive understanding without concerning students mistake in answering the tests. It is in line to the interview with four Physics teachers in Semarang.

One way to know students' misconception is through diagnositic test. The use of diagnostic test can help teacher to discover students' misconception (Lin, 2004). Previous researches have developed some forms of diagnostic test, including one-tier diagnostic test, two-tier diagnostic test, and three-tier diagnostic test. This research used four-tier diagnostic test to identify students' misconception in Geometrical Optics. Four-tier diagnostic test is the development of three-tier diagnostic test by adding the confidence to each answer and reason. The addition of confidence to diagnostic test demands the students to be more careful in choosing answer (Yusrizal & Halim, 2017).

Four-tier diagnostic test has four level. The first tier is a multiple choices test with a key answer and three distractors. The second tier is students' confidence in choosing the answers. The third level is students' reason in choosing answer. The fourth level is students' confidence level in choosing the answer (Fariyani *et al.*, 2015).

METHODS

This research was done to 107 X grade students who already got the material of Geometrical Optics. The data of this research were collected from interviews, questionnaires, and tests. Interview to physics teachers were done to know how far the evaluation is applied by teachers along with their responses to four-tier diagnostic test. The interview was also done to students to confirm their answer in doing the test. A questionnaire is given to students to know their responses to four-tier diagnostic test.

The obtained data were analyzed to map students' conceptual understanding whether understand, do not understand, and misconception. The students' mapping is delivered in Table 1. The mapping is based on the interpretation done by Fariyani *et al.* (2015).

The interpreted data was then analyzed again based on the criteria of understand, not understand, and misconception. These criteria were then divided again into low, medium, and high. The criteria were:

$0\% \leq P < 30\%$: low
$30\% \leq P < 60\%$: medium
$60\% \leq P \leq 100\%$: high (Suwarna, 2013).

Table 1. The Interpretation from Four-tier diagnostic test Results

Answer	Confidence	Reason	Level of Confidence	Criteria
correct	high	correct	high	Understand
correct	low	correct	low	Not Understand
correct	high	correct	low	
correct	low	correct	high	
correct	low	wrong	low	
wrong	low	correct	low	
wrong	low	wrong	low	
correct	high	wrong	low	
wrong	low	correct	high	
correct	low	wrong	high	Misconception
correct	high	wrong	high	
wrong	high	correct	low	
wrong	high	correct	high	
wrong	high	wrong	low	
wrong	low	wrong	high	
wrong	high	wrong	high	

RESULT AND DISCUSSION

The data from the field test were interpreted to know the test items which were understood, not understood, and misconcepted by students. This interpretation is important, since nowadays, most people equalize the meaning of not understand a concept with misconception. Teachers must differentiate students who are able to understand concept well, not understand at all, and experiencing misconception to handle the students correctly.

Hafizah *et al.* (2014) states that the most occurred problem is when teacher seek for remediation with their incapability of categorizing students who experiences misconception or not. Four-tier diagnostic test is a diagnostic test which is used to differentiate students who do not understand concept to students who experience misconception. Gurel *et al.* (2015) states that diagnostic test can differentiate what examiner want the students to understand and what is understood by the students. It supports the statement that diagnostic test is used to segmented students who understand a concept well and understand a concept in minimum portion that they have less confidence to use it. The recapitulation of the interpretation can be seen in Table 2.

Table 2. Interpretation of Four-Tier Diagnostic Test Result

Sub-Chapter	Understand (%)	Not Understand (%)	Misconception (%)
Reflection of Light	52.6	15.2	32.2
Plane Mirror	28.2	31.9	39.9
Convex Mirror	42.7	28.0	29.3
Concave Mirror	24.5	29.0	46.5
Refraction of Light	32.0	34.0	34.0
Positive Lens	15.8	28.6	55.7
Negative Lens	26.5	32.7	40.7
Eyes	32.9	27.7	39.4
Loop	54.2	27.3	18.5
Microscope	29.9	34.6	35.5
Telescope	13.1	31.8	55.1

The interpretation of the data showed that there is a misconception to every sub-chapter of Geometrical Optics. The highest misconception is in the sub-chapter of positive lens. Students were unable to differentiate between biconvex and biconcave lens. Students thought that biconvex lens is a negative lens which is divergent. Another misconception is in sub-chapter of positive lens where students deemed that biconvex lens had negative focus. Students also had a misconception in the process of the refraction of positive. The light to the focus will come through. A reflection will be made from the refraction of positive lens from the intersection of refracted lights. The misconception of lens refraction and the analysis of positive lens were also found by Hafizah *et al.* (2014).

Students were already segmented based on their criteria and analyzed to determine the percentage of the samples. The mapping of the students who understand, not understand, and misconception can be seen in Figure 1.

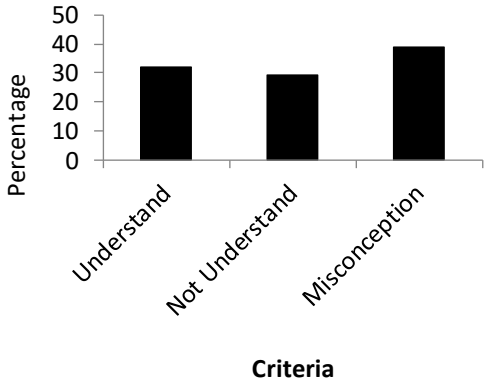

Figure 1. The Percentage of Students based on their Criteria

Figure 1 showed that most of the students experienced misconception than understand and not understand the concept. It is very important to the teachers to know that the students experienced misconception. If misconception was not tracked, it will be remained in the higher level. It opens the possibility that they will spread the misconception to other people. Such kind of behavior will be difficult to change. It is in line to Kaur (2013) that misconception is able to spread and resistant to changes.

Students were segmented to the categories of understand, not understand, and misconception. Each criterion was divided again into high, medium, and low. The grouping of the students can be seen in Figure 2.

Students who experienced misconception in low category were 31.37%; 52.94% in medium category; and 15.69% in high category from all the test items. Most of the misconception experienced by students were in medium level. Students who had misconception will apply the concept that they had believed using the new concept that they accept. Misconception makes students far from the correct concept as they build their own concept (Aydin *et al.*, 2015).

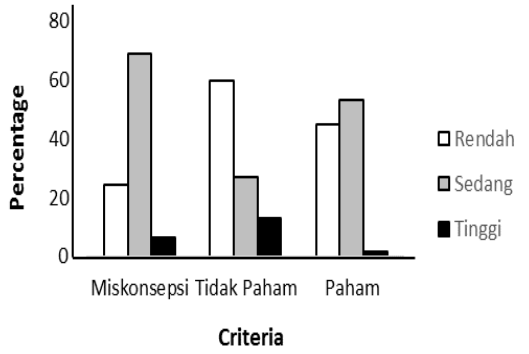

Figure 2. The Average Criteria of Students

The findings of misconception in this research were grouped based on the found misconception. The grouping can be seen in Table 3.

Table 3. Students' Misconception

Sub-Chapter	Misconception
Reflection of Light	Law of Reflection of Light
	Concept of Incident Ray and Refracted Ray
	Determine the Number of Incident Ray and Refracted Ray
Mirror	Characters and Shadow Formation in plane, convex, and concave mirror

Sub-Chapter	Misconception
	Minimum height of plane mirror
	Divergent and Convergent Light
Refraction of Light	Refraction of Light
	Phase velocity, frequence, and length of light wave in different medium
	Refraction of lens only happens once
Lens	Biconvex and biconcave lens
	Shadow formation and the focus of positive and negative lens
	Shadow in positive and negative lens
Eyes	The process of eye vision
	Miopia and Hyperopia
	Determining diopters
Loop	Position of thing to be seen clearly in loop for maximum accomodated sight
	Shadow's magnification in loop for accommodated eyes and not accommodated
Microscope	Light refraction in microscope
	Shadow made by microscope
	Shadow's magnification in microscope
Telescope	Light refraction in Earth's telescope
	Shadow in objective lens of telescope

Based on the interview to the students there were some sources of interviews. It can be from the students, teachers, or the book. Students used logic and intuition to answer the test. Misconception happened to students due to the construction of their daily knowledge. Students also said that they got wrong information from their teachers. It can happen due to students did not absorb the information from the teachers correctly. It can also happen because the teacher had misconception. Teacher should be aware that their misconception can make the students had the same misconception; thereby, the students can get the right material (Lark, 2007).

Friends also become an influential source of misconception. Students tend to gather with their friends to discuss their problems in learning. Problems will happen if their friends give wrong concept which later believed by students.

Suparno (2013) states that textbook which is difficult to understand will make students misconcept. Students will only accept partial information from the book. This incomplete understanding will distract students' understanding of physics.

Every student has different misconception. Aydin *et al.* (2015) mention that different misconceptions come from different school and students' home, which later, it makes students get different understanding from different teachers.

This different background makes different understanding to each student. Children and adults get misconception from the worlds they observe (Stein *et al.*, 2008).

If teacher has known that there is a misconception in the materials or the students, they are obliged to decrease the misconception. Remidiation can be done by emphasizing on the materials with the indication of misconception. The source of misconception should also be acknowledged to prevent its occurrences.

CONCLUSION

Four-tier diagnostic test is an evaluation tool which is used to identify students' misconception. Four-tier diagnostic test has four level. The first tier is a multiple choices test with a key answer and three distractors. The second tier is students' confidence in choosing the answers. The third level is students' reason in choosing answer. The fourth level is students' confidence level in choosing the answer. Students were indicated on having

misconception where 31% were in low category, 53% were in medium category, and 16% were in high category. It is very important for teacher to acknowledge misconception, whether it comes from the students or the teacher himself. Misconception can come from students, teachers, friends, and books.

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