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Detecting Student Misconceptions about Physics Using Three Tier Diagnostic Test with Analysis Certainty of Response Index

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Abstract

Misconceptions are an obstacle in the learning process, especially in physics. One way to detect misconceptions is to use a three-tier diagnostic test and analyze it using the Certainty of Response Index (CRI). The purpose of this study was to detect students' misconceptions on straight motion material using a three-tier diagnostic test with CRI analysis. This type of research is descriptive research. The sample in this study was taken from students at three high schools in East Lombok district, NTB. The number of samples in this study was 132 students. This test instrument consists of 10 question items. The results showed that students still experienced many misconceptions in straight motion material.
Keywords*: Straight motion, misconceptions, three tier diagnostic test, CRI.*

Mendeteksi Miskonsepsi Siswa tentang Fisika Menggunakan Tes Diagnostik Three Tier dengan Certainty of Response Index

Abstrak

Miskonsepsi merupakan penghambat dalam prose pembelajaran, khususnya fisika. Salah satu cara mendeteksi miskonsepsi adalah menggunakan tes diagnostik three tier dan menganalisisnya meggunakan *Certainty of Response Index* (CRI). Tujuan dari penelitian ini adalah mendeteksi miskonsepsi siswa pada materi gerak lurus menggunakan tes diagnostik three tier dengan analisis CRI. Jenis penelitian yang digunakan adalah penelitian deskriptif. Sampel dalam penelitian ini diambil dari siswa pada tiga sekolah menengah atas di kabupaten Lombok Timur, NTB. Jumlah sampel dalam penelitian ini sebanyak 132 siswa. Instrumen tes ini terdiri dari 10 item soal. Hasil penelitian menunjukkan bahwa siswa masih banyak mengalami miskonsepsi pada materi gerak lurus.
Kata Kunci*: Gerak lurus, miskonsepsi, tes diagnostik three tier, CRI.*

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INTRODUCTION

Almost all the concepts of physics have clear meanings and meanings according to the opinion of scientists, but some students have different preconceptions due to experiences in their environment. Some students have a different conception from the concept of scientists. This difference in concept is sometimes true and false. The incompatibility of the concepts that students have if it is wrong is called a misconception (Suparno, 2013).

Misconception is an obstacle for students to understand physics material (Sholihat et al., 2017). The term misconception is used in a concept that conflicts with scientifically accepted theory (Gurel et al., 2015). Misconceptions are a description of the mistakes of students' ideas formed from previous experiences or observations of physical phenomena in everyday life (Neidorf et al., 2020).

Misconceptions arise from daily experiences that occur when interacting with the environment. As a result, concepts are formed in the minds of students that are

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not necessarily correct (Fariyani et al., 2017). In recent years there have been many studies showing that students enter the classroom with many ideas or initial conceptions that have been formed beforehand. Prejudice or early conceptions often experience misunderstandings and do not fit scientific concepts so that they are called misconceptions (Demirci, 2005). Many studies have found that misconceptions are resistant to improvement, which may be partly because they are useful for students in explaining the phenomena of everyday life (Allen, 2014). there are several factors causing the misconception, namely: 1) students 'preconceptions, if students' preconceptions are wrong, it will become a disruption to learning so as to allow misconceptions; 2) associative thinking in the form of incomplete causal thoughts, for example the effect of heating the substance will only increase the temperature, without considering changes in form; 3) humanistic thinking, namely thinking that analogizes physical matter with human social life; 4) incomplete reasoning is caused by incomplete understanding; 5) wrong intuition; 6) Cognitive development of students may experience obstacles that affect understanding the concept; 7) the ability of students, the level of intelligence affects the process of interpreting physics concepts, if the level of intelligence is high, students tend to interpret the concepts more easily and correctly; 8) students' learning motivation, the higher the students' learning motivation in learning physics, the stronger the students' understanding of physics concepts (Suparno, 2013).

Misconceptions have several synonyms such as misunderstanding of concepts, alternative conceptions, naive concepts, intuitions, and so on (Leonard et al., 2014). Misconceptions are misconceptions due to the failure of the process of reconstructing initial knowledge with the latest knowledge. The misconception is the incompatibility of knowledge construction based on one's own experience with scientific understanding (Karpudewan et al., 2017). Misconceptions are prone to occur and are very difficult to get rid of. Misconceptions of physics are the incompatibility of understanding the concepts of physics with actual physics theories or concepts or physicists' opinions regarding certain physics concepts. Misconceptions that exist in students must be immediately reduced and even eliminated to achieve learning objectives so that students' understanding of physics concepts increases and it is expected to improve their thinking skills according to the demands of 21st-century learning. Misconceptions also persist in students if there is no proven error (Taufiq, 2012). Learning that does not consider students' preconceptions can lead to increasingly complex misconceptions. This misconception is very influential on learning outcomes (Aulia et al., 2018). There are several methods used to detect student preconceptions or misconceptions, namely: 1) diagnostic tests for misconceptions with reasons, 2) clinical interviews, and 3) through concept maps (Taufiq, 2012).

Based on these problems, it is necessary to conduct studies and research to find out students 'misconceptions and to know students' initial conceptions. The findings in this study aimed to describe students' misconceptions about straight motion material. This can help in designing lessons that can eliminate these misconceptions.

METHODS

This research is descriptive. Descriptive research was conducted to describe the symptoms, relationships, or research variables without giving treatment (Setyosari, 2015). The stages of research activities, namely; 1) compiling a three-tier diagnostic test, 2) validating the instrument by an expert, 3) giving a test to

students, 4) processing the test results and describing them. This research was conducted on 132 students from three senior high school in East Lombok, NTB. The research instrument used a three-tier test with independent reasons. The three-tier test instrument consists of 10 questions. The material in this research is straight motion with sub material in the form of regular straight motion (GLB), straight motion changing regularly (GLBB), and free-fall motion (GJB). The three-tier test instrument consists of 10 questions. The first section or level contains multiple-choice questions. The second part or level contains the students' reasons for choosing answers. The last section is about the level of confidence of students in their answers. This level of confidence is divided based on the Certainty of Response Index (CRI) as shown in Table 1.

Table 1. CRI and its Criteria

Certainty of Response Index	**Criteria**
0	*Totally guessed answer*
1	*Almost guess*
2	*Not Sure*
3	*Sure*
4	*Almost certain*
5	*Certain*

(A'yun et al., 2018)

As explained above, CRI is a level of students' confidence in their choice of answers. CRI usually uses a Likert scale. The students' conception categories are divided into four categories, namely: understanding concepts/Expert (E), not understanding concepts (NUC), lucky/guessing (L), and misconceptions (M). Misconceptions consist of three categories, namely: false negative misconceptions, false positive misconceptions, and pure misconceptions. More details are shown in Table 2.

Table 2. Students' Conception Categories

Answer	**Low CRI (0-2)**		**High CRI (3-5)**	
	Correct Reason	**Wrong Reason**	**Correct Reason**	**Wrong Reason**
Correct	*Lucky/Guessing* (L)	Not Understanding Concepts (NUC)	Understanding Concepts/Expert (E)	False Positive Misconceptions (M)
Wrong	Not Understanding Concepts (NUC)	Not Understanding Concepts (NUC)	*False Negative* Misconceptions (M)	Pure Misconceptions (M)

RESULT AND DISCUSSIONS

Students' misconceptions on straight motion material were identified by a three-tier diagnostic test consisting of 10 question items. these problems are related to regular straight motion (GLB), regular changeable straight motion (GLBB), and free-fall motion (GJB). Students who are given the test are students who have received learning about straight motion material. The results of the student's misconception analysis are shown in Figure 1.

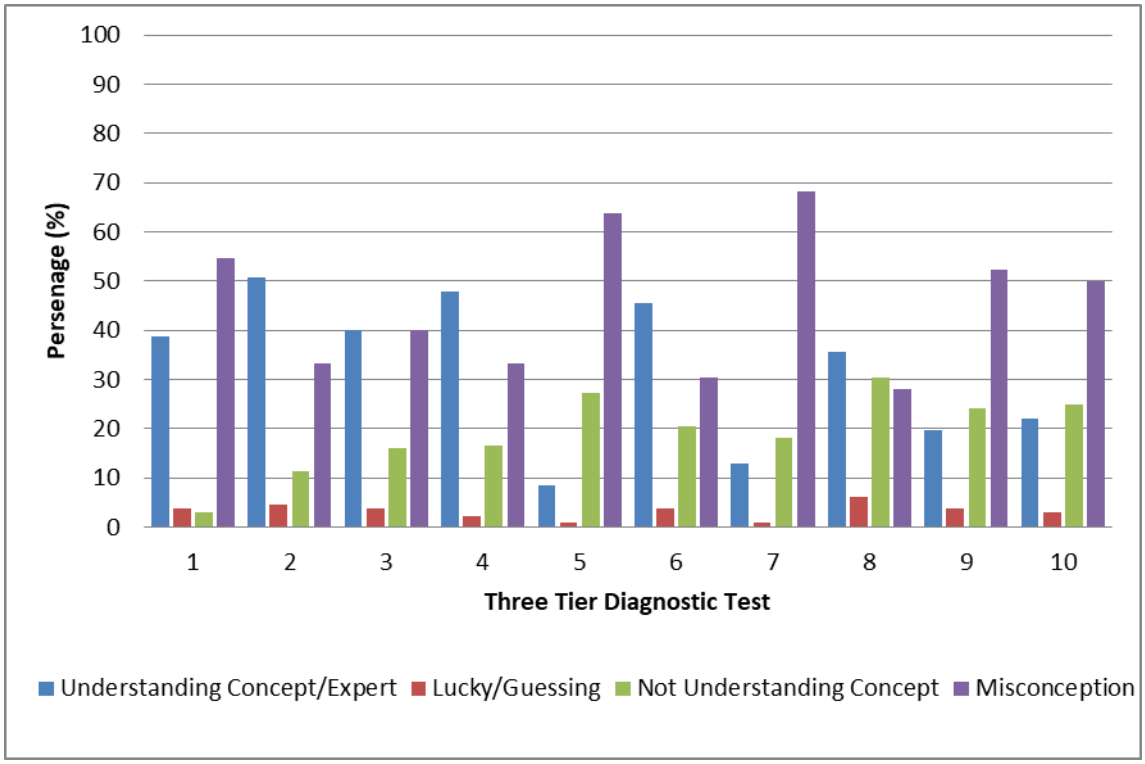

Figure 1. Percentage of students who have misconceptions in straight motion material

Based on Figure 1, it can be seen that misconceptions are still dominant in students. In question item number 1, students are asked related questions about the magnitude/value of acceleration in straight, changing regular motion. Most of the students said that the acceleration was speed dependent. They give the reason that because the speed changes, the acceleration depends on the speed. The percentage of students who experienced misconceptions in question number 1 was 54.55%, the percentage of students who understood the concept was 38.64%, those who guessed were 3.79%, and those who did not understand the concept were 3.03%. The correct concept in this case regarding acceleration in a straight motion changing regularly is constant because the velocity changes regularly.

In question item number 2, the percentage of students who understand the concept is greater than those who experience misconceptions. Students who understood the concept were 50.76%, those who guessed/lucky were 4.55%, those who did not understand the concept were 11.36%, and those who misconceptions were 33.33%. However, the percentage of students who experience misconceptions is still quite large. In question number 2, several statements are given regarding the concept of displacement, and students are asked to choose the correct concept. As seen in Figure 1, most students understand that displacement is a vector quantity and depends on the starting and ending positions. However, some students think that displacement is a scalar quantity and depends on the length of the path.

In question number 3, students are given an overview of a car that moves straight and changes regularly. They were asked to understand the meaning of the problem. The percentage of students who have misconceptions and those who understand the concept is the same (40.15%). Meanwhile, those who did not

understand the concept were 15.91%, and those who guessed were 3.79%. Students who experience misconceptions and do not understand the concept give the answer that the car moves in a straight line, meaning that the car is moving in a straight line at a constant speed. This shows that students have not been able to distinguish the concept between regular straight motion and regular changing straight motion.

Problem number 4, students have given a graph of velocity against time (Figure 2). They were asked to select cycles on a graph depicting regular straight motion. As many as 47.73% of students were able to answer correctly and understand the concept. Students who experience misconceptions are 33.33% and students who do not understand the concept are 16.67%. Meanwhile, students guessed only 2.27%.

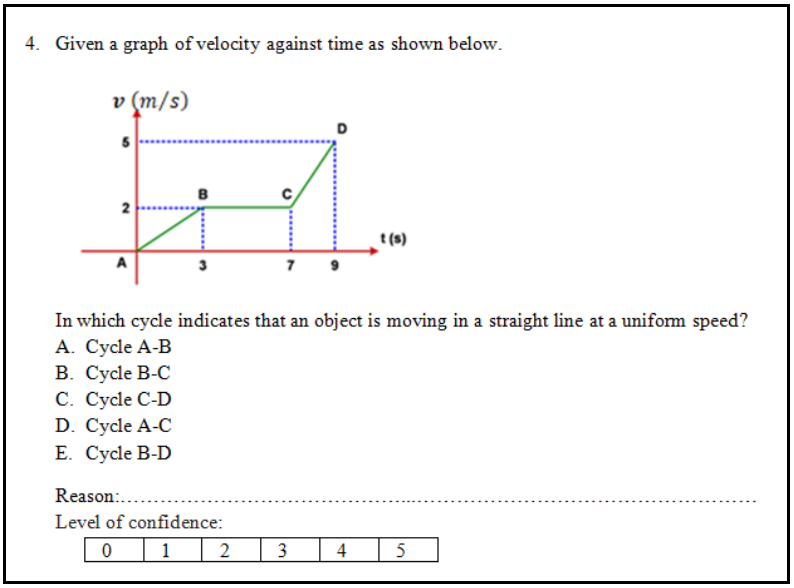

Figure 2. Problem Number 4

Students who understand the concept choose the answer to cycle B-C because in cycle B-C there is no change in object velocity. Students who have misconceptions and do not understand the concept of average choose answer A (cycle A-B) or D (cycle A-C). Most of them who do not understand the concept and experience misconceptions do not give reasons and even they just simply answer. Learning-related to this need to be deepened when teaching because it is related to graphic representation. A good graphic representation can help students understand the concept well.

Problem number 5 is related to the graph of regular straight motion and the graph of regular changing straight motion (Figure 3). Students are asked to choose a graph depicting the concept of regular straight motion and a graph depicting the concept of straight motion changing regularly. Only 8.33% of students answered correctly and had the right reasons. This shows that the ability of students to graphically represent students regarding straight motion is very low. As many as 63.64% of students were categorized as misconceptions and 27.27% of students did not understand the concept. Judging from the students' answers and the reasons were given, it can be said that most students only see the graph from the graph without considering the variables on the x-axis and the y-axis. This is

following the problem in number 4, it was found that students still had difficulty understanding graphics related to the concept of straight motion.

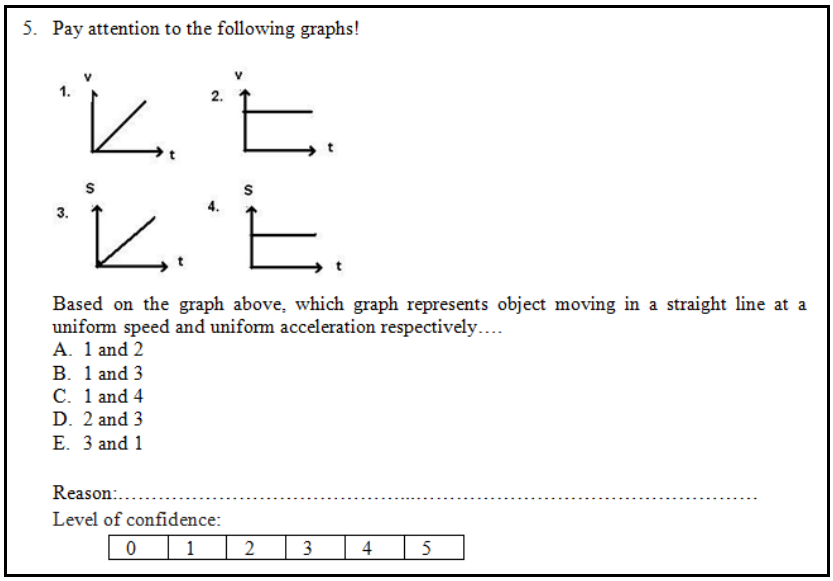

Figure 3. Problem number 5

In question number 6, the percentage of students who understand the concept is greater than those who do not understand the concept or who experience misconceptions. As many as 45.45% of students understood the concept category, 20.45% of students did not understand the concept, and 30.30% experienced misconception. Problem number 6 is related to a graph of slow-motion changing regularly. Students who understand the concept give the reason that the answer is that straight motion changes regularly is slowed down because the graph is decreasing or the speed decreases.

Problem number 7 deals with the results of the ticker timer experiment. As many as 68.18% of students experienced misconceptions and did not understand the concept of 18.18%. Students who understand the concept of 12.88%. The misconception experienced by these students can be seen from their reasons when answering that it appears that the points on the ticker timer on the right are getting more stretched so that the students assume it is an accelerated, regular changing straight motion. They don't pay attention to the direction of force or direction of movement of the timer ticker pulling.

For problem number 8 it deals with the resultant displacement. As many as 35.61% of students understood the concept and were able to calculate the resultant displacement. However, 30.30% did not understand the concept and 28.03% experienced misconception. This happens because of several factors such as students do not understand how to calculate resultants and students do not understand the concept of displacement.

Meanwhile, for questions, number 9 and number 10, the percentage of students who experienced misconceptions was above 50% on average, while those who understood the concept were below 22%. This is because students do not understand the concept of free fall. Students who cannot answer question number 9 will find it difficult to answer question number 10. These two questions are related to one another. Based on the results of the analysis of the students' answers, they still think that in free fall, the mass of the object affects the time. They feel that the greater the mass of the object, the faster it will fall. They do not understand that the

concept of free fall is only affected by gravity and that the initial velocity of free fall is always zero.

Based on the description of students' misconceptions, that misconceptions often occur in students. This misconception is prone to learning because it can hinder the acceptance of further concepts and cause student learning outcomes to be low (Alatas, 2015). In total, the percentage of students' misconceptions on straight motion material is shown in Table 3.

Table 3. Percentage of Student Misconceptions

Category	Percentage
Understanding Concept/Expert	32.12%
Lucky/Guessing	3.26%
Not Understanding Concept	19.24%
Misconception	45.38%

It can be seen in Table 3, most students experience misconceptions about straight motion material. This can have an impact on low student learning outcomes. Misconceptions experienced by students are caused by the students' preconceptions or from the surrounding environment (Ariandini et al., 2013). The emergence of misconceptions is caused by assimilation and accommodation in the human brain in response to and understanding the information it has just received (Setyowati et al., 2011). Misconceptions are dangerous because they give students the wrong thought/sense of knowing which limits the mental effort they invest in learning, and there is interference between the concepts being learned (wrong) and what is being learned (true). Misconceptions can also be permanent when not proven wrong or challenged by other concepts (Taufiq, 2012).

CONCLUSION

The use of a three-tier diagnostic test instrument can detect student misconceptions, even the conceptions that exist in students' thinking can be known. The results showed that most students experienced misconceptions in a straight motion, especially related to the concept of straight motion changing regularly and free-fall motion. This misconception in students is caused by several factors such as the understanding obtained from the previous level of education, environmental factors, and factors in the learning method that are not quite right.

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