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IDENTIFY STUDENT'S MISCONCEPTION: DEVELOPMENT OF A TWO-TIER MULTIPLE-CHOICE DIAGNOSTIC TEST INSTRUMENT WITH THE CRI (CERTAINTY OF RESPONSE INDEX)

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ABSTRACT

This study aimed to determine the quality of the questions and the effectiveness of the two-tier multiple-choice diagnostic test, assisted by the CRI (certainty of response index), to identify students' misconceptions about Newton's law of motion. The type of research used is research and development (R&D) research using the Tessmer development model, which consists of 4 stages: preliminary, self-evaluation, prototyping, and field tests. The trial subjects in this study were 30 students. The instruments used to collect data in this study were tests and questionnaires. The results of this study indicate that the developed diagnostic test meets the valid criteria due to a Content Validity Index value of 1.00 in a very appropriate category. The student response questionnaire met the "achieved" criteria because more than 50% of students responded positively. The results of the reliability test are 0.730 in the high category. The difficulty level of the questions is in the range of 0.48–0.60 in the medium category. The discriminatory power of questions ranges from DP > 0.2 with sufficient category. For the diagnostic test, the average percentage of students who understand the concept is 45.33%, the percentage of students who experience misconceptions is 23.50%, and the percentage of students who do not understand the concept is 31.16%.

Keywords: Two-tier diagnostic test; certainty of response index; misconception

1. INTRODUCTION

One of the aims of education is to advance the cognitive aspects of students. The cognitive domain which is the basis of learning is the aspect of the understanding. Comprehension is the ability to understand certain material and be able to explain and summarize it. In short, students are said to have good comprehension skills if they do not just memorize but can explain the main

content of a text. Therefore, every teacher is required to be able to instill a correct understanding of the concepts of each subject, including physics.

Based on the results of interviews conducted on January 23, 2019, at SMA Negeri 5 Jeneponto, the results show that some students experience misconceptions when faced with physics problems. The error will continue if this misconception is not immediately realized and allowed to develop. Misconceptions often called alternative concepts, are the understanding of concepts that experts do not accept in their field. Still, students believe the concepts they know are correct even though these concepts deviate from their true meaning (Suparno, 2005). For example, students think there is no force acting on a book placed on a table. The concept that students believe is wrong because even though the book is still on the table in the book forces are acting, namely the normal force and gravity, it's just that the resultant force is zero.

Various ways can be used to detect misconceptions, including using diagnostic tests. Several experts have developed diagnostic tests, one of which is the two-tier multiple-choice test developed by Treagust (1988). The test consists of two levels of problem-solving, the first level is a choice of answers that function to test knowledge and the second level is a choice of reasons from the answers chosen to test students' understanding (Chandrasegaran, Treagust, & Mucerino, 2007). One more technique can be used to detect misconceptions, namely the CRI (Certainty of Response Index) developed by Hasan, Bagayoko, and Kelley (1999). CRI is a technique for measuring confidence in answering questions. The confidence level is reflected in a scale with different values (Rahayu, 2018). The CRI method can identify misconceptions and distinguish them between those who understand concepts and those who do not (Mustaqim, Zulfiani, & Herlanti, 2014).

Overcoming the problems experienced by these students, the researcher will develop a two-tier multiple-choice diagnostic test instrument by including the CRI technique so that the results obtained are more specific in classifying students who understand concepts, misconceptions, and do not understand concepts. The physics material studied is Newton's law of motion with the assumption that this material is quite difficult for students to understand and is supported by many research articles which reveal that the material is very susceptible to misconceptions (Muna, 2015).

2. METHODS

The type of research used is R&D (Research and Development) with the Tessmer development model, which goes through 4 stages namely preliminary, cell evaluation, prototyping, and field tests. The subjects of this research trial were 30 students in class X MIA 4 SMA Negeri 5 Jeneponto. The development procedure in this study can be seen in the following chart image.

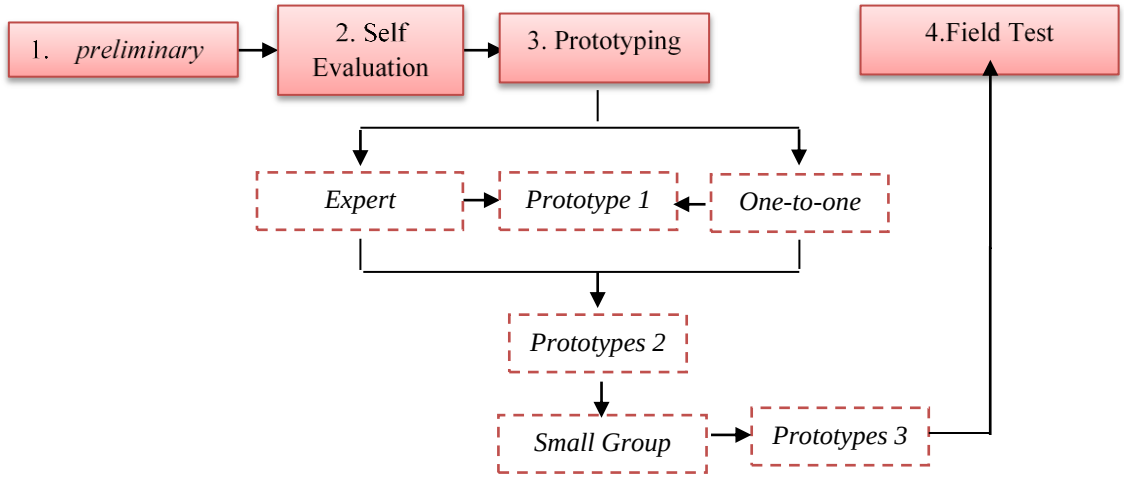

Figure 1. Tessmer development flow

Stage preliminary is the initial stage carried out in this study. The researcher first conducted a literature study regarding misconceptions, diagnostic tests, especially the two-tier multiple choice test, and materials from Newton's laws of motion. After the information has been collected, the next step is to determine the location and subject of the research trial. The selected location was SMA Negeri 5 Jeneponto, with 30 students from class X MIA 4 as the test subjects. Self-evaluation is the next step. At this stage, the researcher conducted curriculum analysis, student analysis, and material analysis and designed a diagnostic test instrument. The next stage is the prototyping stage which includes expert review one-to-one, and small groups. The designed diagnostic test instrument is called prototype I which will be validated by an expert review consisting of 2 physics education lecturers and 1 physics teacher. In line with being validated by the expert review prototype, I was also tested on 3 students (one-to-one). The results of the validation by the expert review plus suggestions and comments from the one-to-one group are used as material for revising prototype I to prototype II which will be tested on 6 students (small group). Suggestions and comments from

the small group will be material for revising prototype II to prototype III which will be tested at the field test stage.

The use of diagnostic tests with two tiers of multiple choiceCRI assistance can make it easier to reveal misconceptions that occur. Analysis to determine misconceptions can be seen in table 1.

Table 1. Results of a Two-Tier Multiple Choice Diagnostic Test

First grade	Second level	CRI	Category
Right	Right	Tall	Understand Concept
Right	Right		
Wrong	Wrong	Low	misconceptions
	Right		
Right	Right		
Wrong	Right	Tall	misconceptions
	Wrong		

3. RESULTS AND DISCUSSION

Based on the analysis using the CVR, it was found that out of the 20 questions that had been made, each item supported the content validity of the test. Then the results of the CVR generated CVI which is the average of the CVR of all items of 1. Based on CVI criteria according to to Hendrayadi (2017), the value is entered into the very appropriate category. The analysis results using Microsoft Excel with the help of the KR formula. 20, obtained a reliability of 0.730. Based on reliability criteria Arifin (2013) the value of 0.73 is included in the high-reliability category. The difficulty level of the diagnostic test instrument can be seen in table 2 below.

Table 2. The results of the analysis of the difficulty level of the diagnostic test instrument

About	Difficulty Level	Category
1	0.6	Currently
2	0.58	Currently
3	0.78	Easy
4	0.73	Easy
5	0.75	Easy
6	0.73	Easy
7	0.48	Currently
8	0.71	Easy
9	0.51	Currently
10	0.71	Easy
11	0.75	Easy
12	0.58	Currently
13	0.66	Currently
14	0.3	Hard
15	0.3	Hard
16	0.3	Hard
17	0.48	Currently
18	0.55	Currently
19	0.3	Hard
20	0.3	Hard

Table 2 shows that there are 8 items in the moderate category, 5 items in the difficult category, and 7 items in the easy category. It can be concluded that most of the questions fall into the medium category which is in the range of 0.48-0.60. That is, the difficulty level of the test is in a good category. The differentiating power of the diagnostic test instruments can be seen in table 3 below.

Table 3. Results of the analysis of distinguishing power of diagnostic test instruments

Question Items	Difference Power	Category
1	0.335	Enough
2	0.269	Enough
3	0.223	Enough
4	0.090	Bad
5	0.295	Enough
6	0.259	Enough
7	0.209	Enough
8	0.052	Bad
9	0.345	Enough
10	0.019	Bad
11	0.226	Enough
12	0.061	Bad
13	0.402	Well
14	0.528	Well
15	0.395	Enough
16	0.461	Well
17	0.276	Enough
18	0.340	Enough
19	0.257	Enough
20	0.469	Well

Table 3 shows that there are 4 items in the good category, 12 items in the sufficient category, and 4 items in the bad category. 4 items that fall into the bad category are not recommended for use in further research because these 4 questions cannot distinguish high and low-ability students. In general, the discriminating power of questions is in the range of DP> 0.2 where the value is included in the sufficient category to be able to distinguish students who have high abilities and those who have low abilities (Arikunto, 2012).

In the one-to-one trial, 90.48% responded positively and 9.52% responded negatively. The small group trial obtained results of 93.75% responding positively and 6.25% responding negatively. It can be concluded that the developed diagnostic test instrument met the "achieved" criteria

because more than 50% of students gave a positive response so that the developed test could be used in field trials.

Based on the 20 diagnostic test questions tested on 30 test subjects, the results showed that 45.33% of the 20 diagnostic test questions were understood by students (understanding of the concept), 23.50% of the 20 diagnostic test questions were misconstrued by students, and 31.16% out of 20 diagnostic test questions students did not understand (did not understand the concept).

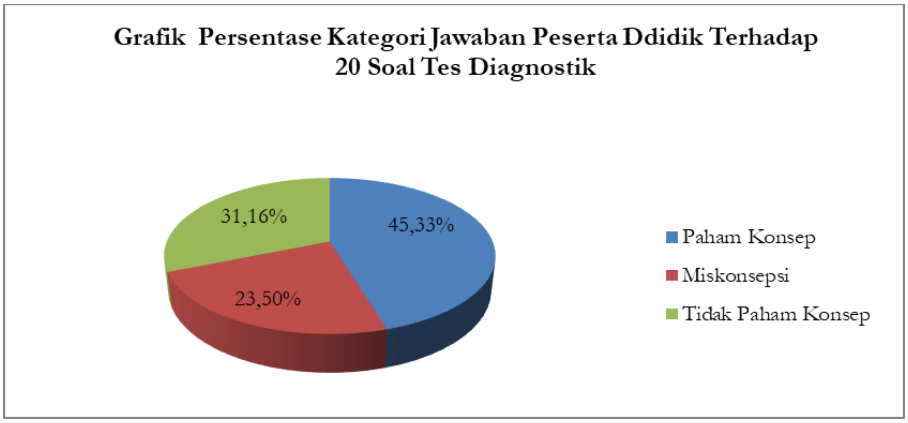

Figure 2. Graph of percentage comparison of understanding concepts, misconceptions, and not understanding concepts from 30 students against 20 diagnostic test questions

The results of the answers from 30 students in the field trial, in terms of those who understood the concept, misconceptions, and did not understand the concept varied for each item. More details can be seen in the following graph.

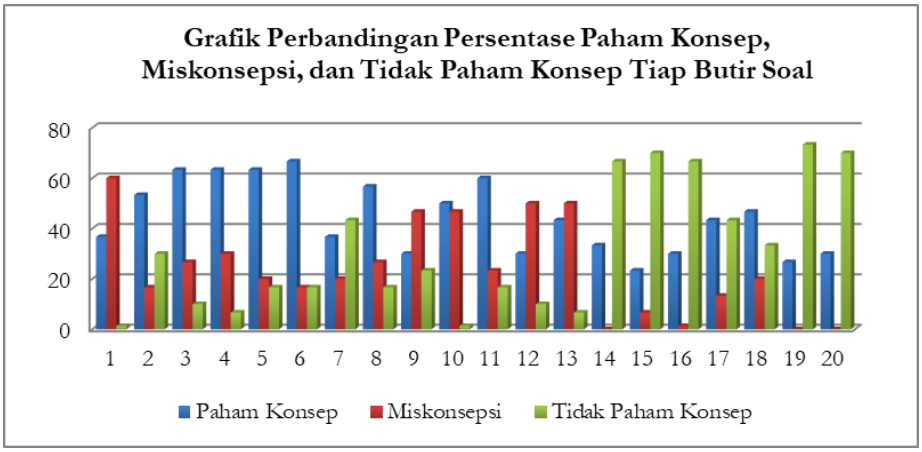

Figure 3. Graph of percentage comparison of understanding concepts, misconceptions, and not understanding concepts

Based on the graph, it can be seen that the percentage of misconceptions varies for each item. The greatest percentage of misconceptions is in question number 1 on the sub-topic of the discussion of the concept of force, while the lowest misconception is in question number 14-20 with the sub-topic of Newton's II law discussion.

The results of the answers of 30 test subjects showed that all test subjects had misconceptions. Furthermore, the test subjects who experienced misconceptions were grouped into low, medium, and high misconceptions. If as many as 1-5 of the 20 questions tested identify misconceptions then they are included in low misconceptions, as many as 6-11 of the 20 questions tested identify misconceptions then they are included in moderate misconceptions and classified in high misconceptions if as many as 12-20 of the 20 questions tested identified misconceptions. Therefore, out of 30 test subjects, 9 people had moderate misconceptions and 21 people had low misconceptions.

The misconception found in the sub-topic of the discussion of the concept of style is that there is an error in defining the types of style. Students still consider the normal force to be the same as gravity, the normal force is always perpendicular to gravity, and the direction of the frictional force is in the same direction as the object's motion. These results were also found in the studies of Mongan (2020), Shalihah (2016), and Saparini (2014) which can be concluded that students are still mistaken in understanding the concept of force acting on objects, especially the difference between normal force and weight.

Misconceptions are found in Newton's first law such as students still assuming that there is no force acting with a resultant force equal to zero. The results of the research found by Fadlan (2011) and Kara (2007) showed that students were still unable to distinguish between "no style" and "the resultant style is zero". Another misconception found is that students think that there is no force acting on a book that is still on the table. The results of the research found by Kaniawati, Fratiwi, Danawan, and Suyana (2019) show that students are still mistaken in understanding the concept of stationary objects. This lack of understanding can be attributed to the inability of students to connect scientific knowledge with phenomena in real life.

The lowest misconception was found in the sub-topic of Newton's II law, the results of which showed that more students did not know the concept due to a lack of mathematical ability. Abbas

and Hidayat (2018) in their research also found that one of the internal factors of students' learning difficulties in physics was low mathematical ability. Misconceptions found in Newton's II law such as students being wrong in describing the force vectors on the X and Y axes. Farihah and Wildani (2018) in their research also found that students were wrong in describing the force vectors acting on objects because students only memorize formulas without understanding the concept.

The misconception found in Newton's third law is that students are mistaken in identifying the application of newton's third law in life. Sitepu and Jacob (2019) and Bayraktar (2009) in their research also found that students were mistaken in identifying the types of questions that were applications of Newton's III law. Another misconception found is the understanding of the concept of action-reaction forces acting on objects. Many students think that both of them work on the same object, even though both of them work on different objects. Nursefriani, Pasaribu, and Kamalud‌ddin (2016); Haris (2013) in his research also found that students considered the action-reaction force to occur on the same object.

Several factors can cause students to experience misconceptions including textbooks, methods, and abilities of students. Textbooks are one of the causes of misconceptions because students often just memorize what is in a textbook without understanding its content. Alias and Ibrahim (2016) in his research also found that many students failed to interpret the meaning of the book because they depended on the contents of the book without understanding its meaning. The choice of method in teaching a concept can be a determinant of whether students can understand the concept being taught or not. Zulvita, Halim, and Elisa (2017) in his research also found that the wrong teaching method would be a special cause of misconceptions. Another factor that causes misconceptions is the ability of students. Students who have low abilities, as a result, become less fast in understanding the concepts taught by the teacher. Therefore, students who have low abilities have the potential to experience misconceptions.

The importance of using diagnostic tests during the learning process takes place because misconceptions will not be known if they are not diagnosed, especially in legal material. Therefore, teachers must be able to design learning processes to facilitate students in learning. This is in line with the research results of Fratiwi, Samsudin, Ramalis, and Saregar (2020) found that Newton's laws contain many basic concepts of physics and are often encountered in everyday life which, if not taught in the right way, can affect student learning outcomes.

The diagnostic test instruments developed as a whole belong to good quality tests. The test developed has a content validity index (CVI) of 1.00 with a very appropriate category. Reliability of 0.730 with high category. The difficulty level of the questions is in the range of 0.48-0.60 in the moderate category. The discriminating power of the items is in the range of DP> 0.2, which means that it is sufficient to distinguish high and low-ability students. Based on the 20 diagnostic test questions tested on 30 test subjects, the results showed that 45.33% of the 20 diagnostic test questions were understood by students (understanding of the concept), 23.50% of the 20 diagnostic test questions were misconstrued by students, and 31.16% out of 20 diagnostic test questions students did not understand (did not understand the concept). Therefore, a two-tier multiple-choice diagnostic test with CRI (Certainty of Response Index) is effective in identifying student misconceptions.

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