



FOUR-TIER DIAGNOSTIC TEST WITH CERTAINTY OF RESPONSE INDEX TO IDENTIFY MISCONCEPTION IN PHYSICS

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ABSTRACT

This study aimed to develop a Four-Tier Test diagnostic test instrument that will be used to identify student misconceptions on work and simple machine topic. This research is a development research using the ADDIE model. The result of the research is a multiple-choice test instrument four-tier diagnostic test with the Certainty of Response Index (CRI) to identify misconceptions. The results of expert validation show that the questions are declared valid. Furthermore, the instrument was tested on grade VIII students of SMP Negeri 1 Kalirejo to determine the level of validity, reliability, difficulty, and differentiation on each item. Of the 20 items developed, 15 of them were declared feasible to identify student misconceptions

FOUR-TIER DIAGNOSTIC TEST DENGAN CERTAINTY OF RESPONSE INDEX UNTUK MENGIDENTIFIKASI MISKONSEPSI FISIKA

Kata Kunci:

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ABSTRAK

Penelitian ini bertujuan untuk mengembangkan instrumen tes diagnostik *Four-Tier Diagnostic Test* yang digunakan untuk mengidentifikasi miskonsepsi peserta didik pada materi usaha dan pesawat sederhana. Penelitian ini merupakan penelitian pengembangan dengan menggunakan model ADDIE. Adapun hasil penelitian yang dikembangkan adalah instrumen tes pilihan ganda bentuk four-tier diagnostic test dengan tingkat keyakinan CRI untuk mengidentifikasi miskonsepsi. Hasil validasi ahli menunjukkan bahwa soal dinyatakan valid. Selanjutnya, instrumen diujicobakan kepada peserta didik kelas VIII SMP Negeri 1 Kalirejo untuk mengetahui tingkat validitas, reliabilitas, kesukaran, dan daya beda pada tiap butir soal. Dari 20 butir soal yang dikembangkan, 15 diantaranya dinyatakan layak untuk mengidentifikasi miskonsepsi peserta didik.

1. INTRODUCTION

One of the problems that is often encountered in education and included in learning physics is misconception [1] [2]. Misconceptions are problems that education practitioners are still working on to solve. The teacher must be sensitive to the misconceptions of students as early as possible, especially in learning physics, where Physics often discusses

abstract concepts [3]. Learning physics requires students to be able to understand concepts and be able to solve various problems related to natural phenomena [4]. Misconception is a fundamental problem in education, especially in learning physics which emphasizes understanding concepts [5]. Errors in understanding concept can cause students to experience misconceptions.

Misconceptions occur because of differences in the concepts understood by students with the concepts presented by experts [6]. Misconceptions if not immediately reduced it will continue and the formation of further scientific concepts will be disrupted, thus affecting student learning outcomes [7],[8], therefore, it is important to identify student misconceptions as early as possible. Based on the results of preliminary research, we found that students of class VIII D and class VIII F of SMP Negeri 1 Kalirejo experienced misconceptions, one of which was on the sub-topic of a simple machine, inclined plane. Students assume that the use of an inclined plane that has a shorter length can simplify human work compared to using a longer inclined plane, because the force applied is smaller. This concept is clearly wrong, and if not resolved immediately, it will affect students' ability to apply the concept.

Understanding physics concepts that are not in line with actual physics concepts, if they continue to occur, it will result in students having difficulty understanding subsequent concepts and can affect learning outcomes [9][10]. Various attempts have been made to overcome misconceptions, previous research stated that to overcome misconceptions, the first step is to identify misconceptions, next, look for the causes of misconceptions, then find solutions to reduce misconceptions [11]. A teacher must be able to detect student misconceptions, so that misconceptions can be resolved immediately. One solution that can be applied to reduce misconceptions is to use the right learning models and media [12]. Besides that, in the learning process, the determination of learning strategies and methods is something that must be considered properly [13]. Meanwhile, to find out students who have misconceptions, the first step to identify them is to use a diagnostic test [14]. It is believed that diagnostic tests can help teachers to detect misconceptions [15].

There are several types of diagnostic tests, including: essay diagnostic tests, multiple choice, interview, and multilevel multiple-choice tests. Each form of diagnostic test has its own advantages and disadvantages. Research conducted by Gaguk that the use of a four-tier diagnostic test with CRI is more effective in identifying misconceptions compared to other diagnostic tests[16].

The four-tier diagnostic test equipped with CRI is the result of the development of the three-tier diagnostic test [17],[11]. The advantages of the four-tier diagnostic test over the three-tier diagnostic test are the addition of a choice of a certain level of answer reasons, so that the resulting data is more accurate. The first level in the four-tier diagnostic test with CRI is a multiple-choice question with three distracting answers and one correct answer. The second level is a scale of the level of confidence of students in choosing answers. The third level is multiple choices which contain students' reasons for answering questions. The fourth level is a scale of the level of certainty of students in choosing the reason for the answer [20]. The advantage of using a four-tier diagnostic test instrument is that teachers can: (1) differentiate the level of confidence in the answer and the level of confidence in the reason, so that they can find out more about the strength of students' conceptual understanding, (2) diagnose student misconceptions more deeply, (3) determine the parts of the topic that need more treatment, (4) plan a better learning to reduce student misconceptions [18]. This research was conducted to make it easier for teachers and education practitioners to identify misconceptions, especially on the subject of simple machines in junior high school students. Several previous studies have developed research

instruments in the form of multiple choices, three tier tests, and even four tier diagnostic tests. However, it is not equipped with the Certainty Response Index (CRI) option [1], [21]–[25]. This research is here to fill this gap by developing a test instrument in the form of a four-tier diagnostic equipped with CRI. So, by using this instrument, misconceptions in students can be recognized more clearly.

2. METHOD

This research was a Research and Development (R&D) which produced a test instrument product in the form of a four-tier diagnostic test with CRI that can be used as an instrument to identify misconceptions on work and simple machine topics. The answer combinations for the four-tier diagnostic test are presented in Table 1 below:

Table 1. Combination of Answers of the Four Tier Diagnostic Test [1][7]

Category	Combination of Answers			Certainty of Response Index
	Answers	Certainty of Response Index	Reasons	
Understand	Correct	Sure	Correct	Sure
	Correct	Not Sure	Correct	Not Sure
	Correct	Sure	Correct	Not Sure
	Correct	Not Sure	Correct	Sure
Not Understand	Correct	Not Sure	Wrong	Not Sure
	Wrong	Not Sure	Correct	Not Sure
	Wrong	Not Sure	Wrong	Not Sure
	Correct	Sure	Wrong	Not Sure
	Wrong	Not Sure	Correct	Sure
	Correct	Not Sure	Wrong	Sure
	Correct	Sure	Wrong	Sure
Misconception	Wrong	Sure	Correct	Not Sure
	Wrong	Sure	Correct	Sure
	Wrong	Sure	Wrong	Not Sure
	Wrong	Not Sure	Wrong	Sure
	Wrong	Sure	Wrong	Sure

CRI (Certainty of Response Index) is a measure of the level of certainty in answering each question [26]. The certainty level used has a scale of one to six. Based on previous research, the use of CRI could make it easier for teachers to identify problems that occurred to students [14], in addition, CRI was also able to distinguish students' answers between students who understand concepts well, did not understand concepts, and misconceptions [27][28]. The level of CRI is presented in table 2 below:

Table 2. CRI Scale[18]

Category	Scale	Certainty Level
Guessing	0	Low/Not Sure
Very Unsure	1	
Not sure	2	
Sure	3	High/Certain
Almost Certain	4	
Certain	5	

This research procedure used the ADDIE development model, where consists of five stages, analysis, design, development, implementation, and evaluation.

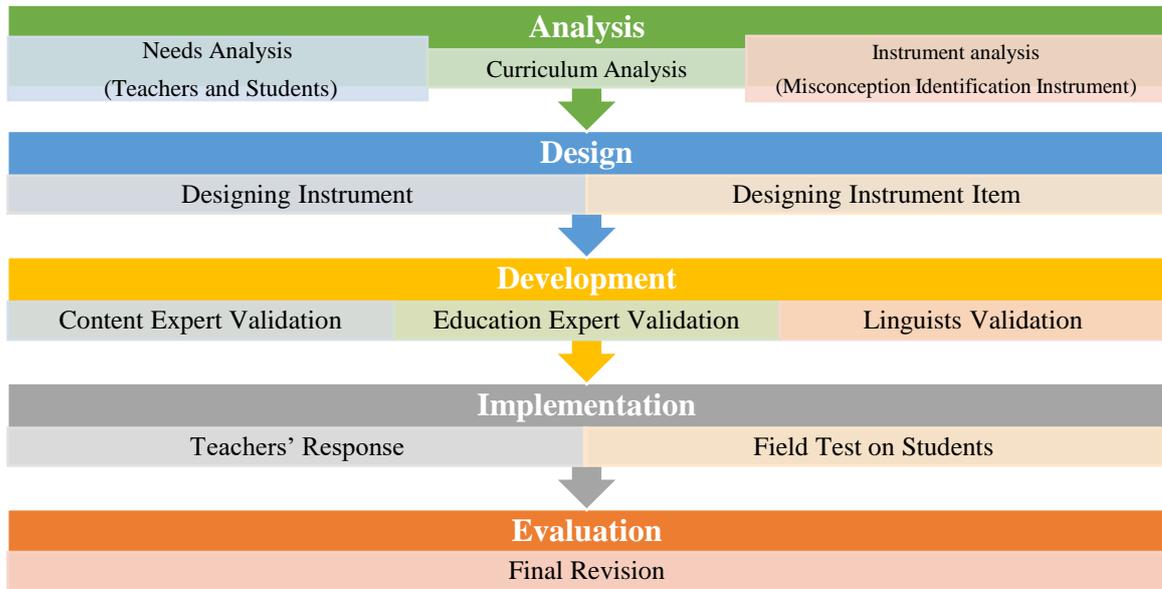


Figure 1. Development Stages

After the instrument was validated by experts, the instrument was then tried out on grade VIII students of SMP Negeri 1 Kalirejo. Data were analyzed to determine the level of validity, reliability, difficulty, and difference power of the test instruments that were made. The results of the data were analyzed by the validity test with the product moment formula [29]

Table 3. Validation Criteria [14]

Criteria	Interpretation
0,81 – 1,00	Very High
0,61 – 0,80	High
0,41 – 0,60	Fair
0,21 – 0,40	Low
0,00 – 0,20	Very Low

The instrument is said to be valid if $r_{count} > r_{table}$. Furthermore, the reliability test was carried out using the Cronbach's Alpha formula [30]

Table 4. Reliability Criteria [31]

Reliability	Criteria
$0,80 < r_{11} \leq 1,00$	Very High
$0,60 < r_{11} \leq 0,80$	High
$0,40 < r_{11} \leq 0,60$	Fair
$0,20 < r_{11} \leq 0,40$	Low
$0,00 < r_{11} \leq 0,20$	Very Low

If $r_{hitung} > r_{tabel}$ then the instrument is valid [31]. Furthermore, the level of difficulty test is carried out with the criteria [14]:

Table 5. Level of Difficulty Criteria [32]

Level of Difficulty Index	Interpretation
0 – 0,30	Sukar
0,31 – 0,70	Cukup (Sedang)
0,71 – 1,00	Mudah

Next, a different power test is carried out with the following criteria:

Table 6. Difference Power Criteria [32]

Difference Power Index	Interpretation
0,00 – 0,20	Poor
0,21 – 0,40	Satisfactory
0,41 – 0,70	Good
0,71 – 1,00	Excellent

3. RESULTS AND DISCUSSION

Based on the results of observations and interviews with teachers and students at SMP N 1 Kalirejo, the teacher has never identified misconceptions in students. Therefore, this school needs an instrument that is able to identify misconceptions in detail and precisely. The question instruments that have been made were then validated by expert lecturers. The validation results from material physics experts, linguists, and educational evaluation experts are presented in Figure 2 below:

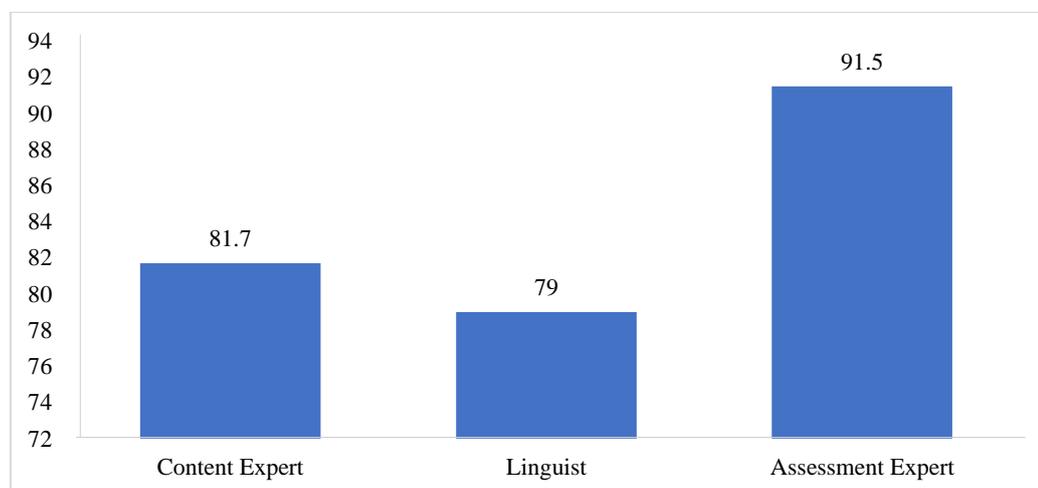


Figure 2. Validation Results of Content Experts, Linguists, and Educational Evaluation Experts

Based on Figure 2, it can be seen that the linguist lecturer stated that this instrument was feasible, while the physics expert lecturer and the educational evaluation expert lecturer stated that this instrument was very suitable to be used as a tool to identify misconceptions. Experts also provided suggestions for improvements to support higher quality instruments. Some of the suggestions given include: 1) Some sentences in the questions are still ambiguous, really need to be improved, 2) The presentation of multilevel questions must be accompanied by clear instructions for filling out the questions, 3) The pictures used in the questions must be made clearer, 4) Problems that use gaps should be more clarified, so that the meaning of the questions can be understood easily.

After the instrument was declared valid by the experts, the instrument was given to the teacher at school to see the teacher’s response. The teacher gave a positive response to this instrument. Then, the instrument trial was conducted on 57 students of SMP Negeri 1

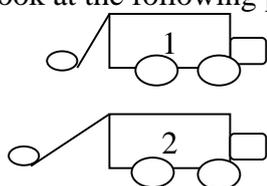
Kalirejo from class VIII D and VIII F. Students were asked to work on 20 items in the form of a four-tier diagnostic test equipped with CRI in order to obtain validity, reliability, difficulty, and difference power values for each item on the instrument. The results of the instrument testing are presented in Table 7 below:

Table 7. Recapitulation of the Results of the Validity Test, Difficulty Level Test, and Difference Power Test

No.	Validity	Level of Difficulty	Difference Power
1	Valid	Moderate	Very Good
2	Valid	Moderate	Very Good
3	Valid	Easy	Good
4	Not Valid	Easy	Bad
5	Valid	Moderate	Fair
6	Valid	Moderate	Fair
7	Valid	Difficult	Good
8	Valid	Moderate	Good
9	Valid	Moderate	Good
10	Valid	Moderate	Very Good
11	Valid	Moderate	Good
12	Valid	Moderate	Fair
13	Valid	Moderate	Very Good
14	Not Valid	Moderate	Good
15	Valid	Moderate	Good
16	Not Valid	Moderate	Bad
17	Valid	Easy	Good
18	Valid	Moderate	Bad
19	Valid	Moderate	Fair
20	Not Valid	Moderate	Bad

In the reliability test, the results obtained $r_{hitung} = 0,76$, meaning that the questions were declared reliable in the high category. Based on table 7, of the 20 questions, there are 5 questions that are declared bad, so that the question cannot be used. Thus, it can be concluded that the questions in the instrument that were suitable for use were 15 items. Examples of valid and reliable instruments are presented below:

Look at the following picture!



The two pictures above show the process of moving rock onto the truck. Which process is easiest?...

- a. a. In figure 1, because the length of the inclined plane is shorter, the force exerted is less
- b. b. In Figure 1, because the length of the inclined plane is shorter, the stone will reach the top of the truck faster
- c. c. In Figure 2, because the inclined plane is longer, less effort is required.
- d. d. In figure 2, because the inclined plane is longer, the force required is smaller.

Certainty of Response Index

0	1	2	3	4	5
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The reason you chose that answer is...

- Because on an inclined plane the equation $F \cdot s = W \cdot h$ applied, so to make it easier to lift the rock with an inclined plane, you must reduce the F value, and increase the length of the inclined plane.
- Because on an inclined plane the equation $F \cdot s = W \cdot h$ applies, so that to make it easier to lift rock with an inclined plane, we must reduce the F value and reduce the length of the inclined plane.
- Because on an inclined plane the equation $F \cdot s = W \cdot h$ applies, so that to lift the rock with an inclined plane, we must reduce the value of W and increase the length of the inclined plane.
- Because on an inclined plane the equation $F \cdot s = W \cdot h$ applies, so that to make it easier to lift the stone with an inclined plane, we must reduce the length of the inclined plane.

Certainty of Response Index

0	1	2	3	4	5
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Misconceptions are very dangerous for students, so they must be detected as early as possible. The negative impacts of misconceptions include: resulting in low concept mastery so that learning outcomes are low, affecting the formation of further scientific concepts, and disrupting the process of forming the ability to identify problems [7],[21],[22]. Therefore, many studies have developed diagnostic tests for misconceptions [23],[24], such as the development of a two-tier diagnostic test to detect misconceptions [18], development of a diagnostic test in the form of a three-tier test to determine the characteristics of misconceptions [15], and the development of a four-tier diagnostic test to reveal students' misconceptions on geometric optics.

This study produced 15 items of misconception diagnostic test instruments in the form of a four-tier test equipped with CRI, which were declared valid with high reliability results, and recognized as very suitable for use by expert lecturers. This instrument was equipped with a Certainty of Response Index (CRI) which can easily show students' confidence in answering questions and providing reasons for answers. This four-tier diagnostic test with CRI is more effective in diagnosing misconceptions so that the identification results of misconceptions will be more accurate.

4. CONCLUSION

The diagnostic test instrument in the form of four-tier diagnostic test with CRI on the work and simple machine topic is a four-level test to diagnose misconceptions, which is equipped with a certainty level in the answers level and reasons for the answers level. This instrument was developed with the ADDIE development model stages. The results of expert validation show that the instruments developed are valid so they are suitable for use. Furthermore, based on the results of trials for class VIII students of SMP Negeri 1 Kalirejo, from the 20 questions developed, it was obtained that 15 questions were appropriate to be used in identifying student misconceptions. So, it can be concluded that this study has succeeded in developing a four-tier diagnostic test instrument with CRI.

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