

Diagnostic Test with Four-Tier in Physics Learning: Case of Misconception in Newton's Law Material

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Submission date: 25-Aug-2021 01:09AM (UTC+0700)

Submission ID: 1635386653

File name: Maharani_2019_J._Phys._Conf._Ser._1155_012022.pdf (531.59K)

Word count: 3376

Character count: 18261

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To cite this article: L Maharani *et al* 2019 *J. Phys.: Conf. Ser.* **1155** 012022

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Diagnostic Test with Four-Tier in Physics Learning: Case of Misconception in Newton's Law Material

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Abstract. Concept understanding is very important in the learning process. Understanding the correct concept has an impact on learning outcomes. This research uses the R & D method which aims to develop misconception detection instruments and produce products in the form of four-tier design misconception detection instruments and see the feasibility of the product. The quality of the instrument was tested by testing the validity of the expert judgment, test questions in the form of validity and reliability tests. The question with valid criteria is 9 questions with moderate reliability. For the feasibility of the instrument, the percentage is 84% with very decent criteria.

1. Introduction

The learning process is an activity carried out by the teacher in an effort to give direction to students in order to have the correct understanding [1-4]. In fact, in a learning process, not all students have the ability to understand concepts well. So that students can misunderstand the concepts learned. Differences in concepts understood by students with the concepts adopted by experts are called misconceptions [5-6].

Misconception occurs due to several things, namely preconceptions, teachers, learning resources, learning methods to students themselves[4-6]. The adverse impact caused by misconceptions is a decrease in learning outcomes [5] because misconceptions experienced by students will hinder understanding the next concept [6].

Based on the description of the dangers caused by misconceptions, it is very necessary to take action to minimize misconceptions. Misconceptions can be minimized by means of identification as early as possible[7]. One form of identification of misconceptions is by giving diagnostic tests to students [8]. This diagnostic test is believed to help the teacher in finding misconceptions of students [9].

The diagnosis test has several types, two-tier [10], three-tier[11], Certainty of Response Index [12] dan four-tier [13]. The diagnostic test developed in this study is a four-level diagnostic test (four-tier). The four-tier diagnostic test is a diagnostic test developed from a three-level diagnostic test [14]. Four-tier diagnostic tests have the advantage that the teacher can dig deeper into the strength of students' conceptual understanding through the level of answer confidence and reason level beliefs, provide the best learning to reduce students' misconceptions, and give more emphasis to the material that causes students to experience misconceptions[8].

Based on the advantages of the four-tier diagnosis test, it is necessary to develop a four-tier misconception detection instrument that will produce quality diagnostic test products. For this study, the development of a four-tier misconception detection test used Newton's law material. The answers and reasons in this study use answers and closed reasons which in previous studies used open reasons. Because mechanics is a material that often leads to misconceptions, so it is necessary to develop misconception detection questions with the mechanic material, one of which is Newton's law. [15].



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2. Research Method

Research methods are carried out to obtain data with specific purposes and uses [16]. This research was carried out in the physics education study program Raden Intan State Islamic University in Lampung. The population in this study were all physical education students of Raden Intan Lampung State Islamic University with a total sample of 96 samples. 32 samples were used for small group trials, and 64 samples were used in large group trials. Data collection in this research uses documentation and tests.

The procedure of this research is based on Borg & Gall's research and development procedure. Borg & Gall's research and development procedures have 10 stages, namely Information Collection, formulating goals, initial product development, initial product field testing, product revision, field testing, product revision, wider scale field testing, final revision, and dissemination. However, this study only used the seven initial stages of the research and development procedure of Borg & Gall. Because with the initial seven stages used in this study, products in the form of instruments can already be used. The procedure in this study is [17] :

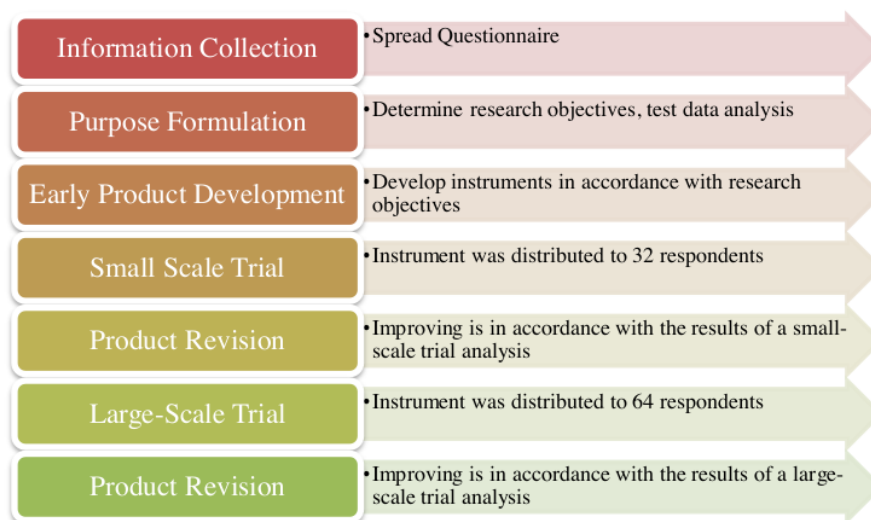


Figure 1. Research Procedure

The research procedure in this study adopted the research and development procedures of Borg & Gall. As for more details, the research procedures in this study are as follows:

- The collection of information in this study was carried out by distributing questionnaires to respondents. Information gathered about whether a test has been identified about misconceptions about Newton's law. It turned out that respondents had never conducted an identification test. Therefore this study is intended to develop misconceptions detection instruments so that educators have reference questions to identify the misconceptions of students from the start.
- The formulation of objectives in this study includes activities to formulate research objectives and tools to analyze the data that has been obtained.
- The development of the instrument at the beginning is the making of misconception detection questions in accordance with the existing references.
- Small-scale trials were conducted on 34 respondents. With the initial distribution of instruments that have been made, in order to see the shortcomings of the instrument.

- e. Product revisions are carried out after a small scale trial. After being analyzed, there are shortcomings and strengths in the instrument, so it is improved to be tested on a larger scale.
- f. Large-scale trials were conducted on 64 respondents.

For data analysis in this study, it was done by matching the respondent's answers with the four-tier diagnostic interpretation and looking at the categories according to the available interpretations. As for the criteria of CRI values both low and small, it can be seen from Saleem Hasan's research that for CRI 0-2 scale it is classified as low CRI (<2.5) and CRI 3-5 scale is classified as high CRI (>2.5)[18]

3. Results and Discussion

Instrument development stages

- a. The collection of information in this study was carried out by distributing questionnaires to respondents. Information gathered about whether a test has been identified about misconceptions about Newton's law. It turned out that respondents had never conducted an identification test. Therefore this study is intended to develop misconceptions detection instruments so that educators have reference questions to identify the misconceptions of students from the start. The purpose of information gathering is so that the products produced are in accordance with the needs of respondents.
- b. The formulation of objectives in this study includes activities to formulate research objectives and tools to analyze the data that has been obtained. In order to remain in the research procedure, this second stage was carried out so that the research was directed. The aim of this research is to produce a product in the form of a misconception diagnostic test that is four-tier diagnostic and see the feasibility of the product produced. Data analysis in this study is to match the respondent's answer with the interpretation of four-tier diagnostics and then categorized according to the categories provided in the four-tier diagnostic interpretation.
- c. The development of the instrument at the beginning is the making of misconception detection questions in accordance with the existing references. At this stage, the initial product developed was a misconception detection instrument with 10 questions. The question used refers to the questions that have been used in the previous research conducted by Dedah Siti Jubaidah[19]. however, this research employed open-ended and close-ended questions. Because according to researchers close-ended questions will reduce answers beyond the material identified.
- d. Small-scale trials were conducted on 34 respondents. After initial product development, the product was tested on a small scale. Of the 10 questions tested, only 9 questions met valid criteria.
- e. Product revisions are carried out after a small scale trial. After being analyzed, there are shortcomings and strengths in the instrument, so it is improved to be tested on a larger scale.
- f. Large-scale trials were conducted on 64 respondents.

Four-Tier Diagnostic Test Validity

Product validity is done in two ways, namely the validity of Expert Judgment conducted by three expert lecturers and the trial of the validity of the items. The expert validator assesses the feasibility of the instrument. The assessment of expert validators is as follows:

Table 1. Expert Judgment Analysis

Expert Validator	Feasibility Percentage
1	80%
2	87.5%
3	84.5%
Rata-Rata	84%

Based on table 1, it was found that the percentage of eligibility for diagnostic test instruments was 84% which was in very reasonable criteria. The validity of the questions were tested for each item,

the number of respondents who followed the validity trials were 32 respondents with a $r_{xytable}$ value of 0.3388. Of the 10 questions tested, there are 9 valid questions. Valid question criteria can be seen in the following table:

Table 2. Validity Test Provisions[20]

r_{xy}	Information
$r_{xyhitung} > r_{xytabel}$	Valid
$r_{xyhitung} < r_{xytabel}$	Tidak Valid

Table 3.Results of Validity Test Analysis

Num ber	r_{xy}	Information	Interpretation
1	0,656	Valid	Tinggi
2	0,626	Valid	Tinggi
3	0,520	Valid	Cukup
4	0,452	Valid	Cukup
5	0,735	Valid	Tinggi
6	0,606	Valid	Tinggi
7	0,368	Valid	Rendah
8	0,607	Valid	Tinggi
9	0,365	Valid	Rendah
10	0,091	Tidak Valid	Sangat Rendah

Four-Tier Diagnostic Test Reliability

Reliability testing is useful for the level of consistency (consistency) of a test, namely the extent to which a test can be trusted to produce a steady score or a fixed result [21]. Reliability analysis obtained the value of 0.693 is on the criteria of moderate reliability. Other studies that develop four-tier diagnostic tests get a reliability value of 0.41[22]and research conducted by Caleon obtained a reliability value of 0.92[13]. Some of the results of previous studies indicate that this study has a fairly good reliability value.

Characteristics of the Four-Tier Diagnostic Test Problem Item

After being tested for validity and reliability, valid and reliable questions have their own characteristics. The characteristics of the problem in this study are the level of difficulty and differentiation. The level of difficulty of this instrument varies. There are 2 easy category questions and 7 medium category questions with a range of 0.5-0.8. The distinguishing power of 9 items contained 3 questions in a very good category and 6 questions in enough categories with a range of 0.3-1.

Four-Tier Diagnostic Test Development

Diagnostic tests are one instrument for detecting misconceptions by knowing the weaknesses and strengths of students in certain lessons [23]. Four-Tier type misconception diagnostics are the development of a Three-Tier type diagnostic misconception [24]. This four-level diagnostic test has four levels. The first level contains the answers to the questions given, the second level contains the level of confidence in the answers chosen, the third level contains the reasons why students choose answers at the first level, and the last is the fourth level which contains the level of confidence in the reasons written by students. In this study the choice of answers and reasons for using closed options. Closed options are used so that students remain in the material detected. The interpretation of the four-tier results can be seen in table 4

Table 4. Interpretation of Four-Tier Diagnostic Test Results

Category	Answer Type			
	Answer	Confidence Rating Index	Reason	Confidence Rating Index
(1)	(2)	(3)	(4)	(5)
Understand	True	$CRI > 2,5$	True	$CRI > 2,5$
Don't Understand the Concept	True	$CRI > 2,5$	True	$CRI \leq 2,5$
	True	$CRI > 2,5$	False	$CRI \leq 2,5$
	True	$CRI \leq 2,5$	True	$CRI > 2,5$
	True	$CRI \leq 2,5$	True	$CRI \leq 2,5$
	True	$CRI \leq 2,5$	False	$CRI \leq 2,5$
	False	$CRI > 2,5$	True	$CRI \leq 2,5$
	False	$CRI > 2,5$	False	$CRI \leq 2,5$
	False	$CRI \leq 2,5$	True	$CRI \leq 2,5$
	False	$CRI \leq 2,5$	False	$CRI \leq 2,5$
Misconception	True	$CRI > 2,5$	False	$CRI > 2,5$
	True	$CRI \leq 2,5$	False	$CRI > 2,5$
	False	$CRI > 2,5$	False	$CRI > 2,5$
	False	$CRI \leq 2,5$	False	$CRI > 2,5$
Error	False	$CRI > 2,5$	True	$CRI > 2,5$
	False	$CRI \leq 2,5$	True	$CRI > 2,5$

Development of instruments in research using Newton's Law material. Newton's law as material for this instrument was made because mechanics was ranked first in material matters which often led to misconceptions. Departing from this, the researcher raised the material of Newton's Law of Law so that references on misconception detection questions are more diverse.

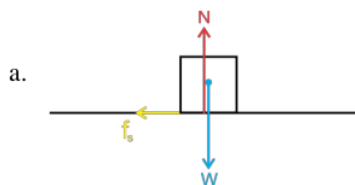
The following example of the problem of the instrument developed in this study is at the C4 cognitive level that is analyzing what forces work on the object:

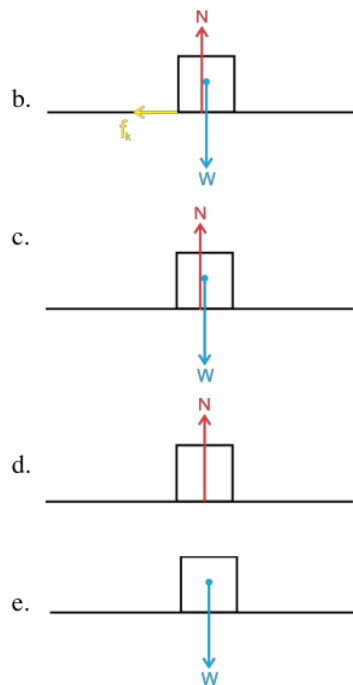
3.1 The following figure shows a book on a table.



Figure 2 Book on a table

the appropriate diagram to illustrate the figure above is?





3.2 The level of Confidence

CRI
0. By Guessing
1. Almost Guessing
2. Unsure
3. Sure
4. Almost Correct
5. Definitely Correct

3.3 Reason for the answer

- Objects always get an influence from the acceleration of gravity.
- The stationary state of an object is the nature of matter.
- Because objects are still, then $\sum F_y = 0$
- Because there is no force acting on the object so that the object remains stationary
- There is a force that is equally large and in the same direction

3.4 Level of confidence in the reasons 3.3?

CRI
1. By Guessing
2. Almost Guessing
3. Unsure
4. Sure
5. Almost Correct
6. Definitely Correct

4. Conclusion

The final product produced is 9 questions with the average level of product feasibility provided by the three experts validator by 84% who are in very reasonable criteria. Test the validity of producing 9 valid questions with moderate reliability.

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