International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 12, Issue 8
August, 2025
Pages: 70-75

Validation of Instrument Test Diagnostic Four Tier Digital to Identify Misconception and Conceptual Understanding of Newton's Law Matter in High School Physics

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http://dx.doi.org/10.18415/ijmmu.v12i8.6940

Abstract

This research aims to produce a digital four-tier diagnostic test instrument product that is qualified to identify misconceptions and conceptual understanding of students reviewed from the validity of the content of the test instrument and the analysis of the digital four tier diagnostic test media. This research is a development research using the 4D method which includes 4 stages namely define, design, development, and disseminate. The research instruments include digital four tier diagnostic test instruments that have been validated logically based on the opinions of experts and empirically based on field trials and declared valid and reliable. The results showed that the digital four tier diagnostic test instrument developed falls into the valid category and can be used based on expert judgment.

Keywords: *Four Tier Digital; Newton's Law; Misconception; Conceptual Understanding*

Introduction

Physics is a branch of Natural Sciences (IPA) that studies natural phenomena and events. Physics is a science that studies phenomena from many abstract concepts that require students to be able to explain them based on concepts in physics. The physics learning process requires special methods, both related to understanding basic concepts and solving physics problems mathematically. Conceptual and analytical abilities to understand concepts need to be emphasized. Understanding concepts in physics learning is important and fundamental(Kurniawan et al., 2020).The ability to understand concepts is capital in facilitating the teaching and learning process so that learning objectives can be achieved efficiently. In line with one of the learning objectives detailed in the Graduate Competency Standards (SKL) of Permendikbud No. 20 of 2016 where students must have conceptual knowledge related to a science.

Students continuously develop knowledge, attitudes and experiences to learn new scientific concepts based on their interactions with the environment and build their initial understanding of science, especially physics, by incorporating the initial knowledge they have acquired into learning activities. The initial understanding that is formed is called alternative concepts and prejudices. Students who have alternative concepts that are the same as their understanding of scientific concepts have good conceptual

understanding, while students who have alternative concepts that are different from their understanding of scientific concepts have misconceptions. (Lampeang et al., 2021). Misconception refers to a concept that is not in accordance with scientific understanding or the understanding accepted by experts in the field, in this case physics.

Misconceptions experienced by students become obstacles for students in the learning process and conceptual understanding. The process of understanding physics concepts in students is one of the challenges for physics teachers. The reason is that students have different experiences in understanding concepts. Several cases show that the construction of concepts related to science can lead to misunderstandings that continue even after learning in class.(Soeharto & Csapó, 2021).

One of the physics materials that has many conceptual variations is Newton's law. Discussion of Newton's law can cause misconceptions and can indicate the level of conceptual understanding of students because Newton's law material is related to phenomena that occur in everyday life. Students have different conceptual understandings for each concept where students often have difficulty describing the concept of equations and explaining a phenomenon based on the concept of Newton's law that has been studied.(Permana et al., 2022). Newton's law is one of the physics concepts studied at the high school level. Newton's law consists of several concepts and applies several concepts to particle and vector dynamics so that to explain phenomena related to Newton's law, students must understand the concept of particle and vector dynamics. Students' efforts to understand the concept of Newton's law are very complex and encounter their own difficulties.(Suhandi et al., 2025).

Students' conceptual understanding of physics subjects, especially Newton's laws, needs to be identified so that educators know the extent of students' conceptual understanding and to find out whether or not students have misconceptions. The level of conceptual understanding and misconceptions in students can be identified through the assessment process. The assessment process is one of the important processes in learning because in addition to being able to identify the level of conceptual understanding and misconceptions, the assessment process can help achieve learning competencies so that it can help students improve their skills in facing globalization. Assessment is a process needed in the learning process to collect and obtain information related to student development. One of the learning assessments in the independent curriculum is diagnostic assessment(Ramadan, 2024). Diagnostic assessments are given to students before teachers design learning. Diagnostic assessments are independent curriculum assessments that are carried out specifically with the aim of identifying or knowing the characteristics, competency conditions, strengths, and weaknesses of students' learning models, so that learning can be designed according to the competencies and conditions of diverse students.(Minister of Education and Culture Regulation, 2022).

Diagnostic assessment is an assessment conducted before the learning process begins which aims to identify the abilities, strengths and weaknesses of students so that teachers can design learning that is tailored to the abilities and characteristics of students. The use of diagnostic assessment to identify misconceptions and levels of student understanding can be in the form of regular multiple choice tests or multilevel multiple choice tests. The four-level diagnostic test is a development of the three-level diagnostic test. The four-level diagnostic test consists of the first level which is a conceptual question, the second level is the student's confidence in answering the first level, the third level is the reason for choosing the answer at the first level, and the fourth level is the student's confidence in answering the third level. The four-level diagnostic test instrument has been proven to be better than the two-level and three-level tests in measuring and identifying misconceptions and levels of conceptual understanding of students.(Astuti et al., 2023).

Along with the development of technology and information used in the learning process, it is necessary to develop assessment applications that can help teachers to determine the level of conceptual understanding and misconceptions of students.(Astuti et al., 2023). The assessment application developed

can help students and teachers in knowing the level of misconception and conceptual understanding of the physics material being studied so that it can be known early and teachers can design appropriate learning strategies. Digital-based assessment has the advantage of saving time and flexibility because the system is automated, reducing cheating and the assessment results will be known immediately.(Abbas & Al-Mukhtar, 2023). Based on the study described above, it is necessary to conduct research related to the development of a four-tier diagnostic test instrument to identify the level of misconceptions and conceptual understanding of students.

Method

The research was conducted using the Research and Development (R&D) method which aims to develop a digital four tier diagnostic test instrument to identify misconceptions and conceptual understanding of students in Newton's Law material. The development of digital media uses a 4D development model, namely define, design, develop, and disseminate.(Thiagarajan et al., 1974). The procedure for developing test instruments using the development model by(Istiyono, 2020)consisting of 3 stages, namely (1) test design, (2) test trial, and (3) test measurement. The development is combined into one procedure by producing a digital four tier diagnostic test instrument product on the POE learning model to identify misconceptions and conceptual understanding of students. The results of the development of the digital diagnostic test instrument are expected to improve student learning outcomes and can help in the process of student learning progress.

Validity testing was conducted for the developed test instrument devices in the form of test grids, test items, and scoring rubrics. Validity was conducted to assess the feasibility of the developed device. Validity was conducted by expert validators, namely lecturers from physics education and practitioners, namely high school teachers. Analysis of the validity results of the instrument using V Aiken. The validity results were used as a basis for revision or improvement of the developed instrument.

The V-Aiken index of the test items is converted into qualitative data. The V-Aiken index value is in the range of 0 to 1. Content validity in the study uses 4 interval scales consisting of: (1)the test instrument cannot be used, (2) the test instrument can be used with major revisions, (3) the test instrument can be used with minor revisions, (4) the test instrument can be used without revisions. The results of the validity analysis are compared with the Right-Tail Probabilities (p) table for Selected Value of Validity Coefficient (V), as presented in table 1:

Table 1: Range of Validity Coefficient Values

Validity Coefficient Value Range	Interpretation of Validity
$0.80 < V \leq 1.00$	Tall
$0.40 < V \leq 0.80$	Currently
$V \leq 0.40$	Low

Result and Discussion

This study uses content validity to test the validity of the developed instrument which aims to determine whether the developed instrument is in accordance with the objectives of the research being conducted. Validity is carried out by providing a validation sheet that has been prepared to the validator to provide an assessment of the developed device. The sheet provided is a question item validation sheet which aims to see the suitability of the developed question items with Learning Achievements (CP),

Learning Objective Flow (ATP), and indicators from the conceptual understanding test. The instrument validation sheet with guidelines for developing learning devices consisting of aspects of material, construction, and language as in attachment 6. The validator carries out the assessment using a checklist system by considering suitability based on these aspects. The scoring scale on the validation sheet uses 4 categories. Content validation of the instrument developed in this study was carried out by 2 lecturers of Physics, FMIPA UNY and 2 teachers (practitioners).

The data obtained are quantitative data on the score of each aspect item and qualitative data in the form of suggestions. The validation data from the validator were then analyzed using the V Aiken formula through the Microsoft Excel program and categorized with the validation index according to Aiken. Based on the results of the overall analysis with the Aiken equation, it states that the four-tier diagnostic test instrument items developed have been valid with a high category. The results of the validation data analysis on the four-tier diagnostic test instrument are presented in table 2.

Table 2: Results of Test Instrument Analysis

Question Items	Mark	Category
1	1	Valid
2	1	Valid
3	1	Valid
4	1	Valid
5	1	Valid
6	0.92	Valid
7	0.92	Valid
8	0.92	Valid
9	1	Valid
10	1	Valid
11	1	Valid
12	1	Valid
13	1	Valid
14	1	Valid
15	0.92	Valid
16	1	Valid
17	1	Valid
18	0.92	Valid
19	1	Valid
20	1	Valid
21	1	Valid

Revisions were made to improve the test instrument according to the validation results after being reviewed by experts and practitioners. The validation results were then revised to adjust to suggestions and comments. The instrument items to identify misconceptions and conceptual understanding that had been improved were then assembled to conduct a trial test and main test. The trial test is expected to determine whether the instrument developed can be understood and comprehended by students according to the research objectives, so that a good test instrument is produced for use in the main test.

Conclusion

The development research conducted resulted in a digital four tier diagnostic test instrument to identify misconceptions and conceptual understanding of students. The results of the data analysis that

have been carried out can be concluded as follows: The digital four tier diagnostic test instrument that was developed is included in the valid category and can be used to identify misconceptions and conceptual understanding of students in Newton's Law material. The results of the validation of the instrument content assessed by the validator have valid criteria and are suitable for use after being analyzed using the V Aiken formula.

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