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Research Article

Analysis of Difficulty in Cognitive Learning Outcomes of Grade X Students on Newton's Law at Senior High School 3 Wera

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Abstract
The difficulties students face in solving the problem can be an indicator of the extent to which they have mastered the material. Therefore, it is necessary to identify the causes of these difficulties and find solutions to address them. This study aims to determine the level of difficulty in the cognitive learning outcomes of 10th-grade students on Newton's laws at SMAN 3 Wera and to identify the factors causing these difficulties. This research is a descriptive study with a qualitative approach, involving a sample of 30 students from class X1 at Senior High School (SMAN) 3 Wera. The data collection methods used include tests, interviews, and documentation, with data analysis involving data reduction and verification or conclusion drawing. Based on the research results and discussion, it can be concluded that: (1) The highest level of difficulty in the cognitive learning outcomes of 10th-grade students is found in the C6 cognitive domain (Evaluation), with only 20% of students able to answer C6 questions. Conversely, the least difficulty is found in the C1 cognitive domain (Understanding), with a success rate of 64.07% and 35.93% of students unable to answer the questions. In the C2 cognitive domain (Understanding), the success rate is 60.83%, in the C3 domain (Application) it is 63.3%, with 36.7% of students unable to answer the questions. The moderate difficulty levels are found in the C4 domain (Analysis) with a success rate of 51.7%, in the C5 domain (Synthesis) with a success rate of 53.3%, and in the C6 domain (Evaluation) with a success rate of 46.6%. (2) The factors causing the difficulties in the cognitive learning outcomes of 10th-grade students in solving problems on Newton's laws at SMAN 3 Wera are (a) difficulty in understanding the problems in the questions and (b) lack of carefulness and haste.

Keywords: Cognitive Learning Outcomes, High School Students, Learning Difficulties, Newton's Laws

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1. INTRODUCTION

Currently, the education system in Indonesia faces significant challenges in achieving the expected competencies of students. These competencies include skills or mastery in specific fields that every student must possess. Recognizing this, the government strives to provide solutions by setting targets to produce superior, creative, skilled, and Pancasila-spirited human resources through education in Indonesia. This aligns with the vision of Indonesia Emas 2045, where education plays a key role in achieving these aspirations. One concrete effort being made is the development of education policies through the launch of the Merdeka Curriculum. This curriculum is designed to address the lack of competencies, both from the educators and the students, and to adapt to the evolving times and societal needs.

Curriculum change is a crucial step since the curriculum is the lifeblood of the education system and must be regularly evaluated. A dynamic and innovative curriculum is needed to keep up with the advancement of science and technology (IPTEK) and societal needs (Amin, 2024; Simamora, 2024; Solekah & Rahayu, 2022). Evaluating learning outcomes is one important aspect of curriculum implementation, aiming to assess the learning difficulties faced by students. Learning difficulties are often marked by obstacles in the learning activities that require greater effort to overcome. Both internal and external factors of students, particularly in terms of cognitive aspects, influence their learning achievements.

Physics is a branch of science that plays a significant role in supporting technological advancements and providing an understanding of natural laws. However, in practice, many students face difficulties in solving Physics problems, especially those related to Newton's laws. Common mistakes often occur in calculations and conceptual understanding. Understanding and addressing these errors in solving Newton's laws problems are crucial because it not only trains students to be more precise and meticulous but also helps them think rationally and systematically.

Based on observations at SMAN 3 Wera, students' skills in solving Newton's law problems remain a challenge in Physics learning, especially in class X, which consists of 30 students. Data show that students' scores on Newton's law topics are still low, with only 40% of students meeting the Minimum Completeness Criteria (KKM). This is due to various factors, including ineffective teaching methods and students' difficulties in understanding concepts.

In Physics, Newton's law topics are essential as they train students to think logically, analytically, and systematically. However, many students still lack understanding of this material. As stated by Abdurrahman & Suyatna (2020), high school students often do not meet the KKM in exams, particularly on Newton's laws of motion. This indicates that students' cognitive and numerical abilities are not yet optimal, necessitating a greater emphasis on more effective teaching methods.

This study aims to analyze the cognitive learning difficulties of class X students on Newton's laws at SMAN 3 Wera. By understanding the causes of these difficulties, appropriate solutions can be found to improve physics learning quality and, ultimately, enhance students' learning outcomes. Efforts to reduce these difficulties are essential so that students can master physics materials well and apply them in daily life.

1.1 Literature Review

1.1.1 Definition of Learning

In the world of education, learning is a crucial process that involves deliberate activities carried out by individuals to achieve changes in their abilities. According to MKDP (2013), learning enables someone who previously could not do something to be able to do it. Yamin (2015) adds that learning is an effort to manifest oneself in a tangible form that can transform a closed state into an essential one. This process involves activities to bring forth new competencies, which then become relatively permanent, through interaction with the environment.

Learning encompasses various aspects such as acquiring information, skills, new attitudes, understanding, or values, usually accompanied by changes in behavior and lasting throughout life (Basleman & Mappa, 2011). According to Kimbler and Mayer, learning is a relatively permanent change in habits resulting from repeated practice, while Bell Gredler states that learning is a gradual and continuous process to acquire various competencies, skills, and attitudes (Karwono & Mularsih, 2018).

Karwono and Mularsih (2018) also describe characteristics of learning, including: (1) behavioral changes as a result of learning, (2) relatively permanent changes, (3) changes in behavior do not occur instantly but through a repeated process, (4) changes are derived from experience, not from maturity and instinct, and (5) experiences must be repeated and reinforced.

1.1.2 Definition of Teaching

Teaching originates from the word 'learn' with the prefix "pem" and suffix "an," indicating external intervention to facilitate the learning process. According to Gagne and Briggs, teaching is a series of activities designed to enable the learning process (Karwono & Mularsih, 2018). The basic concept of teaching includes delivering learning materials and organizing the learning environment to maximize the effectiveness of learning (Sanjaya, 2013).

In the teaching process, students should be the center of activities, although the teacher's role as an instructor remains important. Teaching and learning are two interrelated terms that cannot be separated, as teaching aims to make students learn (Sanjaya, 2013). Teaching also shows students' efforts to study learning materials as a result of interaction with the teacher.

1.1.3 Cognitive Learning Difficulties

Learning difficulties refer to conditions where students face obstacles in achieving optimal learning outcomes (Utami, 2020). Learning outcomes are the implementation of the learning process that shows changes in students from not knowing to knowing. Curriculum and instructional objectives often refer to Bloom's Taxonomy, which divides learning abilities into affective, cognitive, and psychomotor domains (Anderson & Krathwohl, 2002).

The cognitive aspect of Bloom's Taxonomy includes six levels of thinking processes: (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation (Kusuma, 2014). Various test methods, such as direct questions, essays, multiple choice, and portfolios, can be used to measure these cognitive abilities. The cognitive levels in Bloom's Taxonomy have been widely used to structure, understand, implement, and evaluate educational objectives (Winkel, 2006).

1.1.4 Concept of Newton's Laws

In the 17th century, Galileo realized that an object changes speed when a force is applied to it. Sir Isaac Newton later explained the concepts of force and motion through his three laws in the book "Philosophiae Naturalis Principia Mathematica" or "Principia" (Aristi, 2018). Newton's laws include:

- Newton's First Law (Law of Inertia): States that an object will remain at rest or move in a straight line unless acted upon by a force.
- Newton's Second Law: States that the acceleration produced by a net force is directly proportional to and in the direction of the force, and inversely proportional to the mass of the object.
- Newton's Third Law: States that for every action, there is an equal and opposite reaction (Setyawan, 2020).
- These laws form an essential foundation in Physics education, particularly in class X topics on linear motion and gravity. Despite curriculum changes, these laws remain relevant and are used as references in Physics education (Dwi, 2023).

1.1.5 Various Types of Forces

Forces can cause changes in objects, whether in shape, motion properties, speed, or direction of motion. Types of forces include:

- Gravitational Force (w): The force acting on an object due to gravity.
- Normal Force (N): The force acting perpendicular to the contact surface between two objects.
- Frictional Force: The force arising from the roughness of two surfaces in contact, divided into static and kinetic friction.
- Tension Force (T): The force acting on a stretched rope as an action-reaction force.

2. METHOD

2.1 Research Design

This study is a descriptive research using a qualitative approach, where the researcher explains the existing data naturally according to the condition of the research object, and the researcher becomes a key instrument in the research, making the presence of the researcher important (Sugiyono, 2014).

2.2 Location and Time of Research

This research was conducted at SMAN 3 Wera in Bima Regency during January-February 2024.

2.3 Population and Sample

The population is a generalization area related to objects/subjects that have certain qualities and characteristics set by the researcher to be studied and from which conclusions are drawn (Sugiyono, 2013). The population in this study consists of the 30 students of class X1 at SMAN 3 Wera. Non-random sampling technique with purposive sampling was used, so the sample in this study consists of the 30 students of class X1.

2.4 Types and Sources of Data

2.4.1 Types of Research Data

In conducting research, the researcher needs accurate data to ensure the reliability of the study results. There are two types of data in research: qualitative and quantitative data (Arikunto, 2019).

- Quantitative data are numerical data obtained through calculations.
- Qualitative data are descriptive data obtained through social research.

The type of data in this study is qualitative, which is non-numeric data. This data typically includes an analysis of the current conditions in the organization, helping the researcher identify problems. Examples of qualitative data include interview data, observation data, records of past problems, and more.

2.4.2 Sources of Research Data

The data sources in this research include information or subjects and objects, as well as the overall environment from which relevant data can be obtained to answer the research problems.

According to Sudjana (2016), data sources can be documents, objects, events, or interviews with subjects being studied.

There are two kinds of data sources in this study:

Primary Data Sources: These are data obtained directly from the research subjects or during the field research. The main data sources for this study are the teachers and students of class X1 at SMAN 3 Wera.

Secondary Data Sources: These are supplementary data sources that complement the primary data, ensuring the research's validity. The required secondary data sources include observation results and documents related to X at SMAN 3 Wera, which support the primary data.

2.3. Data Collection Methods

The primary data used in this research consists of written data from students' work on cognitive learning difficulties in Newton's law material and interviews with selected students. The data collection methods used in this research are as follows:

2.3.1 Test

A set of questions aimed at measuring an individual's ability or revealing specific aspects of the person being tested (Widoyoko, 2015). The tests in this study are subjective essays, where students answer questions by describing, explaining, discussing, comparing, and providing reasons in their own words (Sudjana, 2014:35). The test consists of 25 questions, including 20 multiple-choice questions and 5 essay questions, given to the 30 students of class X1 at SMAN 3 Wera.

2.3.2 Interviews

A verbal process of asking and answering questions between the interviewer and the respondent to obtain the necessary information (Widoyoko, 2012). There are two types of interviews in this study: with teachers to identify the challenges in teaching physics, and with students to understand the cognitive learning difficulties and their causes in Newton's law material.

Table 1. Examples of Cognitive Questions

Types of Cognitive	Items	Answer
C1 KNOWLEDGE The question requires students to have knowledge of physics in terms of definitions and terminology within the subject.	Newton's first law is often referred to as the law of….. a. Eternity b. Action-reaction c. Balance d. Inertia	D
C2 COMPREHENSION At this level, students are considered to understand the formulas and their usage.	Calculate the acceleration experienced by an object with a mass of 100 kg when it is pulled with a force of 200 N. Also determine the distance it will travel if it is pulled with that force for 20 seconds! a. 200 M b. 400 M c. 520 M d. 530 M	B
C3 APPLICATION At this level, students are able to apply physics concepts and formulas in everyday life, thus being given problems that can be directly visualized in real-life scenarios.	Two objects each 2 kg and 3 kg are on a rough floor surface with a friction coefficient of 0.2 arranged as shown in the picture.  If the static coefficient between two objects is 0.3 and the second object is given a force of F, then the maximum value of F so that the two objects continue to move together is... a. 0 N b. 15 N c. 25 N d. 30 N	C
C4 ANALYSIS Students are given problems that require an analysis of Newton's laws.	An object with a mass of 20 kg lies on a smooth, flat floor. Then the object is affected by a horizontal force to the right of 200 Newtons and to the left of 100 Newtons. After moving 10 seconds the force to the right is removed. Calculate when and where the object will flip! a. 100 Sec b. 20 Sec c. 60 Sec d. 50 Sec	B
C5 SYNTHESIS At this level, students are expected to solve problems that combine several formulas and their understanding of Newton's laws.	A young man stands on a scale in an elevator. Before the elevator moved, the scale showed 60 kg. when the lift moves up, the scale shows 66 kg. Assume the acceleration due to gravity is 10 m/s^2, meaning the elevator rises with that acceleration... a. 6 m/s2 b. 4 m/s2 c. 3 m/s2 d. 1 m/s2	A
C6 EVALUATION At this stage, students are able to analyze and critique what has been taught by providing an overview of all the levels.	An object with a mass of 10 kg is placed on a horizontal plane of light board. If the earth's gravity is 10 m/s^2, calculate the normal pressure force experienced by the object on the plane of the board when it is moved vertically upward at a constant speed and with an acceleration of 2 m/s^2. a. 100 N b. 120 N c. 200 N d. 300 N	B

2.3.3. Documentation

A method of data collection by examining documents related to the research. The documents in this study include students' answer sheets, interview results, and photos taken during the research.

2.4. Data Collection Instruments

To achieve reliable results, instruments are necessary. These include diagnostic questionnaires for learning difficulties in physics and test questions. The test questions consist of physics questions from various sources previously validated by the supervising lecturers and used by previous researchers such as Osy Fitriani Aristi, and questions in the SMA Physics Learning Module published by the Ministry of Education and Culture in 2020, totaling 25 questions, including 5 essay questions validated by the supervising lecturers. The questions cover six cognitive levels according to Bloom's Taxonomy (see Table 1).

2.5. Data Processing Techniques

Data is processed using Microsoft Office Excel, measuring the percentage of students' learning difficulties using the descriptive percentage formula as follows:

$$P = \frac{x}{y} \text{ x } 100\%$$

where:

n = score obtained by students

N = maximum score

P = percentage

2.6. Data Analysis Techniques

This is a descriptive research with a qualitative approach, analyzing data using descriptive words or sentences to explain the research results and objectives. Qualitative research typically analyzes data during fieldwork, conducted concurrently with data collection. Miles and Huberman suggest that data analysis is performed interactively and continuously until it is complete. The activities in data analysis using the Miles and Huberman model include data reduction, data display, and conclusion drawing/verification (Moleong, 2018).

2.6.1 Data Reduction

Data reduction involves summarizing, selecting the main points, focusing on important aspects, and identifying themes and patterns. This process makes the data clearer and helps the researcher in further data collection and analysis. The data reduction steps in this research are:

- Correcting students' work
- Identifying students with the most learning difficulties to be research subjects
- Analyzing and categorizing the selected students' work based on learning difficulties for interviews
- Conducting intensive interviews with the selected research subjects
- Analyzing interview results
- Simplifying and organizing the data into clear and coherent notes

2.6.2 Data Presentation

According to Miles and Huberman (in Sugiyono, 2014: 95), the most frequently used method for presenting data in qualitative research is narrative text. Data presentation organizes and structures the data in a way that makes it easier to understand and answers the research questions. The data presentation steps in this research are:

- Presenting the types of errors per question and samples of the subjects' work for each error type
- Presenting the causes of difficulties per question and samples of interview excerpts for each cause
- Presenting interview findings with teachers

2.6.3 Conclusion or Verification

According to Miles and Huberman (as quoted by Sugiyono, 2014:99), the third step in qualitative data analysis is drawing conclusions and verification. Drawing conclusions or verification is part of a complete configuration activity that answers the research questions. Conclusions are obtained by comparing the analysis of the students' test work with the interview results to identify the types and causes of students' errors in solving problems on Newton's law material.

3. RESULTS

3.1 Difficulty Levels of Cognitive Learning Outcomes of Grade X Students on Newton's Laws at SMAN 3 Wera

In this study, the researcher identified six types of difficulties faced by students in physics, particularly in the cognitive domain on the topic of Newton's Laws. These difficulties include concept mastery, difficulty in relating concepts, difficulty in understanding formulas, and difficulty in applying formulas to solve problems.

The difficulty at the level of understanding (C1) in the ability to state or explain back on Newton's Laws problems was not very low, with a percentage of 63.3%. The low percentage of students understanding the problem indicates that physics learning, especially on Newton's Laws, can be understood by students, with 46.7% of students experiencing difficulty in solving the problem.

Students' learning difficulties at the level of comprehension (C2) involve an inability to understand instructions/problems, interpret, and restate on Newton's Laws problems, indicated by 60.83% of students being able to answer the problems, and only 39.17% of students experiencing difficulty in solving the problems.

These results show that students find it increasingly difficult to learn, particularly the concepts of Newton's Laws. When related to the first difficulty, which is mastering knowledge, these results show a connection that students who do not master the knowledge will also struggle with comprehension. In other words, how can students make connections between understandings if the knowledge itself is not fully understood and mastered? To relate concepts, students must not only memorize the concepts of Newton's Laws but also have a deep understanding and mastery of these concepts. If one concept is well understood and mastered, it will make it easier for students to make connections between these concepts.

Students' learning difficulties at the application level (C3) involve the inability to use concepts in practice or new situations on Newton's Laws problems, indicated by 63.3% of students being able to answer the problems, and 46.7% of students experiencing difficulty in answering the problems. This indicates that students can understand the concepts, showing that the use of concepts in practice that has been carried out in experimental trials on the concept of Newton's Laws can be understood and remembered by students.

Students' learning difficulties at the levels of analysis (C4), synthesis (C5), and evaluation (C6) involve the inability to rearrange components to create new meanings, understandings, structures, and the inability to evaluate and assess something based on norms, references, or criteria. The research results showed that students experienced difficulty in analyzing (C4) with a percentage of 51.7% being able to answer the

problems, and 48.3% experiencing difficulty in answering the problems. In difficulties in synthesis (C5), 53.3% of students answered the problems, and 46.7% experienced difficulty in answering the problems. Difficulty in evaluation (C6) showed that 46.7% of students could answer the problems, and 53.3% experienced difficulty in answering the problems. Students found it difficult to rearrange components that explain and reformulate the concept of Newton's Laws, making it hard for them to interpret and evaluate. The difficulty in mastering formulas is due to students not understanding the use of symbols, operational mathematical signs, and units. It is known that physics is a subject that uses symbols, units, and formulas. The formulas used are obtained and explained through mathematical calculations.

Wijaya et al. (2012) stated that natural phenomena in physics are often described and explained by symbols and mathematical formulas. Therefore, mastery of physics concepts also requires an understanding of basic mathematical concepts. Meanwhile, Mushtag and Khan (2012) reported that one cause of students' difficulties in learning physics is the weakness in mathematical ability. With low mathematical ability, students will increasingly lack the ability to explain the formulas being learned. To master the formulas, students must know the meaning and symbols as well as the units of a formula to link the relationship between one formula and another. If students do not have this ability, they will find it difficult to master the formulas used.

Students' difficulties in solving these problems indicate that they experience learning difficulties in the concept of Newton's Laws. Thus, these difficulties need to be addressed in the learning process, and one alternative to overcome students' learning difficulties is using a learning model that can address these challenges.

Based on the overall research results, it can be said that the lecture method cannot improve the quality of student learning, as it is unable to overcome the difficulties in physics learning outcomes and does not improve students' physics learning outcomes, especially on the concept of Newton's Laws.

3.2 Factors Causing Difficulties in Cognitive Learning Outcomes of Grade X Students in Solving Problems on Newton's Laws at SMAN 3 Wera

Interviews and examination of students' answer sheets and diagnostic questionnaires provided information on the factors causing difficulties in cognitive learning outcomes for students in solving problems on Newton's Laws. According to the findings from these interviews, there are two main reasons why students make mistakes: difficulty in understanding the problems in the questions, and forgetfulness, inattention, and haste. This is explained in the following paragraphs.

3.2.1 Difficulty Understanding the Problems in the Questions

One factor causing most mistakes by students when solving problems on Newton's Laws is their inability to understand the questions. Ahmad (in Rahardjo, 2011:14) explained that students' inability to ascertain what is known and what is asked in the questions becomes a cause of their difficulty in understanding physics problems in the questions. Based on this definition, students are considered to have difficulty understanding the problems in this study if they cannot state what is known and what is asked, do not understand the meaning of sentences or questions, and cannot answer questions.

This factor often leads to mistakes when solving Newton's Laws problems. For example, this happened when Suhita's research team (2012) was solving Newton's Laws problems. Due to not understanding the questions well, 50% of students made mistakes.

3.2.2. Inattention and Haste

Many students usually make mistakes when trying to solve word problems and other types of questions in various subjects due to forgetfulness, carelessness, and urgency. In this study, the material tested was material that had been covered for a long time, contributing to the average factor of forgetfulness and carelessness. Additionally, students' haste in completing the problems contributed to the factors of forgetfulness and inattention.

This factor is the lowest contributing factor for students and the reason why they make mistakes 24 times more often than others. Although the number is small, it has a significant negative impact on students because generally, those who make mistakes due to this factor have a strong understanding of the subject.

4. CONCLUSION

Based on the analysis of the data and discussion of the research results on the difficulty levels of cognitive learning outcomes of Grade X students on Newton's Laws at SMAN 3 Wera, it can be concluded that the most difficult cognitive learning outcome for Grade X students is in the cognitive domain C6 (Evaluation) with 20% of students able to answer C6 questions, while the least difficult is in the cognitive domain C1 (Understanding) with 64.07% of students able to answer, and 35.93% unable to answer. In the cognitive domain C2 (Understanding), 60.83% of students were able to answer, in C3 (Application) 63.3% were able to answer, and 36.7% were unable to answer. The more difficult cognitive domains for Grade X students were C4 (Analysis) with 51.7% able to answer, C5 (Synthesis) with 53.3% able to answer, and C6 (Evaluation) with 46.6% able to answer.

The factors causing cognitive learning difficulties for Grade X students in solving problems on Newton's Laws at SMAN 3 Wera are: (a) difficulty understanding the problems in the questions, where students are considered to have difficulty if they cannot state what is known and what is asked, do not understand the meaning of sentences or questions, and cannot answer questions. (b) inattention and haste, where students' haste in completing the problems contributes to forgetfulness and inattention.

Data Availability Statement. All data can be obtained from the corresponding author.

Conflicts of Interest. The authors declare no conflicts of interest.

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