
IDENTIFICATE STUDENTS PHYSICS LEARNING UNDERSTANDING BY FOUR-TIER DIAGNOSTIC TEST ON EQUILIBRIUM OF RIGID BODY TOPICS

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Abstract

This research aims to determine students' understanding of the equilibrium of rigid body topic by four-tier diagnostic test. This research was conducted in one of the schools in North Sumatra for students in class XI IPA in the 2023/2024 school year, totaling 53 students. Sampling was done by simple random sampling method. Data collection techniques include tests, interviews, and questionnaires. The test instrument used was a valid four-tier diagnostic test with a test reliability value of 0.719 which amounted to 20 items from 14 question indicators. Student results are categorized as student understanding which is divided into Scientific Conception (10%), Rarely Misconception (17%) caused by students being wrong in determining the reason, Negative False (14%) caused by students who are wrong in answering the question but correct in giving reasons, Lack of Knowledge (31%) caused by students who were unsure of the answer they chose, and Misconception (28%) due to students' ability to solve calculation-based problems and image analysis but have confidence in their answers on the topic of Equilibrium of Rigid Bodies.

Keywords: Learning Understanding Categories, Equilibrium of Rigid Body

INTRODUCTION

Physics learning is one of the branches of natural science that discusses natural phenomena and phenomena in everyday life that can be studied using the sensory organs (Rahayu, Harijanto, & Lesmono, 2018). Physics learning is a process to help students to learn well and master the knowledge and concepts of physics and the laws of physics with scientific methods including observing, formulating problems, formulating hypotheses, measuring, analyzing data, and concluding problems and applying them in everyday life (Damayanti, Ngazizah, & Setyadi, 2013). Evaluation can be done to measure and determine the extent to which students process in learning (Nana, 2019). Evaluation results will show basic competencies, materials, or indicators that have not yet reached student mastery (Febriana, 2019).

The national percentage of students who answered correctly based on the material tested in the physics subject was 45.93% mechanics. The absorption value is less than equal to 55.00 in mechanics material there are 11 out of 15 indicators (Kemdikbud, 2018). This means that the percentage of indicator achievement is still very low. In the list of regional and education unit scores, the 2019 National Exam scores for physics subjects at the North Sumatra Province level were (41.62) with the category of lack of achievement.

In general, it is often found that physics teachers tend to use the lecture method as well as students who tend to have difficulty understanding and get bored in learning physics. Students also think that physics is a difficult subject, many mathematical elements, and some students only memorize formulas without knowing the physical meaning, and even have their own thoughts about physics concepts that are not in accordance with the concepts of experts (Handayani, Astutik, & Lesmono, 2018).

This study aims to achieve the following objectives, namely to determine students' understanding of the material on the equilibrium of rigid bodies. Thus, the results of the analysis of the weaknesses experienced by students are obtained correctly. Then, the right solution will be found in overcoming student problems in learning activities.

METHOD

This research was conducted in one of the schools in North Sumatra. The participants in this study were 53 students of class XI Mia odd semester who were determined using simple random sampling technique. The research was conducted using a four-tier diagnostic test instrument that has been developed using the type of research used in Research and Development (R&D) by Borg and Gall. This research design of instrument uses the ADDIE method which consists of five stages namely analysis, design, development, implementation, and evaluation. The test instruments used are valid with a test reliability value of 0.719 which is included in the high reliability value category (Wicaksono, 2022). Data collection techniques in this research through interview, test, and fillingout the questionnaire.

The four-tier diagnostic test sheet and google form containing 20 four-tier diagnostic test items in multiple choice form and prepare the answer key. The large-scale trial was conducted on 53 students of class XI IPA with a duration of 60 minutes.

Table 1. Question indicators

Indicator	Question Indicator	Number
Describe the concept of particle balance and rigid bodies	Recall the requirements for particle equilibrium and rigid body equilibrium	1
	Recall the requirements for particle and rigid body equilibrium	2
	Summarize examples of equilibrium in daily life	3
	Understand the condition of objects in stable equilibrium	4
Solve cases of equilibrium	Determine the state of an object in dynamic equilibrium	5

of a rigid body by using the conditions of equilibrium of a rigid body (translation equilibrium $\sum F_x = 0$ and $\sum F_y = 0$ and rotational equilibrium $\sum \tau = 0$)	Determine the magnitude of the force acting on one of the support poles	6
	Determine the amount of rope tension in everyday life examples	7, 8, 9
Describe the concept of gravity	Identify statements that are consistent with the concepts of center of mass and weight.	10
	Analyze the center of mass of a system of particles	11
Determine the coordinates of the object's center of gravity	Calculate the value of the weight point in a diagram	12, 13
	Determine the overall resultant weight of two joined objects	14
	Calculates the value of the weight point of an object that has an angle to the acting force	15
	Determining the center of gravity of a plane	16, 17
	Determining the point of gravity of a volume of space	18, 19, 20

In the diagnostic test, students' answers to the four-tier diagnostic test are checked for correct and incorrect answers at each level using the answer key reference. The results of checking the correct or incorrect answers to each level of questions are grouped into indicators of student understanding categories. Scoring guidelines for tier-1 to tier-4 with the information that score 1 if the answer is correct and score 0 if the answer is wrong. The indicator of conception profile from the four-tier test result that can be used can be seen in following table.

According to (Gurel et al., 2015) indicator of conception profil from the four-tier test result, there are :

- Scientific conception (SC), if the answers on tier-1 and tier-3 are correct and the student answers confidently on both levels of reasoning
- Lack of knowledge (LK), if the answers on tier-1 and tier-3 are correct or incorrect and the student is unsure on either level of reasoning
- False positive or rarely misconception (FP), if only the answer in tier-3 is wrong
- False negative (FN), if only the answer on tier-1 is wrong
- Misconception (M), if the answers in tier-1 and tier-3 are correct and the student answers unsure at two levels of reasoning.

RESULT AND DISCUSSION

Interpretation of the results of the four-tier diagnostic test is obtained based on the results of the analysis on operational field testing, Based on the results of students' answer, the level of students' knowledges can be categorized as follows :

Table 2. Category of students' level of understanding based on questions

Category	Number of Questions	Total
Low	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	19
Medium	4	1
High	-	-

Based on the results of students' answer, the level of students' lack of knowledges or category of students who do not understand the concept can be categorized as follows :

Table 3. Category of students who do not understand the concept

Category	Number of Questions	Total
Low	-	-
Medium	1, 2, 3, 4, 5, 6, 9, 14, 16, 17,	10
High	7, 8, 10, 11, 12, 13, 15, 18, 19, 20	10

Based on the results of students' answer, the level of students' misconception can be categorized as follows :

Table 4. Category of students with misconceptions based on questions

Category	Number of Questions	Total
Low	1, 3, 4, 5, 8, 10, 11, 12, 13, 19, 20	11
Medium	2, 6, 7, 9, 14, 15, 16, 17, 18,	9
High	-	-

The result of student misconception can be seen in the following graph :

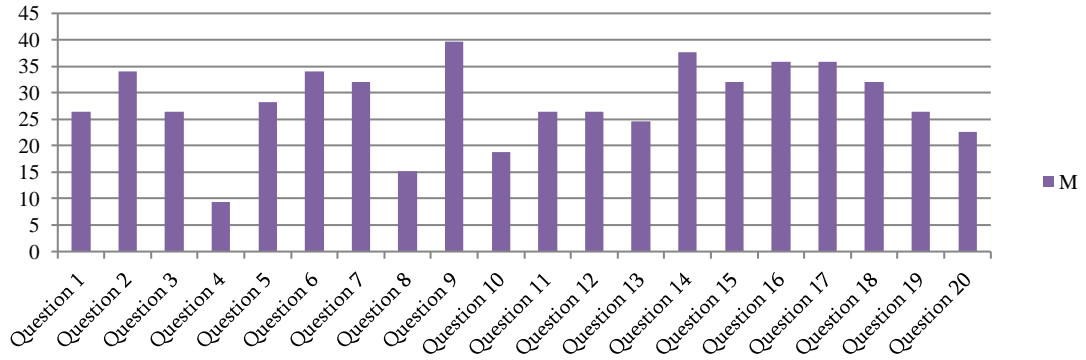


Figure 1. Students' Misconception (M)

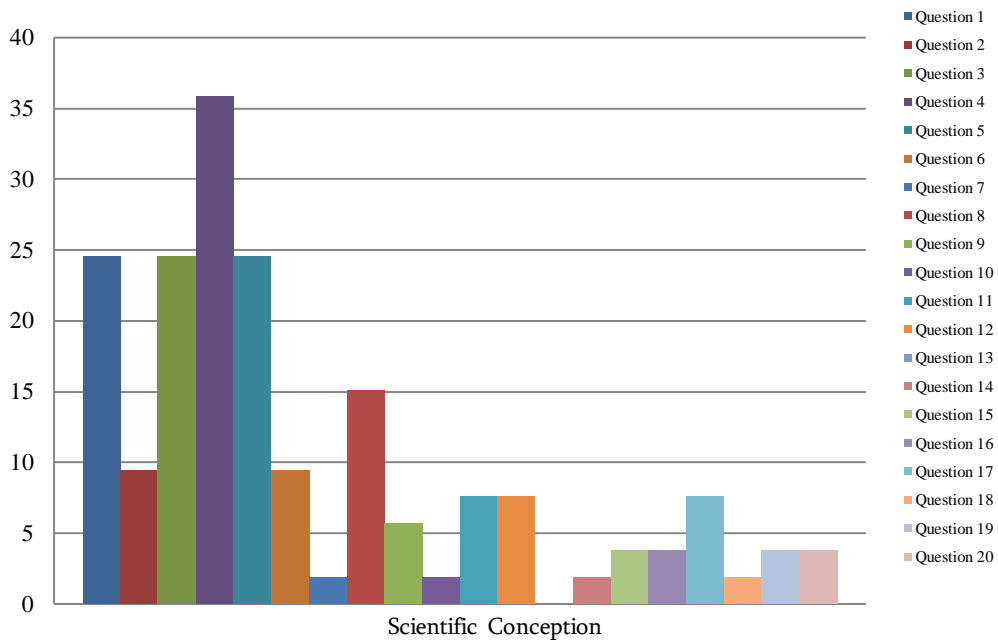


Figure 2. Students Scientific Conception (SC)

The overall level of student understanding is grouped based on the following table and can be seen in comparison through a graph.

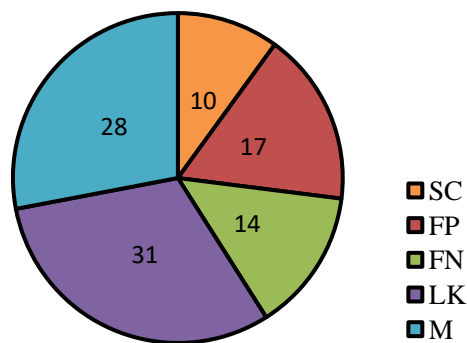


Figure 3. Percentage of students understanding

The results of the analysis, it was found that the percentage of students' understanding of physics concepts on the topic of equilibrium of rigid bodies was 10% which was still in the low category.

Based on the results of interviews conducted with students, on problems in the form of mathematical solutions, students find it difficult to work on problems because they do not have a complete understanding, especially the scope of mechanics. This affects students' understanding of the topic of equilibrium of this rigid body. This can be shown by students' ability to understand the meaning of the problem, analyze images, and calculate numbers.

Students who experience a lack of knowledge because the results obtained by students do not match the answer choices so students choose answers that are close and use the option not sure of the answer chosen. Then, there are students who are original in giving answers so that they make unsure options either in tier-2 or tier-4. In questions in the form of statements, there are still students who are fooled by the choice of answer sentences that are almost the same so that students feel sure they have answered correctly but it turns out that the answer chosen is wrong and this is categorized into misconceptions.

Learning difficulties experienced by students, there are students who understand and have an interest in learning physics and there are also students who are less interested and do not understand physics lessons. If the questionnaire results are adjusted to the results of interviews conducted with students, the learning difficulties experienced by students are the ability to understand and solve physics problems quickly and accurately. This is indicated by the answers of students who stated that their learning methods such as memorizing formulas, asking friends, and not understanding from previous lessons. Students who understand are supported by the focus of students in learning and want to work on their own.

Comparison with the results of other studies is in research by (Severina et al., 2021) student understanding on the topic of equilibrium of rigid bodies using Physics Education and Technology (PhET) simulations was evaluated using a one-tier multiple choice test with five answer choices. The results obtained that the students' understanding was at a value of 0.60 with the category of medium.

Research by (Fariyani et al., 2022) namely the analysis of misconceptions using a four-level diagnostic test on the topic of Rotational Dynamics. Based on the analysis of these misconceptions, it is found that the misconceptions experienced by students are in the low

category where there are 50% misconceptions in the answers, 57.14% in the reasons, and there are 50% in the answers and reasons while in the concept of equilibrium of a rigid body has the highest percentage of understanding, namely 11 19% in the indicator explaining the quantities related to rotational dynamics with the highest percentage of misconceptions 67.23% in the indicator applying the concept of moment of inertia to the motion of an object.

Research conducted by (Istiyono et al., 2022) categorized students as understanding concepts, conceptual errors, and misconceptions can be known by using a valid and reliable four-tier diagnostic test. Based on this research, the largest misconception obtained is the momentum number followed by the topic of Newton's law, particle dynamics, to effort and energy with conceptual misconceptions (FN and LK) of 36.18% related to Newton's law. In the Scientific Concept (SC) category is 12.18% with the topic of particle dynamics at the second largest percentage and Newton's law at the smallest percentage where these topics are the initial knowledge that students must have in learning physics.

CONCLUSION

The four-tier diagnostic test shows the percentage and category of students' understanding in learning physics on the topic of equilibrium of rigid bodies. The categories of student understanding are divided into Scientific Conception (10%), Rarely Misconception (17%), Negative False (14%), Lack of Knowledge (31%), and Misconception (28%) on the topic of Equilibrium of Rigid Bodies. The highest percentage for Lack of Knowledge indicates students who have unsure answers at tier-2 and tier-4 based on the answers chosen at tier-1 and tier-3. This means that by knowing the percentage of understanding and misconceptions experienced by students, teachers can find out the indicators that need to be paid attention to again so that alternatives / solutions can be found to overcome students who do not understand the concepts or misconceptions on the topics discussed.

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