

Identification of students' misconception with isomorphic multiple choices test on the force and newton's law material

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Abstract. The aims of this research to identify students' misconceptions on Force and Newton's Law material using multiple choices isomorphic test. This research conducted in SMA N 4 Yogyakarta. The population used in this research was purposive sampling technique with consideration of the highest to lowest learning outcomes in class XI MIPA. The method used was descriptive analysis design with data collection techniques through written test. This research used 30 multiple choices test consisting of 10 question indicators and each indicator has 3 different context and representation problems but has the same indicator. The results of this study indicate that the level achievement of students' misconceptions are 43%, understanding concepts by 45% and not understanding concepts by 12%.

Keywords: *misconception, isomorphic tests, force and newton's law*

1. Introduction

Students understand a concept that is different from experts known as misconceptions [1], [2]. Students have less mastery of concepts that can interfere with the understanding of the problem solving process [3], [4]. This can have an impact on student achievement [5]. Physics is a subject with interrelated concepts [6]. Physics becomes a difficult subject, because students do not understand the concepts of matter and just memorize without understanding [7].

Student misconceptions are resistant or difficult to eliminate [8]. Misconceptions in physics are mostly experienced by students on material mechanics, Force and Newton's law, and fluid [9]. Newton's Law Material one material that is still experiencing many difficulties due to lack of mastery of concepts including friction, Newton's First Law, Newton's Second Law and Newton's Third Law [10]-[12]. Students who experience misconceptions should be immediately given a diagnostic test to identify misconceptions about themselves [13]. Misunderstanding can be avoided when the student knows the concept of appropriate [14].

Diagnostic tests can be used to identify learning difficulties in students [15]. Isomorphic tests make it easy for students to transfer material that has been studied in a variety of diverse contexts [16]. This test can be used by teachers in determining the extent to which students' understanding of the



workmanship of multiple choice questions [17]. Test use of multiple choices are effective in detecting misconceptions that occur in students [18]-[20]. The teacher can use multiple choice tests to detect misconceptions that occur by providing several alternative answers [21], [22]. Students had misconceptions can be seen clearly on the consistency of answering questions [23]. Students experiencing misunderstandings can be caused due to lack of knowledge of facts and the relationship between some knowledge [24]. Various methods of testing to identify or reduce misconceptions among students have been carried out. The learning process using a model or media assistance can reduce the level of misconception in students [25]. Conceptual learning is the first step that must be done to identify student misconceptions. This can provide information to teachers in developing appropriate learning activities and students experience misconceptions can overcome their mistakes [26], [27].

2. Research method

This research uses a descriptive qualitative design and is carried out in SMA N 4 Yogyakarta. The subjects of this research consisted of 20 students class XI and technique in this research used purposive sampling, namely the selection of subjects chosen based on several considerations with the distribution of high to low abilities. Data collection techniques used are written tests.

The test used is a multiple choice isomorphic test consisting of 30 items with 10 assessment indicators that have been prepared. Where each indicator consists of 3 items with 5 alternative choices of answers. Analysis this research uses quantitative to find out students who experience misconceptions in this study used the grouping of answers from each student's consistency presented in table 1.

Table 1. Conception consistency score.

Answer Criteria	Consistency Category
If you answer correctly three or two questions from three different contexts in the same concept	Understand the Concept
If you answer incorrectly at least two questions from three different contexts in the same concept with the same or consistent answer	Misconception
If you answer incorrectly three questions from different contexts in the same concept but different answer are not consistent	Don't Understand the Concept

As a reference the data was analyzed using the percentage [28]:

$$P = \frac{f}{N} \times 100\% \quad (1)$$

Where:

P = Percentage

f = Frequency

N = Total number frequency

3. Results and Discussion

The instrument of isomorphic multiple choice questions after validity by material experts and physics learning practitioners obtained a value of 91.88 value that is interpreted on scale of 100 that included in both categories. Instrument many as 30 questions used in accordance with suggestions for improvement such as correction of editors in the questions and in the choice of answers, adding information to the problem and repairing a few sentences about the question. The indicators used in isomorphic multiple choice test questions are arranged according to the basic competencies in the curriculum, which are presented in table 2.

Table 2. The percentage of students' number are experiencing misconceptions for each indicator

Indicator	Statement	Percentage of Student (%)
1	Students are able to analyze the concept of Newton's First Law in solving problems of everyday life	10%
2	Students are able to analyze the concept of Newton's Third Law in solving problems of everyday life	40%
3	Students are able to analyze the effect of normal forces on objects	90%
4	Students are able to analyze the effect of reaction and action force	70%
5	Students are able to understand the effect of friction in everyday life.	30%
6	Students can analyze the effect of friction in everyday life	0%
7	Students can analyze the slowdown which is affected by friction in everyday life	30%
8	Students can understand the resultant forces on objects	20%
9	Students can apply the concept of force to the motion on object	30%
10	Students can analyze the influence of forces on objects in the air	70%

Table 1 presented the problem indicators used to identify student answers in the categories of conceptual understanding, misconceptions and not understanding the concept about force and Newton's law. Based on research results from 20 students were given isomorphic multiple choice tests the results are presented in figure 1.

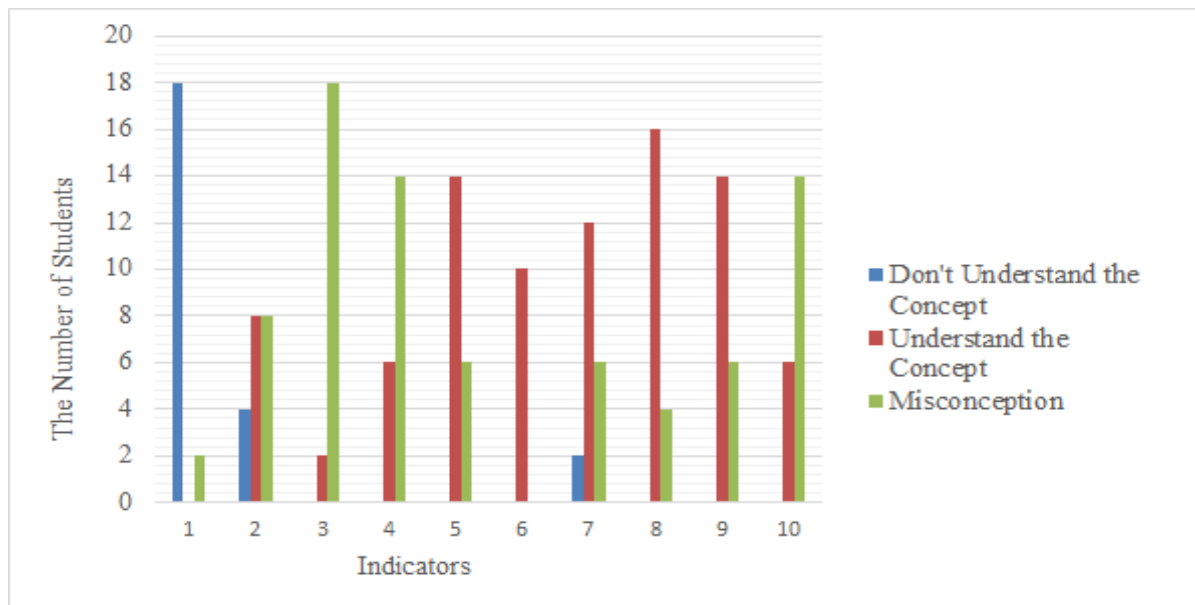


Figure 1. Student answer results

The graph shows the results of grouping based on students' answers for each indicator. The blue graph shows the number of students experiencing not understanding the concept, the red graph shows the number of student experiencing understanding the concept and the green graph shows the number of students experiencing misconception. Based on the data of students' conception diagnostic results, it is found that the number of students does not understand the highest concept in indicator 1 with the question numbers 1,2 and 3. The highest number of students understood the concept in indicator 6 with question numbers 16,17 and 18 and the highest number of misconception students was indicator 3 with question numbers 7,8 and 9.

3.1. Misconception indicator 1

Students are able to analyze the concept of Newton's First Law in solving problems of everyday life that is for question numbers are 1,2 and 3. Based on the results of students' answer patterns, misconceptions still occur is 10% of students still think that objects in a state silence do not have any force. While 90% of students do not understand the concept because not consistent in answer questions.

1. Sebuah gelas kaca terletak di atas meja dan gelas tetap dalam keadaan diam. Pernyataan yang benar berkaitan dengan peristiwa di atas ...
 - A. Gelas kaca tetap diam karena hanya mengalami gaya normal
 - B. Gelas kaca tetap diam karena hanya mengalami gaya berat
 - C. Gelas kaca tetap diam karena hanya mengalami gaya gesek
 - D. Gelas kaca tetap diam karena resultan gaya sama dengan nol
 - ☒ E. Gelas kaca tetap diam karena tidak mengalami gaya apapun
2. Sebuah kaleng biskuit terletak di atas meja ruang tamu dalam keadaan diam. Berikut penyebab terjadinya peristiwa tersebut, kecuali ...
 - ☒ A. Karena kaleng biskuit tersebut tidak memiliki gaya apapun
 - B. Karena kaleng biskuit memiliki resultan gaya sebesar nol
 - C. Karena kaleng biskuit hanya mengalami gaya gesek
 - D. Karena kaleng biskuit hanya mengalami gaya berat
 - E. Karena kaleng biskuit hanya mengalami gaya normal
3. Ruang keluarga Rio terdapat televisi, lemari dan kipas angin saling berdampingan. Saat menyapu ruangan, Rio memindahkan kipas dan lemari ke kanan dekat dengan jendela menjauhi televisi. Setelah menyapu Rio istirahat sambil menonton televisi. Karena tidak terkena angin saat menonton, maka Rio mengembalikan posisi kipas ke tempat semula dari peristiwa di atas, benda yang mengalami gaya adalah ...
 - A. Televisi
 - B. Lemari
 - C. Kipas angin
 - D. Lemari dan kipas angin.

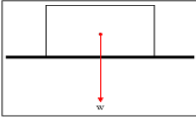
Figure 2. Examples of students' questions and answers which are indicated misconceptions.

3.2. Misconception Indicator 3

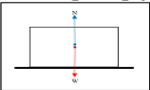
Students are able to analyze the influence of normal forces on objects, namely for questions numbers 7, 8 and 9. When viewed from the pattern of student responses, misconceptions still occur is 90% of students still assume that the normal force and gravity are a pair of reaction actions, normal force and gravity eliminate each other and normal force and gravity have the same point of catching objects, whereas for those who do not understand the concept of 10% because it is not consistent in answering.

soal no. 7-9

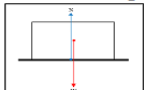
Sebuah balok kayu diletakkan di atas bidang datar berupa lantai keramik seperti ditunjukkan pada gambar



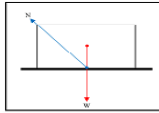
7. Berdasarkan gambar diagram gaya disamping. Pernyataan yang benar mengenai gaya normal adalah
 - ☒ A. Gaya normal selalu berlawanan dengan gaya berat
 - B. Gaya normal selalu tegak lurus gaya berat
 - C. Gaya normal selalu tegak lurus terhadap bidang sentuh
 - D. Gaya normal selalu memiliki besar yang sama dengan gaya berat
 - E. Gaya normal selalu lebih kecil dari gaya berat
8. Manakah diagram gaya normal yang benar untuk diagram gaya pada balok kayu ?




A.



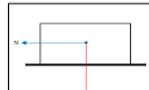
B.



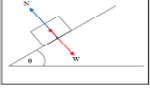
E.



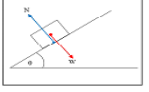
C.



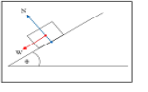
D.
9. Jika balok kayu diletakkan pada bidang miring, manakah diagram gaya yang benar ?



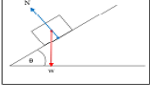
A.



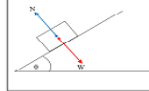
B.



C.



D.



E.

Figure 3. Examples of students' questions and answers which are indicated misconceptions.

3.3. Misconception indicator 4

Students are able to analyze the effect of normal forces on objects, namely for questions numbers 10.11 and 12. When viewed from the pattern of student answers, misconceptions still occur that 70% of students still think that the reaction force acts on the same object, normal and gravity force are action and reaction force pair.

10. Berikut pernyataan yang benar mengenai gaya aksi reaksi, *kecuali* ...
 A. Gaya sama besar
 B. Berlawanan arah
 C. Bekerja pada benda yang sama
 D. Memiliki titik tangkap yang sama
~~E. Selalu saling meniadakan~~

11. Berdasarkan gambar disamping, gaya yang merupakan pasangan aksi reaksi adalah ...
~~A. W_A dan N_A~~
 B. W_A dan W_B
 C. N_A dan N_B
 D. F_A dan F
 E. F_A dan F_B

12. Dua buah benda yang massanya sama digantungkan pada sebuah katrol seperti pada gambar, jika sistem dalam keadaan setimbang, maka pasangan gaya aksi reaksi adalah ...
~~A. T_1 dan T_2~~
 B. T_1 dan T_3
 C. T_2 dan T_3
 D. T_2 dan T_4
 E. T_4 dan T_1

Figure 4. Examples of students' questions and answers which are indicated misconceptions.

Based on the results of isomorphic diagnostic tests, the percentage of students' understanding of Newton's law material is presented in figure 5.

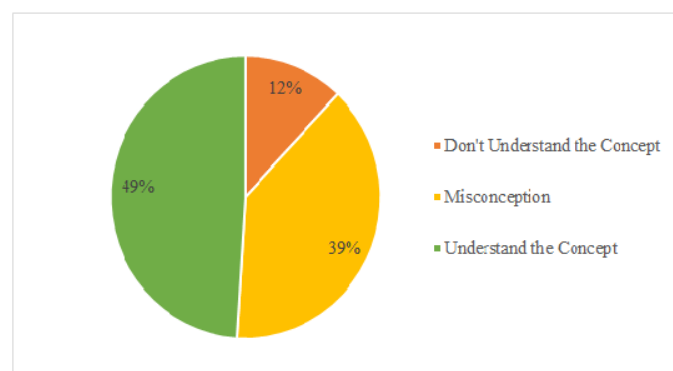


Figure 5. The percentage of students' understanding Newton's law material

The results of students' understanding of class XI Science in Newton's Law material by 12% of students do not understand the concept, 49% of students understand the concept, and 39% of students experience misconceptions. The results of research indicate that misconceptions are still experienced by students almost half the respondents. However, the percentage results obtained are not too large range between understanding concepts, not understanding concepts and misconceptions. The results presented misconceptions still had a significant influence on learning. Misconceptions can occur due to various factors such as from teacher explanations, student experiences or even from the textbooks used. The results of this misconception research are expected to provide information teachers to pay more attention in the process of transferring material and students can be more courageous to ask questions during the learning process.

Based on the results of the research found, multiple choice isomorphic tests can be used to identify students' misconceptions on force and Newton's law material. This results tests can be used to identify research by Shih-Yin Lin and Chandrekha Singh (2013), transferring from a two step problem to a three-step problem the results obtained that by using the problem given to students to be resolved with 2 stages of completion into 3 stages of completion makes students more able to distinguish and explain the basic similarities of problems with isomorphic problems.

The research by Nawati (2017), conceptions through the application of the Interactive Lecture Demonstration model on Mechanical Wave Materials shows that students' consistency in answering questions is still low where, many students answer several questions differently from one another even though they are still with the concept the same one. Research by Wiyani (2019), it was found misconception is a major problem in learning physics in schools.

Teachers must provide solutions to students who experience misconceptions, which one is by using worksheets in reducing misconceptions on students. This worksheet was developed and tested for validity so that an average of 0.91 was obtained with valid criteria. Isomorphic tests in this study are used to identify students who experience misconceptions by seeing consistency in answering the questions given.

4. Conclusion

This research found misconceptions of students can be categorized into three categories, there are: (1) Understanding concepts, (2) Do not understand concepts and (3) misconceptions. Isomorphic multiple choice tests can be used to identify students experiencing misconceptions. The indicator of the tests that experiences the highest misconception are indicator analyzing the influence of normal forces on objects, analyzing the effect of action and reaction force and analyzing the influence forces on objects in the air. Misconceptions on students can be identified from the beginning, so that students do not experience difficulties in the learning process. In addition, the teacher can see the consistency of the results of student answers using a multiple choice isomorphic test.

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