



Misconception Profile of Newton's Law Concept Using Certainty of Response Index (CRI)

Zayyinul Mushthofa[✉], Ani Rusilowati, Sulhadi, Putut Marwoto, Budi Naini Mindyarto

Postgraduate Universitas Negeri Semarang, Semarang, Indonesia

Article Info

Article history:

Received 29 June 2020

Approved 25 August 2020

Published 31 August 2020

Keywords:

CRI, misconceptions,
Newton's law

Abstract

Misconception is an understanding that is believed to be correct but not according to the understanding of the experts. Misconceptions can occur because students build their knowledge gained from daily activities. This study aims to identify misconceptions about Newton's law concept and the causes of the misconceptions. The research type is descriptive quantitative. A total of 30 students of SMA Multazam IBS Semarang were given a true-false objective test and drew a style diagram accompanied by a certainty of response index (CRI). The cause of the misconception was obtained by interviewing 4 students. The results obtained were as many as 20.99% of students experienced misconceptions, 9.99% of students understood the concept, and 69.02% did not understand the concept of Newton's law concept. The most common misconception is that students think that heavier objects will fall faster than lighter objects. The cause of students experiencing misconceptions is the understanding they build themselves; students' carelessness in choosing answers; low reasoning ability; and forget the material that has been delivered.

[✉]Correspondence:

Postgraduate Universitas Negeri Semarang, Jalan Kelud Utara III
No. 37, Kota Semarang, Indonesia 50237
e-mail: zainsmart34@students.unnes.ac.id

INTRODUCTION

Physics is a branch of science that studies the phenomena that occur in the universe. In schools, teachers deliver physics material based on a curriculum that has been prepared and developed according to the conditions and needs of students. Of course, some of the concepts presented have been experienced and some have not. This causes the need to confirm the correctness of the concepts they have compiled according to their experiences. The concepts that they believe to be true are not all in accordance with the concepts described by the experts. An understanding that is believed to be correct but is not in accordance with the understanding of the experts is called a misconception (Yuliati, 2017).

Misconceptions often occur in physics subjects, especially mechanics (Fadllan, 2011). In the mechanics material, there are still many students who are wrong in drawing the vectors of forces that occur on objects and do not understand the physical meaning of where the force comes from and what the force is working on (Muna, 2015). Students tend to think logically on physical quantities without using physics concepts (Munfaridah *et al.*, 2017). Research by Fariyani *et al.* (2017) To identify the misconception of geometric optical material, the highest student misconception is diffuse reflection and the lowest is the concept of image magnification in the loop.

Misconceptions occur because students build their own understanding from daily activities and partly because of misconceptions that are conveyed by the teacher (Fariyani *et al.*, 2017). In constructing his knowledge, it is possible to make mistakes from what is understood. This is because students do not have a scientific framework to understand the concepts being studied (Putra *et al.*, 2016). According to Hakim *et al.* (2012) students with high cognitive abilities tend to have misconceptions. This is because they have many alternative concepts but some are not in accordance with the concepts described by experts. Students who have low cognitive abilities tend to have low misconceptions. Students in this condition are categorized as not understanding the concept, not misconception. Students who experience high cognitive conflict are also not free from misconceptions as well (A'yun & Suyono, 2020). From the research of Wahyuningsih *et al.* (2013) students in understanding the concept will not be separated from the misconception.

There are several causes that make students experience misconceptions. The result of the study which is from Silung (2016) shows that the occurrence of misconception is difficult to understand for the students because the representative materials and questions during teaching and learning presented in the form of

pictures and diagrams are complex. According to Khoiri *et al.* (2017) there are formulas, symbols, and pictures in physics teaching materials that cause students to experience misconceptions. Misconceptions can also occur due to false negatives or students' carelessness in choosing answers (Syahrul & Setyarsih, 2015). According to Aulia *et al.* (2018) students experience misconceptions because of the lack of concepts that are obtained and the lack of attention of students when taught. Lack of student interest in physics and the habit of memorizing theories without understanding are also causes of misconceptions (Lestari *et al.*, 2015). Students just remembered the mathematical equations without understanding the physical meaning (Januarifin *et al.*, 2018). Sources that cause students to experience misconceptions include teaching materials, teachers, and students themselves (Bayuni *et al.*, 2018).

The result of students' misconception will affect to their output or goal in study. This misconception will also have an impact on the construction of knowledge in the next material. The teacher needs to identify in order to find out which sub-material misconceptions occur. Furthermore, teachers can reduce and even eliminate misconceptions by means of remediation (Haeroni *et al.*, 2019). Remediation can be done by means of learning that focuses on concepts that have misconceptions.

The method to reveal student misconceptions can be done by conducting a diagnostic test (Sholihat *et al.*, 2017). This is because the diagnostic test can identify students' understanding such as: understanding concepts, not understanding concepts, and misconceptions. Gurel & Eryilmaz (2015) states the types of diagnostic instruments that are often used including: interviews, open tests, multiple choice tests, and multilevel multiple choice tests. Hasan, *et al.* (1999) developed a simple way to identify misconceptions, namely the Certainty of Response Index (CRI) method. CRI is obtained by using students' answers to the questions given. There is a scale of 0-5 on the CRI to determine a certain level of certainty for each student's answer. On this scale, it starts with guessing answers until students feel very confident about the answers.

Newton's law is one of the chapters in physics that students find difficult. This chapter is in the field of mechanics, precisely dynamics, which is the field that studies the motion of objects and their causes. The research results obtained by Fadllan (2011) mechanics is a physical material that experiences the most misconceptions. In this chapter, the field studied is quite broad because the examples and applications of Newton's Law occur in various fields in everyday life. The depiction of force vectors in the event of a moving object will

certainly be different if the object is in different conditions.

METHOD

This research is in the form of quantitative descriptive. A total of 30 students of SMA Multazam IBS Semarang consisting of 23 students of class XI and 7 students of class XII were taken as samples in this study. The sample was taken using a purposive sampling technique with the assumption that they have received Newton's law material in class X. The questions given are 10 consisting of 8 true-false objective tests that ask about the basic concepts of Newton's law and 2 questions about drawing force diagrams. The question is designed with the certainty of response index (CRI) method. The indicators measured in this study were

misconceptions, understanding concepts, and not understanding concepts. The answers obtained were then analyzed by calculating the percentage of misconceptions, understanding the concept, and not understanding the concept in each question and the question as a whole. True-false questions are assessed objectively while drawing questions are judged based on the truth in drawing style diagrams. Furthermore, interviews were conducted with 4 students consisting of 2 male students and 2 female students. The selection of the 4 students was based on their answers which experienced many misconceptions. This activity was carried out to obtain in-depth data on misconceptions and the causes of misconceptions. The flow of this research can be explained through the schematic in the Figure 1.

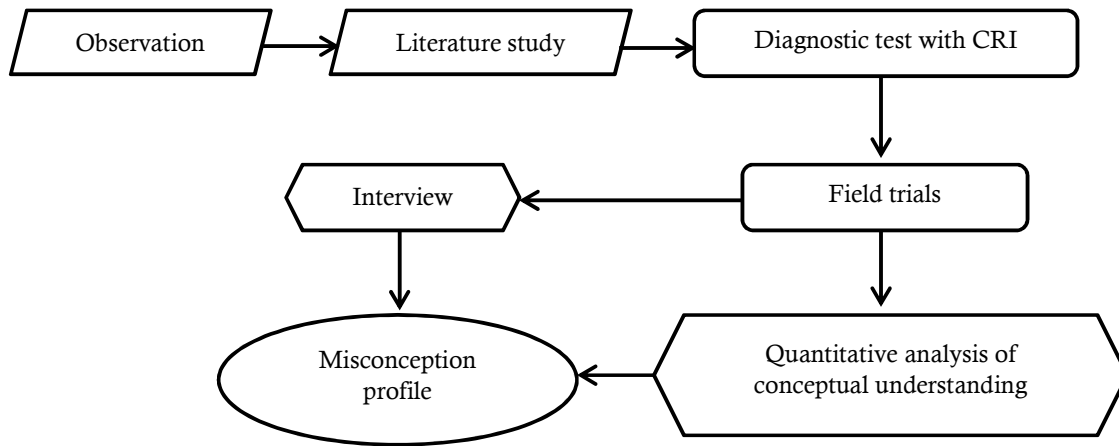


Figure 1. Flow chart of the research

RESULTS AND DISCUSSION

The results of student misconceptions data on Newton's law material are stated in Table 1. While the results of interviews with researchers and

4 students (R1, R2, R3, and R4) are presented in the following conversation on Table 2.

Table 1. Student Misconceptions Results

No.	Question	Misconception (%)	Understand the concept (%)	Do not understand (%)
1	An object will slow down if there is no resultant force acting on it	23.33	3.33	73.33
2	The amount of friction does not depend on the coefficient of friction alone	0	30	70
3	The motion of the object will follow the direction of the strongest force acting on it	23.33	3.33	73.33
4	An object that has a constant resultant force will move at a constant speed	23.33	3.33	73.33
5	An object will move faster / slower when the resultant force is constant	23.33	0	76.67
6	Heavier objects will fall faster than lighter objects	33.33	0	66.67
7	The normal force on an object is always equal to the weight of the object	13.33	16.67	70
8	The normal force in the direction is always perpendicular to the floor surface	0	23.33	76.67
9	Students are asked to draw a force diagram of a block of mass m at rest on a smooth floor	36.67	10	53.33
10	Students are asked to draw a force diagram of a block of mass m resting on a rough floor with an angle of θ . If there is an external force pushing the block up by F .	33.33	10	56.67
Overall percentage		20.99	9.99	69.02

Table 2. Results of Interviews

Researcher	Respondent	Code
“In problem number one, is it true that an object will slow down if there is no resultant force acting on it?” “What is the reason?”	“Right” “If an object is pushed and then released, the object will stop because there is no resultant force.”	R1
“Are you sure about your answer?” “Where did you get that concept from?”	“Certain” “From the understanding that I built myself”	
“In question number two, is it true that the magnitude of the frictional force does not depend on the coefficient of friction alone?” “Why is that?”	“Wrong” “Because friction is also affected by the surface area of the object.”	
“Are you sure?” “In problem number three, is it true that the motion of an object will follow the direction of the strongest force acting on it?” “What is the reason?”	“Not sure” “Right” “The most obvious example is tug of war, the motion of the rope will follow the strongest pull”	
“Are you sure?” “Where did you get that concept from?”	“Certain” “From everyday life.”	

<p>“In question number four, is it true that an object that gets a constant resultant force will move at a constant speed?”</p> <p>“What is the reason?”</p> <p>“Are you sure about your answer?”</p> <p>“Where did you get that concept from?”</p> <p>“In question number five, is it true that an object will move faster/slower when the resultant force is constant?”</p> <p>“What is the reason?”</p> <p>“Are you sure?”</p> <p>“Where did you get that concept from?”</p> <p>“In question number six, is it true that the heavier object will fall faster than the lighter object?”</p> <p>“What is the reason?”</p> <p>“Are you sure about your answer?”</p> <p>“Where did you get that concept from?”</p> <p>“If, for example, two of the same paper, the first paper is folded so that it is small while the other is left. Both were dropped simultaneously from the same height. Which fell first?”</p> <p>“In question number seven, is it true that the normal force on an object is always equal to the weight of the object?”</p> <p>“Why is that?”</p> <p>“Are you sure?”</p> <p>“Where did you get that concept from?”</p> <p>“In problem number eight, is it true that the normal force is always perpendicular to the floor surface?”</p> <p>“What is the reason?”</p> <p>“Are you sure?”</p> <p>“Where did you get that concept from?”</p> <p>“In problem number nine, how is the force diagram drawn for a block of mass m at rest on a smooth floor?”</p> <p>“Are you sure about your answer?”</p> <p>Why in drawing gravity not starting from the center of gravity?</p> <p>“In problem number ten, how to draw a force diagram of a block of mass m lying on a rough floor with a slope of angle. If there is an external force pushing the block up by F”</p> <p>“Are you sure about your answer?”</p>	<p>“Right”</p> <p>“For example, a cart pushed with a constant force will move at a constant speed”</p> <p>“Certain”</p> <p>“From everyday events”</p> <p>“Wrong”</p> <p>“If the force is constant then the velocity is also constant”</p> <p>“Certain”</p> <p>“My own understanding”</p> <p>“Right”</p> <p>“For example, cotton and stone when dropped, the stone will reach the ground first”</p> <p>“Certain”</p> <p>“Everyday Phenomenon”</p> <p>“Folded paper”</p> <p>“Right”</p> <p>“From various discussions about the normal force, the magnitude is the same as the gravity”</p> <p>“Certain”</p> <p>“From the book”</p> <p>Right</p> <p>“If the object is on an inclined plane, then the direction of the normal force is perpendicular to the surface”</p> <p>“Certain”</p> <p>“Book”</p> <p>“The gravity is going down and the normal force is going up”</p> <p>“Certain”</p> <p>Oh yes, I had forgotten. Was in a hurry to do it</p> <p>“I just drew the gravity and the normal style. Reasoning on mechanics is still low.”</p> <p>“Not sure”</p>	<p>R2</p> <p>R3</p> <p>R4</p>
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Based on Table 1, 23.33% of students experienced misconceptions in the first question, the remaining 73.33% did not understand the concept, and 3.33% understood the concept. Some students thought that an object will move slowly if there is no resultant force acting on it. This is of course wrong, if the resultant force is equal to zero it means that the object is at rest. In constructing his knowledge,

it is possible to make mistakes from what is understood (Putra *et al.*, 2016). In the second question the students did not experience any misconceptions but 70% did not understand the concept. The amount of friction does not depend on the coefficient of friction alone is true.

In the third question ask whether the motion of the object will follow the direction of the

strongest force acting on it. Of these questions, 23.33% experienced misconceptions, 3.33% understood the concept, and the rest did not understand the concept. Students experience misconceptions because they have an assumption in the example of the attractive force in the tug of war that the direction of the resultant force certainly follows the direction of the strongest force. Students do not think how the forces that work form an angle so that the direction of the resultant force does not follow the direction of the strongest force. Whereas in the fourth question, 23.33% of students experienced misconceptions, 3.33% understood the concept, and 73.33% did not understand the concept. Students assume that a constant force causes an object to experience a constant velocity. Students consider pushing an object like a cart if the speed is constant it means that it is pushed with a constant force. According to Fariyani, et al. (2017) misconceptions occur because students build their own understanding from daily activities. In the fifth question, 23.33% also experienced misconceptions. In this problem, it is the reinforcement of the fourth problem which discusses that if the force applied is constant then the object will experience acceleration or deceleration.

In the sixth question, 33.33% of students thought that heavier objects would fall faster than light objects. Students have an analogy that rocks will fall faster than cotton. When students are asked which question will fall first if two papers are the

same size then one of them is folded so that it becomes small and then dropped. They agreed that the folded paper would fall first. This is of course a misconception that is built by students. In the seventh question, 13.33% of students think that the normal force will always be the same as the object's gravity. Students do not think that it turns out that the normal force of the object on an inclined surface is different from the weight of the object. In the eighth question as many as 23, 33% understand the concept that the normal directional force is always perpendicular to the ground surface of the floor / plane. In this question, none of the students had misconceptions.

In the ninth and tenth questions students are asked to draw a force diagram on a still and moving object on an inclined plane. As many as 36.67% of students experienced misconceptions in drawing still object diagrams. The description of gravity does not start from the point of gravity of the object. This also happens when students draw moving objects on an inclined plane. As many as 33.33% of students experienced misconceptions in drawing style diagrams in the tenth question. This also happened to Muna's research (2015) some students experience misconceptions in drawing force diagrams on moving objects. In the problem of drawing diagrams, some students actually drew the speed graph. They do not understand the orders or the meaning of the questions asked.

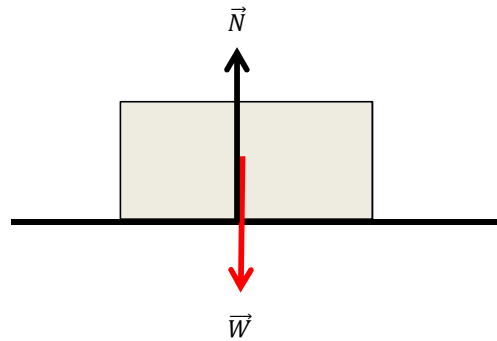


Figure 2. Force diagram of a still

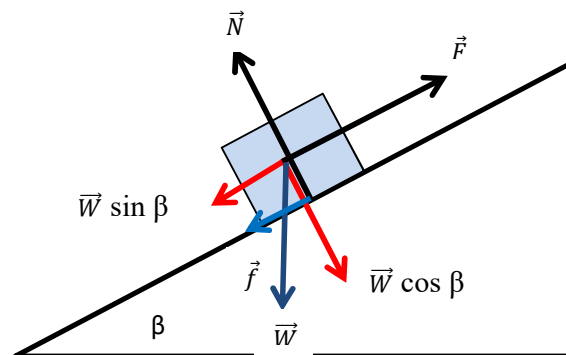


Figure 3. Force diagram of moving object on an inclined plane

The depiction of the style diagram in Figure 2 allows students to draw a heavy diagram from the floor surface. This is not appropriate because the weight diagram starts from the point of weight. Figure 3 allows students not to understand what style diagrams work on the state of the object. Students may think the weight of objects is always the opposite of normal force. Depictions of force vectors such as Normal force (\vec{N}), weight force (\vec{W}), tensile/thrust (\vec{F}), and friction force (\vec{f}) in a system of stationary and moving objects are still widely depicted without physically meaning where the force originated and worked on what the force was (Muna, 2015). Representations of materials and problems during learning that are usually presented in the form of drawings and diagrams are difficult for students to understand (Silung *et al.* 2016).

Based on Table 1, it can be stated that from the 10 questions given by students, 20.99% experienced misconceptions, 9.99% understood the concept, and 69.02% did not understand the concept. Based on Table 2, the factor that causes students to experience this misconception is that they claim to have built their own understanding. Fariyani, *et al.* (2017) said that misconceptions are built from knowledge obtained from everyday life. Some of the others admitted that they were careless in choosing their answers. This is in accordance with the statement of Syahrul & Setyarsih (2015) Misconceptions can also occur due to false negatives or students' carelessness in choosing answers. They also claim to have limited reasoning abilities in understanding the material presented and forgetting the material that has been taught.

CONCLUSION

Based on the results and discussion, it can be concluded that as many as 20.99% of students experience misconceptions, 9.99% of students understand the concept, and 69.02% do not understand the concept of Newton's law material. The most common misconception is that students think that heavier objects will fall faster than lighter objects. The cause of students experiencing misconceptions is the understanding they build themselves; students' carelessness in choosing answers; low reasoning ability; and forget the material that has been delivered.

ACKNOWLEDGMENT

Thanks are delivered to the head of SMA Multazam IBS Semarang who has given permission to take research data.

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