Misconception of weights, normal forces and Newton third law

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Abstract. Research has been conducted relating to the concept of forces in physics learning. The purpose of this study is to identify student’s misconception and difficulties in determining the weight and normal from tail of vector, the weight and the normal direction of vector and Newton third law. The study was conducted in two groups of students. The first group was microteaching class and the second group was students who had studied mechanics. The research method is carried out with two approaches namely qualitative and quantitative. The quantitative method is done by using a test instrument given to participants through the pre-test and post-test stages. While the qualitative method of conducting interviews with participants after the post-test session. The results of the study showed that 55% of students were unable to determine the exact gravity capture point, and 93% of students were unable to describe the exact position of the normal force, and 95% of students answered incorrectly about the concept of action forces similar to the reaction forces. From the interviews, it was revealed that students were still confused by the representation of the vector of force representations and not sure about the drawing vector they made. Physics will be well understood if style concept learning is given on the basis of the philosophy of science correctly. Research recommendations are very important that students understand the concept of forces correctly which is based on the application of appropriate vector concepts.

Keywords: Misconception, Weight Force, Normal Force, Newton Third Law.

1. Introduction

The concept of force is a central concept in classical physics, especially in the field of mechanics which is taught from junior high school to university level. The concept of force vectors is an abstract concept, in physics learning always uses image representation to explain force vectors that work on an object.

The concept of force is fundamental in classical physics, especially in mechanics. A simple example can be found several force concepts such as weight force, normal force, action force and reaction force. In addition to mechanics, force is also taught on electrostatic topics, magnets, etc.; therefore force is an important concept in physics [1]. In fact, many students understand that force only affects the movement of an object. For example, gravity is not a force, but only what makes it fall [2].

The problem of misconception in various fields of science, especially physics has long occurred. This is because misconception is a serious problem in learning physics. Misconceptions about a concept can hinder students from learning new physics topics. Thus, the impact of understanding
students' concepts becomes low even more fatal because they are prospective physics teachers. In addition, students who experience misconceptions are suspected to have difficulty mastering the concept. Misconceptions that occur in many physical concepts include the concept of gravity, normal force, and Newton's third law. Misconceptions experienced by some students due to a lack of understanding the concept of force in determining the point of capture of the vector, the direction of the vector, understanding the resultant forces where there are some students assume the normal force is upward while the weight force is going down, should be towards the center of the earth, opposite the normal force so that the total is zero (stationary) and many understand it as a pair of action forces and reaction forces[3].

2. Conceptual Framework
Gravity \( w \) is the force possessed by mass objects that are in a gravitational field, the direction always goes to the center of the earth. The weight force is influenced by the magnitude of the gravitational acceleration at that place and is also called the gravitational force. Normal force is a force that only appears when two objects are touched. The direction of the normal force is always perpendicular to the touch plane [4], [5]. The concept of forces originates from Newton's law and is a central concept in classical mechanics theory taught from the junior high school level to university level, especially the representation of images used in the study of force concepts in free body diagrams that describe force vectors acting on an object. Where the weight in all places on the surface of the earth will always lead to the center of the earth. The weight force and mass have a directly proportional relationship as well as the acceleration of Earth's gravity. The concept of force in Newton's Law is a concept that is difficult for students [6], we found that most students experience misconceptions in describing weight forces and normal forces. This research has shown that students have difficulties with force concepts in basic physics lectures or introductory physics.

Misconceptions or misunderstanding that occur in prospective physics teacher who are seen through diagnostic tests by Renner and Brumby [7] classify them in two degrees of understanding, namely misconceptions and understanding some of which are indicated by misconceptions. Some students' answers were illogical and there were answers that showed understanding of a concept but showed misconceptions. For example, the existence of weight and normal forces are always considered as a pair of action-reaction forces and always work together in a system.

3. Method
Research begins with the study of physical literature, especially in mechanics for several cases in the concepts of gravity, normal force, and action-reaction force. From literature studies obtained information that there are still many students who have difficulty in learning vectors ([8],[9],[10], [12], [6]). The study was conducted at the Faculty of Mathematics and Natural Sciences UNIMA majoring in Physics, involving 40 students who were divided into 2 groups each consisting of 20 students. The first group is students who are taking Micro Teaching classes (groups of students preparing for teaching practice at school), the second group is students who have studied mechanics.

Quantitative research data were obtained through pre-test and post-test stages. The research data were qualitatively obtained through interviews. The test instruments are arranged in the form of short answer test questions (simple essay tests) in the form of simple drawings. The test is done to find out the mastery of the material about gravity, normal force, and Newton's third law. Interviews were conducted to determine the difficulties and misconceptions of students about normal force, gravity, and Newton's third law.

The first question is in the form of a picture of someone climbing a slippery stem, where the rod is lubricated so it is considered very slippery. Students are asked to draw a style that works on people who climb. The answer to the problem is that the gravity only comes from the center of the weight of the person who is climbing, in the form of a straight line to the center of the earth, without the frictional force on the trunk.

Identification of misconceptions and difficulties are done on 4 important things:
1. Weight force vector direction sign $\mathbf{w}$
2. The direction of the weight force vector $\mathbf{w}$ towards the center of the earth
3. Position of capture point of weight force vector $\mathbf{w}$ is in the middle of the body/center of body weight
4. The weight force vector $\mathbf{w}$ is on the falling path of the object

![Figure 1. A slippery pole climbing.](image)

The second question, in the form of a box image placed on a flat table, in a state of not motion. Students are asked to draw the forces that works on box system. The answer is a picture of a box on a table/flat area, as same as figure 2. The catch point (tail) of weight force vector $\mathbf{w}$ is in the middle of a box placed on the table, located at the diagonal intersection of the square shape, and goes to the center of the earth. The capture point (tail) of the normal force vector $\mathbf{N}$ is drawn from the boundary touch surface of the box and perpendicular to the table surface, and is the same length as the weight force vector $\mathbf{w}$ but in the opposite direction.

![Figure 2. Weight force $\mathbf{w}$ and normal force work $\mathbf{N}$ on a box placed on a table and not move.](image)

Identification of difficulties and misconceptions is done on 6 important things:
1. The direction vector of weight force $\mathbf{w}$ is towards the center of the earth
2. The direction vector of the normal force $\mathbf{N}$ is perpendicular to the plane of table
3. Position of the capture point vector $\mathbf{w}$ at the center of the object
4. Position of capture point vector $\mathbf{N}$ on the boundary touch surface
5. The vectors $\mathbf{N}$ and $\mathbf{w}$ are the same length and opposite direction
6. Identification of physical quantities that are not asked

The total questions that will be tested on the two groups of students are 10 simple test essay questions. These questions will be done by students for 12-15 minutes.
4. Result and Discussion
The results of the study were students' answers to the two main questions which were developed into 10 questions with short answers in a short amount of time. Students' answers after processing the data obtained as in the table below. From the research results obtained the fact that there are several concepts in which more than 50% of students answer incorrectly. These concepts are the concept of the position of capture point of weight force \( w \) of 11 students or 55% in the group of students who are taking microteaching lectures and the group who have been following mechanics, the concept of the position of capture point of the normal force \( N \) on the touch surface boundary of 18 students or 90% in the group of students who have followed mechanics, and the concept of \( N = -w \) is not a pair of Newton's legal action reaction forces pair of 19 students or 95% in the group of students who are taking microteaching lectures. This shows that there are still many students who experience misconceptions and difficulties in understanding the concept of weight force \( w \), the normal force \( N \), and the action force are the same as the opponents of the reaction force, Newton's third law.

| No. | Identification of Misconceptions and Difficulties | % error | Group 1 | Group 2 | Figure |
|-----|-------------------------------------------------|---------|---------|---------|--------|
| 1.  | Weight force vector direction sign \( w \)       | 45      | 40      |         |        |
| 2.  | The direction of the weight force vector \( w \) towards the center of the earth | 55      | 55      | Figure 1|
| 3.  | Position of capture point of weight force vector \( w \) is in the middle of the body/center of body weight | 40      | 45      |        |
| 4.  | The weight force vector \( w \) is on the falling path of the object | 30      | 45      |        |
| 5.  | The direction vector of weight force \( w \) is towards the center of the earth | 20      | 30      | Figure 2|
| 6.  | The direction vector of the normal force \( N \) is perpendicular to the plane of table | 30      | 20      |        |
| 7.  | Position of the capture point vector \( w \) at the center of the object | 35      | 20      |        |
| 8.  | Position of capture point vector \( N \) on the boundary touch surface | 45      | 45      |        |
| 9.  | The vectors \( N \) and \( w \) are the same length and opposite direction | 95      | 90      |        |
| 10  | Identification of physical quantities that are not asked | 20      | 30      |        |

Mean 41.5 42
Std 21.8645 21.4396
Score min 20 20
Score max 95 90
Range 75 70

The results of interviews with the two groups of students were chosen by 10 out of 40 students, and information was obtained that: students were confused by drawing vector force representations, and were not sure of the drawings they made. Likewise, with Newton's third law concept.
5. **Conclusion**

In understanding classical physics, vectors become important basic concepts mastered. Weight force and normal force are important basic concepts that originate from Newton's philosophical laws of physics. The findings of the research show that students have difficulty understanding the concept of force correctly, especially the weight and normal forces. Our research recommendations in vector teaching are applied multi-representation to enhance and enrich vector knowledge. This is in line with research from Sirait and Oktavianty [13] one of the factors that can affect student performance in completing the concept of force is to master vectors.

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