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The Teaching Methods to Understand Force as a Vector Using the Visual Experiment Devices

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Abstract: The purpose of this study is whether the visual experiment devices and methods can make the lower secondary school students understand that a force has a vector with the direction and the size. Although they can compose two forces, they hard to discompose one force. So, I made the experiment devices and demonstrated at science class. After that, most students understood the relationship the degree of the decomposition and the group of the direction and size of the component force.

Introduction

Although most lower secondary school students can compose a force, they hard to decompose one force with two forces. I predicted the one of the reasons that a resultant force decides on just one force but one decompositon force changes many direction and many size. Some precending studies reported their point of view about the composition and decomposition of force. Those are that the component force has no connection with the angle of decomposition (Shindo, 2000), and that the length of rope of the component of the force is the force size (Miyata, 2007), and that the size of the component force is never bigger than the size of the resultant force (Miyata, 2008). These findings indicate that they understand the skill of the method of the drawing figures, but they don't understand that the force has the vector with the direction and the size. The lower secondary school students don't study the word of a vector, but they need to have the vectorial viewpoint to master the composition and decomposition of the force. Therefore, to achieve the purpose, I built the two hypothesis. One is that they watch the direction and size of the component foce using the visual experimental device, and draw the arrow with the length which is replaced the value of the experiment results on their work-sheets. Another is when they furthermore draw the two component forces of the decomposed force, they find that the size of one force changes by the angle of decomposition but the size of another force is constant. I assumed that they could understand the relevant the angle with the size and the direction of the component force. To verify these hypothesis, I test if the teaching methods using the visual experiment devices can make the lower secondary school students understand that a force has a vector with the direction and the size.

Experiment Devices

I showed the experiment devices to figure 1. It is made with some parts. I used the digital scale not the spring scale. Because the spring scale extends with the weight and the angle between two scales change. The smallest unit of the digital scales is 0.05N. The angle can be changed using the each clamp. I set the level to the center of the pipe to keep it horizontally. Three digital scales indicated the correct value in the experiment. For instance, when the angle was 60 degree and the weight was 3.00N, all digital scales indicated 3.00N. There is no problem for their learning as the error is a few.

figure 1. *Experiment Devices*

Methods & Results

In the science class, the teacher demonstrated the experiment and all students read the values of the scales directly or using the web camera. After that, they replaced the value with the length, and drew the arrow. They watched both the length of the each arrow and the each angle, and they found that the component force changes bigger as much as the angle changed bigger. In the next, they decomposed the component force into the upward force and the rightward force and drew it(figure 2). When they watched their own figures, most students found that the size of the rightward force changed by the angle of decomposition but the size of upward force did not change. After the experiment, some students described the following considerations in the work-sheet. 'When I decomposed the resultant force, the direction and the size of the component force changed by the angle.' , 'About the size change of the component force, the size of the vertical direction of the resultant force changes, but the size of the same direction as the resultant force does not change.', 'Hereafter, when I would have baggage with my friend, two people were going to approach as much as possible.'. These description suggest that they consider the force the vector with the size and the direction. Also, after this science class, they were asked to answer some questions. The theme was why the prop of Akashi Kaikyo Bridge which is the world's longest suspension bridge was very high. Most students could solve the questions using the decompositon of the force and some students described the impression that they learned that the decompositon of the force was used in society.

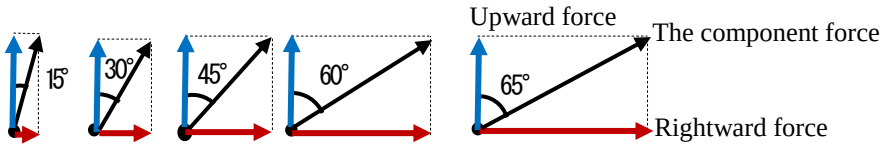

figure 2. *The upward force and rightward force of the component force*

Coclusion

Most students could understand a force as a vector by learning with the visual experiment devices and the work-sheets. But it is important whether it can inflect in various situation. They will try some achievement test at lower scondary school and at high school. I will follow their learning. And I expect to clarify the achievement and the problem of their learning. At first, I will investigate the proficiency test results at lower secondary school and expect to report when I make my presentation.

References

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