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# Application of vector representation in learning physical concepts about vector subtraction

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**Abstract**
Research has been conducted related to the use of semiotic representations in physics learning. The purpose of this study is to determine whether there are differences in average learning outcomes using the Wort-It-Out Teaching Strategy (WIOTS) learning model on the application of vector representation in learning physical concepts about vector subtraction. This research was conducted at the Department of Physics at Manado State University in the third and fifth semester totaling 25 people. This type of research is experimental research. The data analysis technique in this study used a t test with SPSS 22 assistance. The results of the t test were obtained $t_{count}$ = 17,887 and $t_{table}$ = 2,06390 at a significance of 0.05, so because the value of $t_{count} > t_{table}$ it can be concluded that there were differences in average physics learning outcomes by using the Work-It-Out-Teaching Strategy learning model on the application of semiotic representations of vector subtraction material in basic physics learning. Thus, this shows that through the treatment of Work-It-Out-Teaching Strategy has a positive influence in student physics learning outcomes, especially in the vector subtraction material, it is expected that lecturers will apply the Work-It-Out-Teaching Strategy learning model. on other physics lecture topics to improve student learning outcomes.

**Keywords:** WIOTS, semiotic representation, vector subtraction

## 1. Introduction
The difficulty of students in learning physics is mainly due to lack of skills and understanding of mathematics, especially vectors. Students need a good understanding of the basic concepts of vectors to succeed in introductory physics [1].
Vector is basic knowledge which is essential and fundamental in the field of science, especially physics (physics) and engineering (engineering). The importance of vector knowledge is especially in its application in the fields of mechanics and electronics [2].
Understanding the quantity of vectors is needed in the success of learning physics. However, many physics education researchers find that students still have misconceptions or misconceptions about vectors even though they have learned them. In general, the concept of a vector consists of vector quantities, addition, subtraction, vector components, scalar product (dot product) and vector product (cross product).
The concept of vector subtraction is one of the concepts that is difficult for students. The vector subtraction operation is the same principle as the vector addition operation, but by reversing the vector subtraction direction.
Barniola and Zavala (2010) suggested that it is important to note that although most students were able to solve problems correctly, there were still some students who still had difficulties in basic vector operations even though they had taken an introductory physics class [3]. Van Deventer and Wittmann also found that students performed better in physics (50% correct) compared to the mathematical context (20% correct) for one dimensional subtraction, because students often use the physics context to get the correct signs [4].

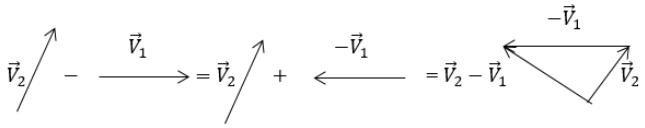


**Fig 1:** Subtracting two vectors: $\vec{V}_2 - \vec{V}_1$

Students have difficulty in understanding the basic concepts of vectors and in-depth concepts because teaching is often just providing material without giving a picture or representing concepts that students must understand.
Therefore, in learning physics is very important a representation. Representing vector images correctly can help students understand concepts and solve problems procedurally and systematically. In physics often involves models of physical phenomena in real life using external representations which include concrete to abstract forms: images, diagrams, words, graphs and equations [5].
The use of learning strategies has an important role for the learning process. Where the learning strategy is one of the factors that can improve student learning outcomes. One learning strategy that can be used to improve student learning outcomes on vector subtraction material is Word-It-Out Teaching Strategy (WIOTS).
WIOTS aims to describe the rationale and pedagogical features of the Work-It-Out (WIO) teaching strategy that has been developed to fill students' gaps and understandings and to involve them in basic skills. Operational elements developed for the WIO teaching strategy, such as videos depicting experts in physics that discuss the basic "why" and "how" of learning in diagrams and formulas. This WIO teaching strategy helps make students more independent because there is a high level of involvement of students with WIO activities [6].

## 2. Conceptual framework

Vector is a picture or sign of a directed imaginary line. This directional line is an important sign and is used extensively in physics such as the magnitude of displacement physics, velocity, acceleration, force, momentum, field strength.

Vector as a directed line, the direction sign is indicated by an arrow (head) at the end of the vector that is at point P, while the base of the vector that is at point O is called the capture point of the vector (tail). The vector capture point plays an important role in expressing the position or position of the vector is placed. For example for a particular object, the position of the capture point must be at the center of mass of the object or the center of gravity of the object in question. The center of mass is at the midpoint of the round object. If the object is in the air then the object will experience the attraction of the earth, and the object falls down due to the influence of the object's gravity. The gravity vector is directed downward as indicated by the directed line vector. The catch point of the gravity vector is at the center of mass of the object. The position of the vector capture point determines the distance of the vector with another point that becomes the reference. The length of a vector's line represents the size of the vector. The longer the vector line means the bigger the vector. The magnitude of a vector represents a quantity of physical quantities called scalar quantities. Physics quantities that only state great values, for example distance, rate, energy, power, and etc.

## 3. Methodology

This research was conducted at the Department of Physics at the State University of Manado in the class of 2018 students in the 2018/2019 school year. This study uses a Work-It-Out Teaching Strategy (WIOTS) learning strategy which consists of 6 stages: edge of ability, expert video and video watching workshop, analysis of the video / worksheet, focus activity, finishing the initial ZPD activity, group presentations. 1) Edge of ability: at this stage students are formed into groups of 4 people, and do the initial response to the challenge phase which is the maximum limit of the ability or activity of the Proximal Development Zone (ZPD). 2) Expert vidio and vidio-watching workshop: in this stage students watch videos that contain discussions conducted by experts and individually complete worksheets. 3) Analysis of the video / worksheet: at this stage students are asked to analyze the video. Before continuing on to the next step, the teacher will give a few minutes opportunity for students to practice what they have just learned to improve their final achievement. 4) Focus activity: at this stage students are asked to work in pairs and are asked to do concentration activities to practice what they have just learned. During this activity, the instructor interacts with students in one group with the group level providing timely support to assist students in their assignments. 5) Finishing the initial ZPD activity: at this stage the paired students are asked to return to their previous group to complete the ZPD activity. 6) Group presentations: at this stage the study groups then present their challenges in front of the class.

## 4. Results and Discussion

There are many research findings related to the representation of semiotics with the problem of vector subtraction as stated by Barniol and Zavala (2014). He argues that students still face some difficulties in vector subtraction written in unit-vector notation. There are 75% of students who answer correctly. Researchers found only one significant error (8%) where students incorrectly answered i + j. Students correctly subtract the x-component from vector (i), but incorrectly subtract the y-component from the (j) axis. Students add the y-component. It seems that the negative sign of the y-component of vector B is shaking them up. Difficulties faced by students are the signs in the calculation [7].

Based on the data analysis of the results of research conducted on the third and fifth semester students of the Department of Physics, Manado State University shows that there are differences in the average results of studying physics students. Before being given treatment the average physics learning outcomes of students measured by pretest was 20.6 while the average physics learning outcomes of students after being given treatment as measured by posttest was 65.3.

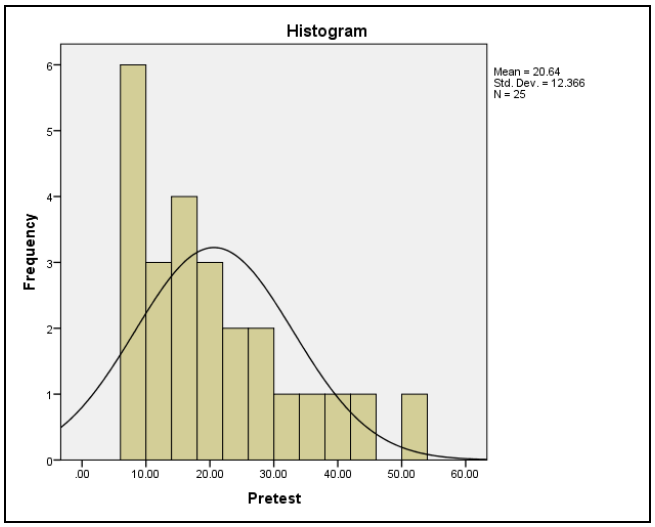


**Fig 2:** Histogram of Pretest Learning Outcomes Data

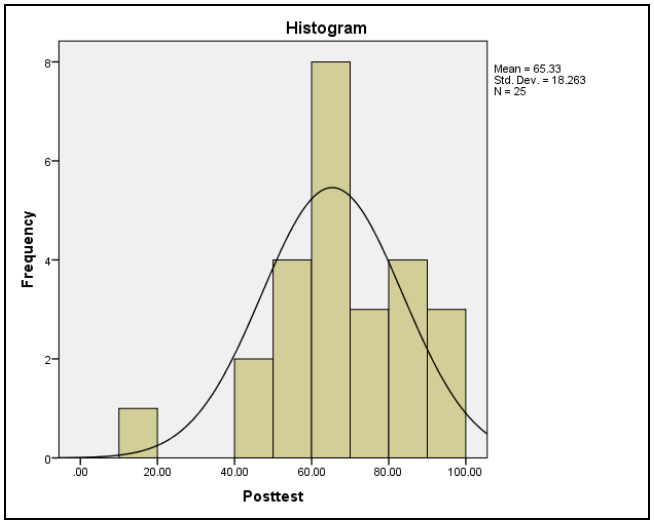


**Fig 3:** Histogram of Posttest Learning Outcomes Data

By using the normal distribution statistics (t test) performed on the pretest and posttest have significant differences as in the table below:

**Table 1:** One-Sample Test

| One-Sample Test | | | | | | |
|---|---|---|---|---|---|---|
| | Test Value = 0 | | | | | |
| | T | Df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Pretest | 8.346 | 24 | .000 | 20.64000 | 15.5358 | 25.7442 |
| Posttest | 17.887 | 24 | .000 | 65.33307 | 57.7944 | 72.8717 |

Based on the table above for the average of learning outcomes after being given the treatment, it was obtained tcount = 17.887 and ttable = 2.06390 with a significant level α = 0.05 and that obtained in the one-sample-test was obtained 0,000 which means 0,000 <0.05 so it can be concluded accept H1. This means that there are differences in the average pretest and posttest learning outcomes of students by using the WIOTS learning model on the application of vector representations in learning physics concepts about vector reduction.

## 5. Conclusion

Based on research that has been carried out on semester III and V students of Physics Department of Manado State University in vector learning, especially on the topic of vector subtraction discussion, it can be seen that the average physics learning outcomes of students are better after applying the WIOTS learning model with an average student physics learning outcome before applying the WIOTS learning model.

It can be concluded that the WIOTS learning model has a positive effect on student physics learning outcomes, especially on vector subtraction material because this WIO teaching strategy helps students be more independent because there is a high level of involvement of students with WIO activities.

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