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Work-it-out teaching strategy in physics learning equilibrium system

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Abstract
Some research shows that Physics Students have basic knowledge about Forces and even the Physics Students who have studied Basic Physics and Mechanics have significant difficulties with the Students who only studied Basic Physics. Compatible and creative learning models can improve the ability of students as individuals and socially. This research aims to identify the problems the students usually faces in solving basic physics problems, especially the Forces of Equilibrium System when a stairs leaning against a wall. The WIOTS (Work-It-Out Teaching Strategy) model can improve individual abilities by referring to ZPD or the Proximal Development Zone that can also improve the abilities of each individual as a social creature. Research that has been conducted to 26 Physics Students using the WIOTS model by gave them 2 tests, first is Pre-Test and then the treatment (lecturer) using WIOTS 6 stages, and finished it with second test, Post-Test. It showed that the minimum value obtained before the treatment is 22.00 while the maximum value is 78.00. After the treatment, minimum value obtained was 63.64 while the maximum value was 90.91. This shows that the treatment using the WIOTS Learning Model is proven to be able to improve the Physics Student learning outcomes in learning Physics of Equivalence of Objects.

Keywords: WIOTS, ZPD, equilibrium system

Introduction
In learning physics, it is often faced the new subjects or concepts that are even difficult to understand. Even ways to solve the problems related to physics concepts are also difficult. Differences representations such as experiments, equations, calculations, measurements, graphs and concept completion, also cause the students to agreed that physics is a difficult subject to learn. For example, students need to change the representation in graphic formed to mathematical formed. According to Dermici in "A Study About Students' Misconceptions in Force and Motion Concepts by Incorporating a Web-Assisted Physics Program", for 2 decades, research that has been done in the field of physics education shows the difficulties of students because of the lack of ability to perform formal operations which is aimed at studying physics. According to Funda Ornek, in "What Makes Physics Difficult?" (Ornek, 2008), was found that students and teaching assistants who took the tests that were given, and the results were not much different to each other. One of the causes are insufficient examples daily and problem solving, especially questions about concepts in the classroom, there are also several factors such as unused guidance, too many complex questions and difficult questions on the exam.
In "Students' Difficulties Regarding Vector Representations in Free-Body Systems" (2018) by C. Poluakan and J. Runtuwene (Poluakan, 2018) was explained that research had been carried out by giving questions that were often encountered in university physics, about mechanics especially when a ladder that is propped against a wall without friction and is erected on a rough floor. What is demanded from the case above is to identify the position and direction of the weight forces of the ladder, the position and direction of the normal forces on the wall and on the floor, the direction and position of friction on the rough floor, and the position of the Head-Tail of the vectors. The presentations obtained of the wrong answers from the two groups are not much different. Some of the errors identified from this presentation are the gravity W which was not resolved, the Normal N Force which was misplaced, and the Friction Force f which was placed where there should not be friction. In minimizing the lack of a basic understanding of physics, learning method are made that are claimed to improve understanding of physics so that it can also improve learning outcomes in physics. According to Christine Creagh in "Work-It-Out: A Strategy for Teaching First Year University Students 'Things They Should Already Know'" (Creagh, 2014) said that Work-It-Out Teaching Strategy is a strategy developed as part of the Australian Office of Learning and Teaching National Teaching Fellowship, which is to help students in the first year to improve the basic skills and communication skills that can be needed in the first year and also in the future.

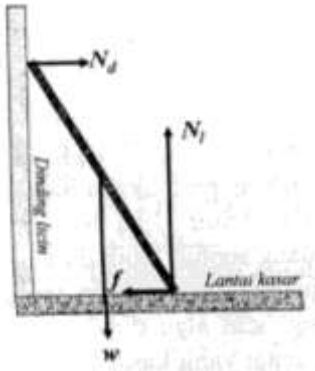

Fig 1

According to data from research reports conducted by C. Poluakan, to students of the Department of Physics at Manado State University by divided students into two

groups, the first group is a group of students who have passed the Basic Physics course. While the second group is a group of students who have passed the Basic Physics and also Mechanics courses. Was found that there were no significant differences between the mistakes made by the two of groups. Presentations for Normal N Forces errors not written by group I, incorrectly as much as 94% while group II incorrectly as much as 100%. For the Normal N Forces on the wrong places, the wrong answer from Group I is 69% while Group II is 90%. For Normal Forces N on the wrong floor, the wrong answers from Group I were 69% and from Group II 90%. For friction forces f is put in the wrong places (even though there is no friction) from Group I as much as 63% while from Group II as much as 95%. Then for the friction force f on the rough floor not written from Group I is as much as 69% while from Group II as much as 90%. And lastly for the friction force f on the floor that was not written, from Group I it was 81% while from Group II it was 90%.

Conceptual Framework

WIOTS (Work-It-Out Teaching Strategy)

Work-It-Out Teaching Strategy was first developed by Christine Creagh at Murdoch University of Australia 2014. In her research intended to help students in the first year to be able to pursue lessons and also add basic skills, especially communication skills that are claimed to be very necessary at the university. By doing activities using the WIOTS method, it can involve the basic abilities of students, activities and thought processes that experts usually do. At certain times students work alone, in pairs, or in groups which can increase interaction between students and can also promote existing learning communities. Regarding the stages that carried out in this strategy, are as follows:

1. Edge of ability

In this stage students are formed in groups of 4 people, and do the initial response to the challenge stage which is the maximum limit of the ability or activity of the Proximal Development Zone (ZPD). And in this case, challenges related to the WIOTS workshop material include:

- Reading textbooks for information and understanding
- Making diagrams to help in explanation and understanding
- Asking about formulas to trigger relationships and adding understanding in basic knowledge
- Designing experiments to complete a problem which also helps increase understanding in knowledge

2. Expert video and video-watching workshop

In this stage students watch a video that did by the experts, and individually finish the worksheets that had been given before the watching video stage starts. Before students watch the videos that have been prepared, first read the worksheets that will be done in order to know what really needs to be noticed.

3. Analysis of the video/worksheet

Next stage is, the students analyzes the video that had been watched before. And before move to the next stage, the students are given some time to train themselves in order to increase their knowledge for the last stage, presentation.

4. Focus activity

For this stage students are asked to work in pairs and do the concentration activities to practice what they have just learned.

5. Finishing the initial ZPD activity

The paired students were asked to be back to their previous group to complete the activity about ZPD.

6. Group presentations

The groups that formed on the first stage, then presents their challenges in front of the whole class.

Cognitive theory by Lev Vygotsky

M According to Mustafa Cakir in the “Constructivist Approach to Learning in Science and Their Implications for Science Pedagogy: A Literature Review” (Cakir, 2008), the work aspect of Vygotsky himself, who steals the most attention among teachers and psychologists is his argument for the basic culture of interpretation and understanding for the presence of "Proximal Zone Development". This refers to the idea that there is a zone for each student, which on one side is limited by the threshold of development that needed for learning, and the other is limited by the upper limit of the student's current ability to study material under consideration (Vygotsky, 1978).

Vygotsky believes that there is an important relationship and interaction between: what students learn are influencing the course of the development of the concepts that obtained from daily experiences and vice versa. The differences between the two categories of concepts is the presence and absence from a system.

To detail the size of learning, Vygotsky describes a very important concept: the Zone of Proximal Development (ZPD). According to him, ZPD is the distance between the level of actual development as determined by solving the independent problems, and the level of potential development determined by the solving problems under adult guidance or collaboration with peers who are considered more capable.

Physics Concepts

If there is an object:

1. A book placed on a table,
2. A hockey chip is launched at a constant speed on a surface without friction.

The objects above can be said to be in equilibrium. The following equilibrium conditions:

1. Constant Linear Momentum $\vec{P}$
2. Constant Linear Momentum $\vec{L}$

The core of the discussion is if the above constant situation is equal to zero; It can be broadly focused on immovable objects, both translational and rotational, on observed objects. So, this object can be said to be in a state of equilibrium. Terms of Equilibrium Translational motion in matter is regulated in Newton's Second Law in the form of linear momentum, below:

$$\vec{F}_{net} = \frac{d\vec{P}}{dt}$$

If the object is in a state of translational equilibrium, then $\vec{P}$ is constant so $d\vec{P}/dt = 0$ will be obtained $\vec{F}_{net} = 0$ (force balance).
Rotational motion on matter is regulated in Newton's Second Law in the form of angular momentum, below:

$$\vec{\tau}_{net} = \frac{d\vec{L}}{dt}$$

If the object is in rotational balance then $\vec{L}$ is constant obtained $d\vec{L}/dt = 0$, we get $\vec{\tau}_{net} = 0$ in other words torque balance. Then the two statements fulfill:

1. The sum of all force vectors that affect the object must be zero.
2. The sum of all the torque vectors that affect the object must be zero.

This is a condition of equilibrium. In equilibrium $\vec{P}$ and $\vec{L}$ are constant but not zero.
The two equations are the same vector equations as the three equations which say they all point to the axis coordinates:
Force balance Torque balance

$$F_{net,x} = 0 \qquad \tau_{net,x} = 0$$
$$F_{net,y} = 0 \qquad \tau_{net,y} = 0$$
$$F_{net,z} = 0 \qquad \tau_{net,z} = 0$$

N_d, the normal force of the wall is slippery against the ladder
N_l, the normal Forces of the floor is rough against the ladder
f, the frictional force between the ladder and the floor.

Method
The type of research used in this experiment is Quasi Experiment Research with the aim of comparing the learning outcomes of students who have not learned by using the WIOTS method with the outcomes that already done the WIOTS method. The plan of this research is carried out in the Department of Physics Education at Manado State University in the even semester of 2019. The subjects of this study were students in semester 1 and semester 3 in the 2018/2019 academy year. The research design used in this study is an experimental designed.
O_1 x O_2
O_1 = *Pre-Test*
O_2 = *Post-Test*
x = *Treatment*

In this study there are two variables, namely:
1. Conceptual Definition

The conceptual definition of this research is the use of the WIOTS (Work-It-Out Teaching Strategy) Method in learning the material physics of object balance, especially in the case of ladder propped against the wall.

20.Operational Definitions
The Operational Definition of this research is the learning outcomes of students who have applied the WIOTS (Work-It-Out Teaching Strategy) Method in learning the physics of Object Equilibrium especially in the case of ladder propped against a wall.
The instrument used in this study is test. The tests provided consisted of Pre-Test questions and Post-Test questions in the form of descriptive questions.

The Preparatory stages in the research procedure include
a. Carry out observations on the subject of research, with the aim of looking for problems faced by students in the learning process.
b. Develop Learning Implementation Plan on material equilibrium system topic.
c. Providing media and tools to support the implementation of the learning process.
d. Prepare assessment instruments in the form of Pre-Test and Post-Test questions.

3. Implementation stage
The implementation phase in the research procedure includes:
a. Provide Pre-Test questions for classes that have been determined.
b. Carry out the learning process with material equilibrium objects in accordance with the learning tools that have been prepared.
c. Provide Post-Test questions after applying the WIOTS method to material equilibrium objects.

4. Evaluation stage
The evaluation phase in the research procedure includes:
a) Processing data on the results of research that has been carried out.
b) Discussing research data that has been carried out
c) Arrange conclusions or results of research.

Data analysis techniques used in hypothesis testing consist of Descriptive Result Test, Normality Test and Hypothesis Test. All of which use the SPSS application (Statistical Package for the Social Sciences) version 2.2.
The research statistical hypothesis in this study is as follows.

$$H_0 : \mu_1 \leq 75$$
$$H_a : \mu_1 > 75$$

$H_0 : \mu_1$ = Use of the WIOTS (Work-It-Out Teaching Strategy) method in learning physics Material Equilibrium does not have a positive effect on student learning outcomes in the Physics Department in semester 3 and semester 1 at Manado State University.
$H_a : \mu_1$ Use of the WIOTS (Work-It-Out Teaching Strategy) method in learning physics Material Equilibrium has a positive effect on student learning outcomes in the Physics Department in semester 3 and semester 1 at Manado State University.

Results
This research was started by giving a test called Pre-Test to Semester 1 and Semester 3 Students in the Physics Department of Manado State University. Then proceed with learning adapted to the Work-It-Out Teaching Strategy

(WIOTS) Learning Method which consists of 6 Stages included Edge of the ability, Expert video, Analysis of the video, Focus activity, Finishing the ZPD activity, and Group presentations. Then given a final test called the Post-Test.
The following are descriptive results of students who before (Pre-Test) and after (Post-Test) the WIOTS learning method is applied to the object equilibrium material.

Statistic Descriptive Results Table

Table 1

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	26	22.00	78.00	45.2308	17.16114
Posttest	26	63.64	90.91	79.0210	8.33961
Valid N (listwise)	26				

Normality test results table

Table 2
One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		26
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	8.16176965
Most Extreme Differences	Absolute	.105
	Positive	.072
	Negative	-.105
Test Statistic		.105
Asymp. Sig. (2-tailed)		.200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

The results of the tests that have been carried out then do the Hypothesis Test because it has passed the Normality Test and it has been proven that the data is normally distributed. Following are the results of the Hypothesis Test found from the SPSS application.

Hypothesis Test Results Table

Table 3

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
HasilBelajar	20.676	51	.000	62.12500	56.0935	68.1565

Based on the results of the hypothesis test table with a real level $\alpha = 0.05$ and obtained from the t_{count} of 20.676 and t_{table} = 2.00758, it can be concluded accept H_a. With the acceptance of H_a means that it is proven that there are differences in the average physics learning outcomes in the material object balance in students who have applied the WIOTS (Work-It-Out Teaching Strategy) model.

Then based on the results of data retrieval that was carried out in November 2019 at the Physics Department Students Semester 1 and Semester 3, which have been carried out Statistical Tests found that there are differences in the results of the Pre-Test conducted before lectures that there are minimum values of 22.00 and maximum of 78 00 while the Post-Test value obtained by the WIOTS Model has been applied that the minimum value is 63.64 and the maximum value is 90.91.
And before doing the Hypothesis Test the Normality Test is performed first on the SPSS application which has been proven to be Normal Distributed because it gets a result of 0.200, which is more than 0.05.
Then from the results of the Data Normality Test which are proven to be Normal Distributed, then the Hypothesis Test is conducted. Based on the results of the Hypothesis Test with a real level $\alpha = 0.05$ and obtained from t_{count} of 20.676 and t_{table} = 2.00758, because $t_{count} > t_{table}$, it can be concluded accept H_a.

Conclusion

The research that has been conducted concluded that the use of the WIOTS (Work-It-Out Teaching Strategy) method in learning Physics of Equilibrium of Objects can improve student learning outcomes.
WIOTS Method is a learning method that focuses on students to develop themselves but still do not forget the life of socializing. So it is suggested that Teachers can try to use the WIOTS Learning Method on Physics material.

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