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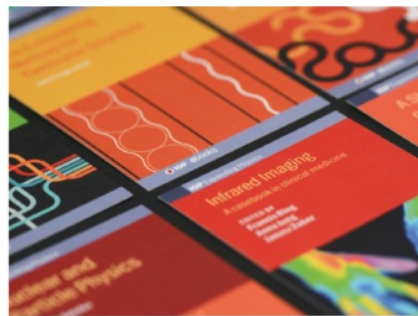
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Inquiry learning model with advance organizers to improve students' understanding on physics concepts

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Inquiry learning model with advance organizers to improve students' understanding on physics concepts

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Abstract. The inquiry model is one of the learning models that have the potential to train students' high-level skills and thinking. These activities require good initial knowledge of students. An advance organizer is one strategy that can be used to overcome this problem. The purpose of this study was to examine the effectiveness of the inquiry model with advanced organizers in improving students' conceptual understanding. The research design used was a non-equivalent pretest and posttest group. The research subjects were divided into two groups, namely the experimental group and the control group. Data were analyzed by N-gain test. The results showed that the understanding of the concept of the experimental group was better than the control group. Thus it can be concluded that the inquiry model combined with an advanced organizer is effective in increasing mastery of students' physics concepts. In general, the increase in the experimental group was higher than the control group both in the cognitive aspects and in each sub-material.

1. Introduction

Learning is defined as processing information and experience as a result of student interaction with learning resources and the environment [1]. Constructivists argue that during learning students are actively encouraged to build knowledge, find concepts, and develop thinking skills to solve problems [2]. It was found that the implementation of learning physics in schools lacked facilitating students to practice problem-solving [3] and understood concepts that were intact and good [4].

Physics is one branch of science that focuses on the study of matter, energy, and the relationship between the two [5]. Physics is built on concepts, laws, and theories written in physical quantities and mathematical equations [6]. This explains that understanding concepts is the main aspect of physics learning. Understanding of students physics concepts is closely related to constructive learning [7] and meaningful [8]. Meaningful learning is learning that is accompanied by an understanding that will occur if the new information received by students has a close bond with existing concepts or can be accepted and already stored in cognitive structures [9] so that it can encourage students to build their knowledge.

One constructivist model that can be used in physics learning is an inquiry model. Inquiry model is a learning model that gives students the experience of doing problem-solving through activities such as stating problems, formulating hypotheses, designing and conducting investigations, and making and evaluating conclusions [10]. Implementation of the inquiry model in learning can be carried out in four levels; namely, demonstration, structured, guided, and open [11].

Each level of inquiry has a different influence on the development of students' abilities. Rahmat & Chanunan [12] stated that the application of free inquiry has more potential in facilitating the development of skills of students who have high or low academic abilities. In addition, the application of free inquiry is more effective in improving students' conceptual understanding [13]. Understanding of concepts relates to students' ability to distinguish and build relationships between concepts. So we need a strategy that can help students who have low academic abilities to be ready to carry out inquiry activities and also help activate initial knowledge in the cognitive structure of students.

The cognitive structure of students is one of the main factors that regulate whether new material will be meaningful and how well it can be maintained [9]. One strategy that can be used in preparing and strengthening students' cognitive structure is an advance organizer (AO). AO is information presented in the form of concepts and relationships between concepts before learning, which aim to integrate new knowledge with the knowledge that students already have [9, 14].

Based on the description above, it can be concluded that AO is very suitable to be integrated with the inquiry model. Korur et al. [15] stated that the integration of AO with the 5E model effectively improved students' scientific learning achievement. In addition, the implementation of generative learning models with AO can improve students' physics problem-solving abilities [16]. This study aims to examine the effectiveness of the combination of inquiry with AO in improving the understanding of students' physics concepts in work and energy.

2. Methods

The research design used was a nonequivalent pretest-posttest control group [17]. Determination of samples is done by purposive sampling technique. The sample is high school students in Mataram, which are divided into two groups: the experimental group is 22 students, and the control group is 25 students. The experimental group was taught with a model of inquiry with AO for three meetings. While the control group uses a conventional model. Data was collected using test questions understanding concepts in the form of multiple choice. The concepts in problem are work and energy material which consists of several sub-material, namely work, kinetic energy, potential energy, power, conservative and non-conservative force, and conservation of mechanical energy law. The instruments of understanding concepts are arranged based on the cognitive aspects of Krathwohl's taxonomy which consist of C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), and C6 (create). So that in this study, three data will be discussed, namely the understanding of students' concepts in general on the concepts of business and energy, based on sub-material and aspects of cognitive levels. Data were analyzed using the N-Gain score to find out how much the students' understanding of the concept improved after being given treatment. The data is then interpreted in the low category (N-gain <30.0), medium (70.0> N-gain ≥ 30.0), high (N-gain> 70.0) [18].

3. Result and Discussion

Improved understanding of concepts in this study can be observed from the increase between students' pretest and posttest scores. The level of understanding of students' concepts is analyzed based on sub-material and indicators of understanding the concepts of physics in the matter of work and energy. Based on data of research, it was found that the average N-gain score of the experimental group was higher than the control group. However, the increase in understanding of the concepts of the two groups is still in the moderate category.
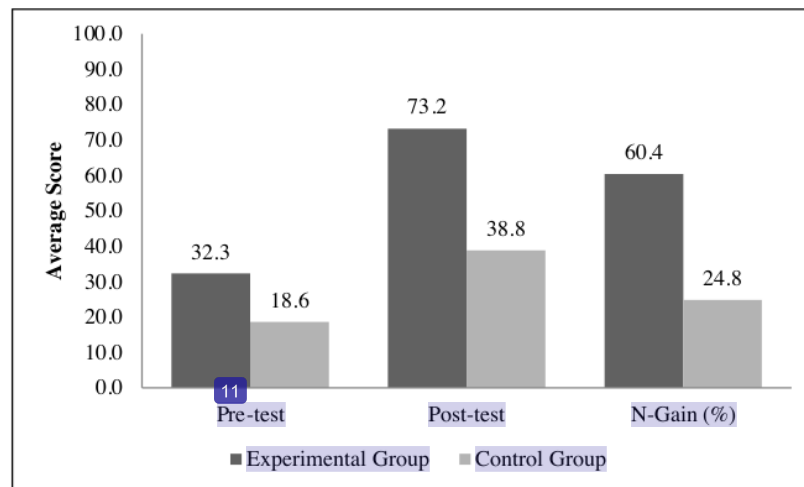
Figure 1. Comparison Average Score of Student Concept Understanding

Figure 1 shows that an improved understanding of the concept of higher in the experimental group than the control group. This increase occurred because of the application of the inquiry model with AO. This model can help learning meaningful for students. The presentation of AO before inquiry activities can help students know the conceptual framework to be studied, connecting experiences with concepts of work and energy [19]. AO is made based on the principle of reconciliation integrative and progressive differential will help the process of receiving and storage concepts in students' memories. The right use of AO in learning can improve students' cognitive learning outcomes [20].

In another study it was found that the use of models combined with appropriate learning media was proven to improve mastery of students 'physics concepts [21], and students' critical thinking skills, especially in making judgments about concepts [22].

The results of the study show that the inquiry model with AO increases students' understanding of the concept of work and energy. Tracker & Friedman [23] states that AO can help students organize information during the implementation of inquiry learning models. According to Korur et al. [15] that the integration of the 5E model with AO effectively improves student learning outcomes in physics material. Hasbiyaloh et al. [24] and Harjono et al. [25] stated that the application of learning models with AO had a positive influence on improving student physics learning outcomes.
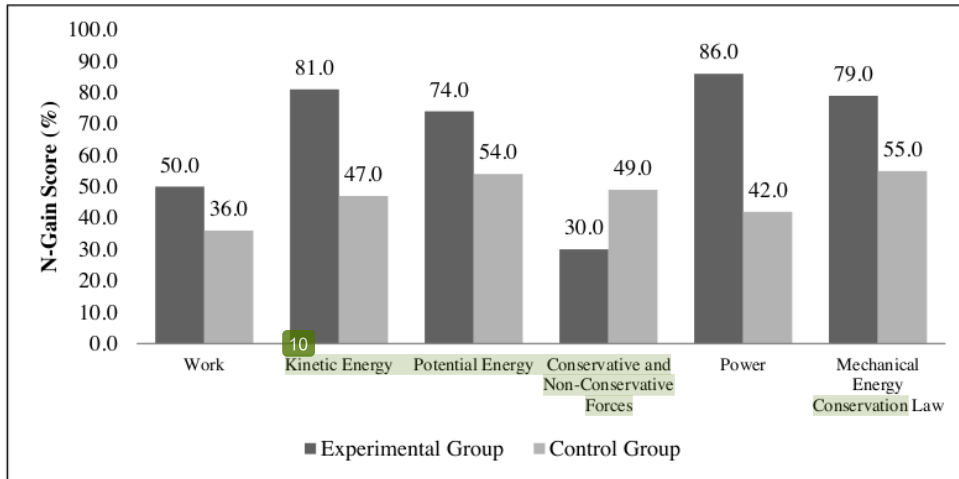
Figure 2. Comparison of Improvement Score of Students in Each Concept

This study also reviewed the level of students' conceptual understanding of the concept of work and energy, as shown in Figure 2. Understanding of students in the experimental group scored the highest on the power concept and the lowest on the concept of conservative and non-conservative force. While the highest score control group on the concept of potential energy and the lowest on the work concept. Understanding of students in the experimental group was higher than the control group in almost all concepts except for the concept of conservative and nonconservative force. These results are due to the students' ability to apply the equation is still lacking in this concept. This is because students do not practice to solve the same problem with the test. In addition, students' ability to describe the forces acting on a system still needs to be improved. Many students cannot solve the problem with this concept.
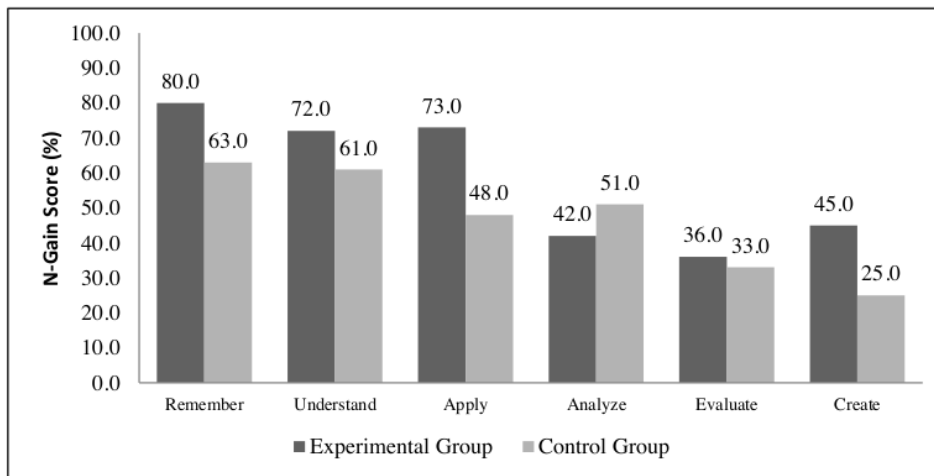

Figure 3. Comparison Improvement of Students' Concept on Each Cognitive Aspect

Comparison of differences in cognitive level increase between the experimental group and the control group can be seen in Figure 3. Based on Figure 3, the highest increase in cognitive aspects in the two groups occurred in the remembering and lowest aspects in the experimental group while the control group was creative. Understanding of students in the experimental group in each cognitive aspect is

generally higher than the control group, except in the evaluation aspect. This is because students do not yet understand the concept of conservative and non-conservative forces, which makes students unable to compare large differences in the effort produced by conservative and non-conservative forces. In general, the level of understanding of students in the experimental group is higher than the control group on cognitive and sub-material aspects of work and energy. Inquiry learning models and AO allow students to interpret and build their knowledge. According to Kusdiastuti et al. [26], the application of the inquiry model can increase students' understanding of concepts. Guided inquiry model combined with the use of computer technology has been proven to improve students' science process skills in physics, especially in hypothesizing, practicing, and communicating [27]. Hermansyah et al. [7] stated that the use of inquiry models helps students develop the ability to analyze, evaluate, and create through experimental activities to solve problems.

4. Conclusion

The implementation of inquiry model with AO in physics learning can improve students' understanding of work and energy concept. Improvement understanding of the concept in the experimental group is higher than the control group in every cognitive level and sub material aspect of work and energy concept.

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