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The Effect of Scaffolding-Based Worksheet in the Discovery Learning Model on Physics Learning Outcomes

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ABSTRACT

Physics learning outcomes are underdeveloped because the learning model is still teacher-centered and needs to involve by teaching materials that enhance the learning process. The discovery learning model, is one of learning model that can enhance physics learning outcomes, which involves engaged and student-centered. Media and teaching materials must support the applied discovery learning model by using the worksheets with scaffolding are effective and practical for the discovery learning model. This study aims to see whether there is an effect of the application of scaffolding-based worksheet in the discovery learning model on the physics learning outcomes of students.

The type of research conducted was a quasi-experiment using the Randomized Posttest Only Control Group Design. The population of this study were all students of class XI.F of Senior High School in Padang. Sampling was done with Purposive Sampling technique. Data analysis techniques used are normality test, homogeneity test and hypothesis test.

According to data analysis with hypothesis testing obtained $t_h<t_t$ *where 2.129<1.667* H_0 *is rejected and* H_1 *is accepted, it can be concluded in the study that application of scaffolding-based worksheet in the discovery learning model has a significant effect on the physics learning outcomes on the knowledge aspect. The results of this study are used as input for teachers and prospective teachers. Improve themselves in connection with the teaching that has been done and the student learning outcomes that have been achieved by varying the learning model with the appropriate learning media to improve student physics learning outcomes.*

Keywords: Worksheet, Scaffoling, Discovery Learning Model, Physics Learning Outcomes

I. INTRODUCTION

Enhancing the caliber of human resources can be achieved through education, which is a methodical and structured endeavor to create a conducive learning atmosphere and process. Its objective is to enable students to actively cultivate their inherent potential and acquire traits that are deemed essential by themselves, the society, the nation, and the state, including but not limited to, religious and spiritual fortitude, self-discipline, personality, intellect, and moral values. [1]. Education is also defined as the process of influencing students both physically and mentally so that they can adapt well to the environment, so from this statement education can instill positive values in students [2]. The progress of a nation cannot be separated from educational factors, because education has an important role in efforts to improve human resources which are an important element in advancing and improving the quality of education by improving the quality of the teaching and learning process. However, the current situation and condition of education in Indonesia is quite alarming.

The demands of education in the 21st century are increasingly becoming more complex, demanding superior quality human resources that are critical, creative and innovative [3]. The development and change of life in society as a result of the utilization of information and communication technology is very fast. This has led to the expectation of achieving very high student learning outcomes because technology is considered capable enough to help students in the learning process. In fact, if reviewed further, the factors that may improve learning outcomes are not only the use of technology, but the role of teachers in using media and innovative learning models.

Physics is a subject that studies the nature and symptoms of nature [4]. In reviewing physics lessons at the high school level, most students find physics difficult to understand. The higher the level of education, the more complex the material taught. Students' lack of interest in learning physics results in low physics learning outcomes.

Learning outcomes are a student's level of success in learning which will be expressed by the value obtained through a test of the subject matter. Learning outcomes are one indicator of the learning process which includes three aspects, namely: attitudes (affective), knowledge (cognitive), and skills (psychomotor) [5]. The importance of studying physics for students includes helping students solve real-life problems related to physics and being able to prove the truth of a theory or concept that has existed before. Physics always prioritizes concepts so that from there a mathematical formula for certain materials is obtained.

In order to encourage an effective communication between students and teachers during the physics learning process, teachers must be extremely selective in innovative learning models they have chosen. The model in physics learning serves to facilitate teachers in teaching students to more easily understand the material presented based on syntax / steps that have been structured in such a way, so that will be able to promote student learning outcomes [6]. One of the cutting-edge educational approaches is the discovery learning model. This approach strives to encourage students to independently explore learning concepts, which implies that the learning material is not presented in its entirety, but rather requires students to arrange and cultivate their own knowledge and abilities to tackle problems [7]. Due to the fact that the focus of learning is primarily on the student and the teacher simply serves as a facilitator, this model is able to produce engaged and meaningful learning. The discovery learning model's syntax consists of stimulation, problem formulation, data gathering, data processing, data verification, and generalization. [8].

To promote the effectiveness of the learning models utilized and enhance student learning outcomes, learning media utilization is just as crucial as choosing cutting-edge learning models [9]. In order for students to obtain the desired learning outcomes, learning media must be pertinent to the learning model being used in learning activities. The quality of the learning process will improve, as will the student learning outcomes as a measure of educational achievement, if a teacher is able to effectively collaborate learning models and learning media.

Worksheet is one of the learning tools that can be applied. Worksheet are worksheets that have assignments for pupils to complete. Worksheets typically take the form of stages and instructions to finish a task [10]. The benefit of this worksheet for teachers is that it makes it simpler for them to conduct educational activities, while the benefit for students is that they will learn independently and develop their comprehension and ability to complete written projects.

One of the weaknesses of the discovery learning model is that students who have less ability at the beginning of learning will experience difficulties in the form of mindsets that tend to be abstract (not directed) towards the problem under study, possibly because the topic chosen is out of context so that students have difficulty connecting the physics concepts found, and eventually cause frustration in students [11]. Therefore, teachers need to vary the discovery learning model with worksheet assisted by scaffolding.

Scaffolding refers to giving students the necessary support when learning and understanding concepts in order to increase their capacity for learning [12]. The type of scaffolding in question is conceptual scaffolding which is described as assistance given to students to analyze complex problems so that they can be solved by students. Conceptual scaffolding provides a conceptual foothold to students who need more understanding. So that conceptual scaffolding can make students not confused and make it easier for students to find physics concepts in the worksheet that will be used.

Students are initially motivated to foster their individual creativity, drive, and proficiency. Then, by completing the provided framework, students gather information and develop their own skills. When students are able to complete the lesson, scaffolding assistance can be scaled back or even discontinued. Therefore, student learning results will dramatically improve if the instructor is able to implement the discovery learning paradigm while receiving scaffolding [13]. Therefore, it can be claimed that scaffolding is used in this study to facilitate learning for students by including it into the worksheet and the discovery learning model's syntax [14].

The use of scaffolding-based worksheet in the discovery learning model does not only contain questions that students must do, but there is scaffolding assistance in the form of questions that stimulate students' thinking in solving physics concepts and providing tutorials to support the implementation of work procedures so that concept discovery time is more effective and efficient. According to the aforementioned explanation, the aim of this research is to evaluate the impact of scaffolding-based worksheet in the discovery approach to learning on the academic achievements of students from Senior High School in Padang in the subject of physics. While the research hypothesis H_0: There is no effect of scaffolding-based worksheet in discovery learning model on student physics learning outcomes and H_1: there is an effect of scaffolding-based worksheet in discovery learning model on student physics learning outcomes.

II. METHOD

The research methodology employed here in is the quasi-experimental approach. While this method incorporates a control group, it is not entirely effective in regulating external variables that influence the experiment's execution [15]. In conducting this study, the sample population was segregated into two groups: the experimental group, which received scaffolding-based worksheet treatment in the discovery learning model, and the control group, which was administered worksheet from the school utilizing the discovery learning model.

The methodology of this research consisted of a randomized posttest only control group. The experimental group and the control group are not chosen at random in this approach. The experimental group and the control group are both compared in this design after getting treatment. Treatments for the experimental class and the control class were different. In contrast to the control class, which used worksheet from the school, the experimental class used scaffolding-based worksheet in the discovery learning model. A posttest, or test provided after the learning activities are completed, will be administered following the administration of each treatment with the goal of determining the students' final learning outcomes. [16]. The research design can be seen in table 1.

Table 1. Research Design

Class	Treatment	Posttest
Experiment	X_1	O
Control	X_2	O

(Source: Ref [17]**)**

All of the class XI Phase F (science-physics division) students at Senior High School in Padang who were enrolled in the even semester of the 2022–2023 academic year comprised the study's affordable population. Purposive sampling was used to conduct the sampling for this investigation. The sample selection was carried out with the consideration of the subject teacher who categorized two classes that were homogeneous and had the same average ability in terms of the results of the daily assessment and the final assessment of the odd semester. The two classes were class XI Phase F.6 as the experimental group and class XI Phase F.5 as the control group.

The variables in the study include: The independent variable is the scaffolding-based worksheet in the discovery learning model, the dependent variable is the physics learning outcomes of high school students and the control variable is the same learning model, the material used is the same according to the independent curriculum, the number and type of questions tested in both classes are the same.

The research procedure consists of 3 stages including the planning stage, the implementation stage and the completion stage. The planning stage is the initial stage of making a research proposal, determining the research site, determining the research sample class, preparing learning tools and assessment instruments. The implementation stage is the stage of applying media and learning models in experimental and control classes as well as the stage of data collection during the learning process. The completion stage is the stage of collecting and processing data then analyzing the data and then completing the research report.

The information presented in this research pertains to the academic achievements of students in the field of physics, specifically in regards to their comprehension of temperature and heat topics. The data collection technique used the final test questions in the form of multiple choice as many as 30 questions. The items used in this test have been tested for validity, reliability, difficulty level and differentiation. The data analysis technique uses normality test with liliefors test and homogeneity test with F test. Data requirements are normally distributed $L_h < L_t$ and data requirements have homogeneous variance $F_h < F_t$. After the data is normally distributed and homogeneous, hypothesis testing is carried out with the t test to determine whether H_0 is accepted or rejected. H_0 testing conditions are accepted if $t_h < t_t$ and H_0 is rejected if it has another price at a significant level of 0.05. After processing the data, it is then analyzed and conclusions are drawn in the study.

III. RESULTS AND DISCUSSION

A. Results

The data found in this study is in the form of physics learning outcomes students in the aspect of knowledge (cognitive). The physics learning outcomes data was obtained through a written test at the end of the research activities in the form of objective questions as many as 30 items. This test was given to both sample classes after each was applied to different treatments. Based on the results of statistical calculations, the mean value, standard deviation and variance of the experiment and control groups are obtained in table 2 below.

Table 2. Mean, Highest, Lowest, Standard Deviation and Variance of Sample Classes

Class	N	Values		$\bar{X}$	S^2	S
		Highest	Lowest			
Experiment	35	97	57	82	149.652	12.2332
Control	35	90	40	73	162.608	12.7518

According to table 2, the mean score of the experimental group in knowledge-based physics learning outcomes is greater than that of the control group. Additionally, the standard deviation of the experimental group is lower than that of the control group, signifying that the physics learning outcomes of the experimental group are more uniformly distributed than those of the control group. The variance value of the experimental group is lower than that of the control group, which suggests that the physics learning outcomes of the control group are more diverse than those of the experimental group.

Data was analyzed to figure out if the adoption of scaffolding-based worksheet in the discovery learning model on physics learning material temperature and heat improved learning outcomes for students in class XI Phase F Senior High School in Padang. Statistics can be used to demonstrate how scaffolding-based worksheet is used in the discovery learning model. The homogeneity and normality tests that were previously performed on the two sample groups' means are compared during the hypothesis testing process.

In order to determine if the sample class is derived from a standard population, the Liliefors test is utilized to conduct a normality examination. The normality examination yielded the values L_h and L_t at a significance level (α) of 0.05 for N = 35, as shown in table 3.

Table 3. Calculation Results of the Normality Test of the Final Test of the Sample Class Knowledge Aspects

Class	A	N	L_h	L_t	Description
Experiment	0.05	35	0.1066	0.1498	Normal
Control		35	0.1088	0.1498	Normal

According to table 3, it can be seen that both sample groups have a value of $L_h < L_t$ at the real level of 0.05, indicating that the final tests of both samples are normally distributed.

Once the test for normal distribution is conducted, the next step is to perform the homogeneity test in order to determine if the variances of the two sample groups are uniform. Table 4 presents the outcomes of the homogeneity test computation.

Table 4. Results of Homogeneity Test Calculation of the Final Test of the Sample Class Knowledge Aspect

Class	A	N	S^2	F_h	F_t	Description
Experiment	0.05	35	149.652	1.0866	1.30435	Homogen
Control		35	162.608			

According to table 4, it can be seen for both sample classes at the real level of 0.05, it can be seen that the value of F_h is 1.0866 and F_t at $dk_{numerator}$ 34 and $dk_{denominator}$ 34 is 1.30435. The results show that $F_h < F_t$, this means that the data of the two sample group have a homogeneous variance.

The test of hypothesis employs the two-sample t-test to determine whether the hypothesis should be accepted or rejected. This test is carried out subsequent to the normality test and homogeneity test. Since it can be deduced from both the normality test and homogeneity test that the samples are normally distributed and have uniform variances, the t-test is used to determine the findings of the hypothesis. Table 5 displays the computed results.

Table 5. Calculation Result of Hypothesis Posttest of Sample Class Knowledge Aspect

Class	1-α	N	$\overline{X}$	S^2	t_h	t_t
Experiment	0.95	35	82	149.6521	2.851	1.667
Control		35	73	162.6084		

From table 5, it can be seen that t_h = 2.129 while t_t = 1.667 with the test criteria H_0 is accepted if $t_h < t_t$ and H_0 is rejected if it has another price at a significant level of 0.05 with degrees of freedom dk = (n1 + n2) - 2. Because the price of t is not in the H_0 acceptance area, it is concluded that H_1 is accepted at a significancy level of 0.05.

According to statistical analysis has conducted from the data of the two sample classes, it can be seen that there is a significant effect on the application of scaffolding-based worksheet in the discovery learning model in the knowledge aspect. The acceptance and rejection curve of the null hypothesis can be seen in Figure 1 below.

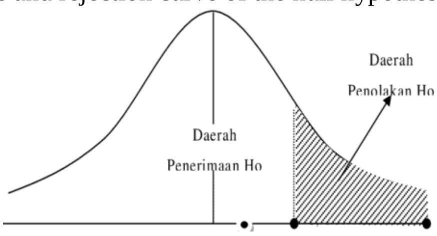

Fig 1. Acceptance and Rejection Curves of the Null Hypothesis

Based on Figure 1, the hypothesis acceptance curve on the knowledge aspect shows that t_h is in the H_0 rejection area, which means that the difference in treatment in the two sample classes has an effect. So, there is a significant effect of using scaffolding-based worksheet in the discovery learning model on physics learning outcomes of students in class XI Phase F Senior High School in Padang in the knowledge aspect.

B. Discussion

The previously stated tentative proposition, which posits that "there is an effect of scaffolding-based worksheet in discovery learning model on student physics learning outcomes" is supported by the results of the analysis of data on the students' physics learning outcomes. This is due to the advantageous outcomes of the scaffolding-based worksheet in the discovery learning model on the knowledge aspect of physics learning. This is demonstrated by the fact that students who study using scaffolding-based worksheet in the discovery learning model achieve higher average final test scores than students in classes that simply use worksheet from the school.

While scaffolding-based worksheet is used in discovery learning model, student learning outcomes in physics improve because worksheet gives students more direction on finding issues in physics and tends to make them more engaged in learning process activities [18]. The adoption of discovery learning models can transform passive learning situations into active and creative ones, which supports this argument. The use of worksheet also helps students become more independent and find their own thoughts. Additionally, the benefit of worksheets for students is that they will learn to read, comprehend, and complete written assignments on their own. [19]. This causes students' physics learning outcomes to improve.

Based on the results of monitoring student engagement throughout the educational experience, it has been determined that the experimental group displays a greater level of activity when compared to the control group. In general, students in the experimental class shown eagerness and enthusiasm for learning, as evidenced by their happy expressions and lack of tenseness when engaging in the session, giving the impression that they were serious about their studies and that student-teacher interaction was successful. The findings of the worksheet completed by the experimental class's students also demonstrate that students are able to identify the concepts of temperature and heat in a thorough and organized manner in accordance with the worksheet's procedures. Additionally, students have complied with all instructions for each exercise, both throughout

The worksheet utilized in the experimental class is one that the researcher created. It is the goal of this worksheet to make it simpler for students to understand and complete the worksheet's tasks. In order to make it simpler for students to follow the established procedures, scaffolding is also provided for the content of the worksheet in the form of questions to focus concentration, QR codes containing practicum tutorial videos, and other tools. Then, in accordance with the current syntax, this worksheet is implemented in learning process utilizing the discovery learning model. Students find the topics they learn on their own thanks to the discovery learning model's syntax. Students digest information using the discovery learning model as a mental process [20]. Therefore, scaffolding helps students learn effectively, efficiently, and enjoyably because it stimulates students' minds. [21]. Moreover, the provision of scaffolds facilitates the assimilation of information by students. In syntax of the discovery learning model, teachers also provide guidance, motivation, examples, keywords or other things that can lure students towards independent learning. [22]. Then the teacher encourages students who have high Zone of Proximal Developement (ZPD) to help students with low ZPD in solving worksheet. This causes students as a whole to understand the subject matter more deeply and remember it again easily. The preparation of worksheet also utilizes textbooks and other information source materials so that it can become worksheet that can improve students' physics learning outcomes. In addition to the use of worksheet, there are several other factors that influence the improvement of students' physics learning outcomes, one of which is the teacher. Other factors are student environmental factors such as parents, friends and the environment, all of which cannot be controlled by the teacher.

When conducting research using scaffolding-based worksheet in the discovery learning model, researchers experienced several obstacles. The first obstacle is students who are not familiar with the discovery learning model and scaffolding-based worksheet. During learning process, it is expected that all students are active in learning activities and discover the concepts learned themselves. However, in reality there are still students who do not understand the steps of the scaffolding-based worksheet in the discovery learning model. To overcome this obstacle, teachers are expected to explain the definition and steps of discovery learning model before the learning process.

The second obstacle, when carrying out experiments, is the difficulty of controlling time and all student activities because students feel interested and curious about the experimental tools that will be used. To overcome this, at the time of the experimental activities tried to supervise students closely, so that the time to carry out the experiment could be used effectively and efficiently.

The third obstacle, there are still some students who do not read and understand the activity objectives and learning objectives in the scaffolding-based worksheet, so they do not understand the subject matter and learning activities contained in the worksheet. To overcome this, the teacher tried to guide students and remind them to read the worksheet properly and correctly.

IV. CONCLUSION

After conducting research using scaffolding-based worksheet and data processing, disparities in the findings of physics learning outcomes were obtained in the experimental and control classes. It was observed that students who were taught through scaffolding-based worksheet in the discovery learning model had an average score of 82 on the knowledge aspect, whereas those who were taught using worksheet from school had an average score of 73. This indicates that the average academic progress of the experimental group was superior to that of the control group.

The implementation of the scaffolding-based worksheet in discovery learning model has a positive influence on physics learning outcomes. The results of this study are used as input for teachers and prospective teachers to improve themselves in connection with the teaching that has been done and the student learning outcomes that have been achieved by varying the learning model with the appropriate learning media to improve student physics learning outcomes.

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