The Influence of Discovery Learning Model using PhET and Scientific Skills of Class XI High School Students

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Abstract. This study aims to determine the effect of interaction between discovery learning models and scientific attitudes on students metacognitive skills. The method used in this study is a quasi experimental design of treatment by level 2x2. The number of samples in this study was 144 high school grade XI students. The sample was divided into two, namely the control class and the experimental class. The control class was given learning using the free discovery model while the experimental class uses the guided discovery model by having high and low student scientific attitudes. After treatment was given to both groups, a test was conducted to find out the students metacognitive skills. Then compare the two results to see the interaction between learning models and scientific attitudes towards students metacognitive skills.

1. Introduction

One of the keys to a person's success in the world of reform is the mastery of metacognitive abilities [1]. Metacognition is one of the main issues in science education. Metacognitive skills are one of the skills that students must possess in the curriculum. are important skills that can equip students in the life of the century [2].

Educational experts view the exact sciences as not only consisting of facts, concepts, and theories that can be memorized, but also consisting of active activities or processes using scientific thoughts and attitudes in studying problems or natural phenomena that cannot be explained. The ability of students to process solving problems is one of the benchmarks in achieving physics learning [3].

There is one interactive simulation learning media called Physics Education Technology (PhET). PhET is an interactive simulation of physical phenomena, based on research that is provided free of charge. There are several physics simulations in PhET, including simulations of waves. By using PhET students can encourage students to investigate various kinds of real and abstract material.

The use of the Guided Discovery learning model helps to outline the early stages of 21st-century skills, learning developed to encourage educators, service providers, learners, administrators, and policymakers to achieve learning goals. In the 21st century, educators must help build an understanding of knowledge and skills in the learning environment. Learning in the 21st century emphasizes 4c, namely communication, collaboration, critical thinking, and creativity. Several studies have shown that the Guided Discovery learning model has a positive impact on the scientific and metacognitive attitudes of students. The research conducted shows that the practical guide based on the discovery learning model can improve metacognition in every student [4].

Based on the description of the results of observations and preliminary studies, it was found that learning activities have not raised problem-solving problems for students, but only invite students to verify the facts of the concepts that have been conveyed by the teacher. Likewise, in practicum-based learning, students are not faced with problems that must be solved, so that students do not find facts,
concepts, theories as a result of their findings. This is due to the limited time for effective learning and
the lack of teacher ability in understanding the appropriate model in the delivery of each physics
material which has different characters.

This study aims to determine the comparison between the Guided Discovery learning model and
the Free Discovery learning model on the metacognitive abilities of students in terms of scientific
attitudes in class XI MIPA students.

2. Method
The method used in this study is a quantitative research method with an experimental design, namely
quasi-experimental or Quasi-Experimental Design with a two-way Anova research design or treatment
by level 2x2. In this research design, there are two independent variables, namely the learning model
as a variable treatment and scientific attitude as an attribute variable, and one dependent variable,
metacognitive skills. Each independent variable is classified into two types, namely the guided
discovery learning model and the free discovery model, while the scientific attitude consists of a high
scientific attitude and a low scientific attitude.

| Scientific Skills | Learning Models |
|-------------------|-----------------|
|                   | Free Discovery   | Guided Discovery |
| High              | A_1B_1           | A_2B_1           |
| Low               | A_1B_2           | A_2B_2           |

The quasi-experimental form has a control group, but cannot function fully to control external
variables that affect the implementation of the experiment. In this design, neither the experimental
group, nor the control group was selected randomly[5]. Instead, before being given treatment to both
groups, a pretest was carried out to determine the extent to which the students' basic abilities were in
the concepts to be studied. Furthermore, the two groups were given different treatments, namely, the
experimental group was given learning treatment using the Guided Discovery model and had high and
low scientific attitudes. While the control group was given learning treatment using the Free
Discovery model and had high and low scientific attitudes. After being given treatment to both groups,
a posttest will be conducted to determine the extent of the students' metacognitive skills [6].

3. Result and Discussion
The results of the analysis of the average metacognitive score in each data group are presented in
Table 2. Based on the data in Table 2 explains that: 1) the metacognitive of students who learn by
applying the free discovery learning model is lower than students who learn by the guided discovery
learning model, 2) the metacognitive of students who have high scientific attitudes is greater than
students who have low scientific attitudes, 3) students who have high scientific attitudes,
metacognitive students who are taught by applying the free discovery model are lower than students
who are taught by guided discovery learning models, and 4 ) in students who have low scientific
attitudes, metacognitive students who are taught by applying the free discovery model are lower than
students who are taught by the guided discovery learning model.
Table 2. Average Metacognition Scores for Each Group.

| Scientific Skills | Learning Models | Total |
|-------------------|----------------|-------|
|                   | Free Discovery | Guided Discovery |       |
| High              | 42.65          | 42.85  | 42.75 |
| Low               | 38.80          | 46.30  | 42.55 |
| Total             | 40.28          | 43.88  |       |

The results obtained to state that in achieving learning outcomes, the guided discovery learning model is better than the free discovery learning model. This is because, in the free discovery learning model, students determine the goals and desired to learn experiences, the teacher only gives students' problems and learning situations. Students examine the facts or relationships contained in the problem and conclude (generalizations) from what students find. While in the guided discovery learning model, the teacher provides examples of specific topics and guides students to understand the topic.

Before testing the hypothesis, the normality test and homogeneity test were carried out using IBM SPSS software. Normality test was performed using the Shapiro-Wilk test. From the results of the calculation of the normality test, it was found that the students' metacognitive data were normally distributed. Homogeneity variations were tested using Levene's test. The results obtained from the Levene test stated that the students' metacognition between groups of learning models was homogeneous. After the normality test and homogeneity test were carried out, the hypothesis was tested using ANOVA [7]. The results of hypothesis testing indicate that the effect of the learning model on students' metacognition is significant so that students who learn through the free discovery learning model get lower scores than students who are taught by applying the guided discovery learning model, while the main influence of scientific attitudes on metacognition is not significant. There is also a significant interaction between learning models and scientific attitudes. For students who have a low scientific attitude, the guided discovery learning model produces higher metacognition than the free discovery learning model. For students who have a high scientific attitude, the learning model has no significant effect. The interaction between the discovery learning model and scientific attitude states that the discovery learning model has a significant impact on increasing students' metacognition. The Discovery learning model is one of the methods in teaching cognitive theory by prioritizing the teacher's role in creating learning situations that involve students in active and independent learning. The Discovery learning method is a teaching method that regulates teaching in such a way that children acquire knowledge that they previously did not know, not through notification, partially or wholly discovered by themselves [8].

During the learning process, students who have a low scientific attitude learn by applying the free discovery model have difficulty adapting to the stages in the free discovery learning model. Meanwhile, students who have a high scientific attitude seem easy to adapt to the stages in the free discovery and guided discovery learning models. Students show a more positive attitude towards guided discovery learning than free discovery learning. Students prefer to study with research procedures provided by the teacher. Whereas in free discovery learning, learning is student-centered and not teacher-centered, so that students determine the goals and desired to learn experiences, the teacher only gives problems and learning situations for students. Students examine the facts or relationships contained in the problem and conclude what students find.

4. Conclusion
Based on the research results obtained by analyzing the data, it can be concluded that the metacognitive of students who learn by applying the free discovery learning model is lower than students who learn through the guided discovery learning model. Based on hypothesis testing, there is a significant difference in metacognition between students who are learned to apply the free discovery
learning model and students who learn to apply the guided discovery learning model, and there is a significant interaction effect between the learning model and students' scientific attitudes towards students' metacognition learning outcomes.

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