

## META-ANALYSIS OF THE EFFECT OF DISCOVERY LEARNING MODEL ON PHYSICS LEARNING OUTCOMES

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### ABSTRACT

*The purpose of this study is to learn the great impact the discovery learning model has on learning, based on education and lesson materials. The kind of research is a meta-analysis. The subject of this study is 24 scientific articles published by some journals from 2015 to 2020. Research instruments of coding sheets. For the impact of the discovery learning model on high school education, it has a moderate category with the effect size of 0.72 and the ladder junior high school education has high ratings on an effect size of 1.26. the impact of the discovery learning model on lesson materials has a moderate category with an effect size range of 0.67 to 0.80. As for high ratings, it has an effect size of 1.20. In general, the discovery learning model affects the study of physics.*

**Keywords:** *Meta-analysis, Discovery learning, Learning outcomes*

### INTRODUCTION

Currently, learning outcomes have not been able to achieve scores above the average. This is influenced by teachers who still have not varied learning models and predominantly use conventional learning models. Learning outcomes are influenced by the learning model.

One of the learning models that can improve student learning outcomes is the *discovery learning* model. *Discovery learning* is a teaching model designed with the aim of helping students develop thinking skills and problem-solving skills, emphasizing the importance of helping students to understand the idea of a discipline, involving student activeness in the learning process and ensuring that learning occurs through discovery (Marizal Fitri, 2015). Learning *discovery learning* model students are required to learn for themselves through activeness with the concepts and principles that exist in the learning process (Ruth Fika, 2018). From the quotation, it can be concluded that *discovery learning* is one of the learning models that invites students to be more active and confident in their learning outcomes.

According to research conducted by Adlina, Sondang R, et al (2019) states that the effect of student learning outcomes applying the *discovery learning* model assisted by PhET simulation is higher than the learning outcomes of students who apply conventional learning models. Sartika Harahap and Abubakar (2019) stated that the learning outcomes of students who apply the *discovery learning model* are higher than the learning outcomes of students who apply conventional learning models. Rika Sari Indah Harahap and Eidi Sihombing (2015) concluded that the ability of learning outcomes and learning activities using the *discovery learning* model is better than using conventional

methods. Meanwhile, according to the research of Muhammad Kadri and Meika Rahmawati (2015) revealed that the *discovery learning model* has a significant effect than conventional learning in improving student learning outcomes on the subject matter of temperature and heat in class X even semester of SMA Swasta Budi Satrya Medan T.P 2014/2015. However, the results of some of these studies are still in limitations, among others, limited material, limited number of samples and media. Therefore, meta-analysis research is needed in order to find out more broadly the effect of the *discovery learning* model on learning outcomes.

Meta-analysis is a study that uses existing studies and then is used by researchers which is carried out quantitatively and systematically in order to obtain more accurate conclusions. (Ratnawati, Apino, Kartianom, Djidu, & Anazifa, 2018). Therefore, the research was conducted to find out how much influence the *discovery learning* model has on learning outcomes.

## METHODS

This type of research is a meta-analysis study that examines 24 educational and research journal articles whose data are obtained in the form of a summary of the 24 journal articles used. Meta analysis is a type of research that is quantitative because it uses numerical calculations, statistics with the aim of compiling and extracting information from the large amount of data used so that it is impossible to use with other methods (anggreni et al., 2019).

The sample data in the study was obtained from the results of previous studies using 24 relevant national education journal articles. The journal articles used were published in the last 5 years, 2015-2020. The selected journal articles reviewed the effect of the discovery learning model on physics learning outcomes. The instrument used in this study to collect data is an observation sheet (coding). This coding is used to facilitate the data collection process and analyze the data.

Table 1. The distribution of the 24 journal articles can be seen in the groups in the following table.

Article Code	Education Level	Material	Media	Approach and Methods	Teaching Materials
A1	HIGH SCHOOL	Temperature and Heat	-	-	-
A2	HIGH SCHOOL	Effort and Energy	Mind mapping	-	-
A3	HIGH SCHOOL	Momentum and impulse	-	-	-
A4	SMP	Caloric	-	-	-
A5	HIGH SCHOOL	Static Fluid	-	scientific	-
A6	HIGH SCHOOL	-	-	-	Module

A7	HIGH SCHOOL	-	PhET	-	-
A8	HIGH SCHOOL	-	-	-	-
A9	HIGH SCHOOL	-	-	Peer instruction	-
A10	SMP	-	-	Scaffolding	-
A11	HIGH SCHOOL	Temperature and Heat	-	-	-
A12	HIGH SCHOOL	Momentum and impulse	-	-	-
A13	HIGH SCHOOL	Momentum and impulse	PhET	-	-
A14	HIGH SCHOOL	-	-	-	-
A15	HIGH SCHOOL	-	-	-	LKPD
A16	SMP	-	-	-	LKS
A17	HIGH SCHOOL	Straight Motion	-	Scientific	-
A18	HIGH SCHOOL	Straight Motion	-	-	-
A19	HIGH SCHOOL	Dynamic Electricity	-	-	-
A20	HIGH SCHOOL	Static Fluid	PhET	-	-
A21	HIGH SCHOOL	-	-	Scientific	-
A22	HIGH SCHOOL	Dynamic Fluid	-	-	-
A23	HIGH SCHOOL	Vibration	-	-	-
A24	HIGH SCHOOL	Momentum and impulse	-	-	-

The steps of meta-analysis research according to David B. Wilson and George A. Kelley in (Anggreni et al., 2019), namely:

- a. In this research, the problem and topic studied is the effect of *discovery learning* model on physics learning outcomes.
- b. Determining the period of previous studies used as data sources. The results of previous studies used as data sources in this study are national journals in the 2015-2020 period.

- c. Search for research reports from various sources that are relevant to the topic you want to research.
- d. Read the titles and abstracts of educational journals and see if the content matches the topic you want to research.
- e. Focusing the research on the problem, research methodology such as type of research, place and time of research, methods, population, sample, sampling techniques, data analysis techniques, and results.
- f. Categorize each study.
- g. Comparing the results of all studies according to their categories.
- h. Analyze the conclusions found.

According to Anggreni et al (2019), several things that must be done when analyzing data in this meta-analysis research are:

1. Analyzed the *effect size* (ES) of each journal.
2. Analyzed the *effect size* (ES) of the journal based on the type of model classification used.
3. Analyzing the relationship between variables based on the *effect size* of each journal to see students' physics learning outcomes.

In comparative research, conversion is first carried out so that further analysis can be carried out.

Conversion test formula:

$$d = 2t / \sqrt{N} \text{ or}$$

$$d = 2r / \sqrt{(1 - r)^2}$$

$$r = t / \sqrt{t^2 + (N - 2)}$$

$$r = (d/2) / \sqrt{1 + (d/2)^2} \quad (1)$$

$$t = \sqrt{F}$$

$$D = \sum Wi di / \sum Ni$$

The Hunter-Schmidt meta-analysis for correlation analysis includes the following steps:

1. Calculating the *mean* population correlation,  $\rho_{xy}(r)$ , calculated using the formula:

$$\sum[N_i r_i] / \sum N_i \quad (2)$$

$r$  is the correlation of study  $i$ ,  $n$  and  $N_i$  is the number of individuals in study  $i$ .

2. Calculating the variance of  $r$ ,  $S^2$ ,  $(\sigma^2)$  with the formula:

$$\sum[N_i (r_i - r)^2] / \sum N_i \quad (3)$$

3. Calculating the sampling error variance:

$$(\sigma^2 e) = (1 - r^2)^2 / (N - 1) \quad (4)$$

4. Calculates the corrected variance or true variance:

$$(\sigma_{\rho_{xy}}^2) = \sigma^2 r - \sigma^2 e \quad (5)$$

5. Calculating the combined *mean*:

$$A = \text{Ave}(a) \text{Ave}(b) \quad (6)$$

6. Calculating the corrected population correlation:

$$\rho = \text{Ave}(\rho_i) = \text{Ave } r / A \quad (7)$$

7. Calculating the sum of squares of the coefficients of variation:

$$V = SD^2 / Ave^2 \quad (8)$$

8. Calculating the true correlation variation:

$$Var(\rho) = [var(\rho_0) - \rho^2 A^2] / A^2 \quad (9)$$

9. Calculating the confidence interval:

$$M\rho = \rho \pm 1,96 (SD) \quad (10)$$

The way to find the *effect size* in the research used is:

$$ES = \frac{\bar{x}_{post} - \bar{x}_{pre}}{SD_{pre}} \quad (1)$$

$$ES = \frac{\bar{x}_{eks} - \bar{x}_{kon}}{SD_{kon}} \quad (2)$$

$$SD = t \sqrt{\frac{1}{N_e} - \frac{1}{N_k}} \quad (3)$$

Description:

ES = *Effect size*

$\bar{x}_{post}$  = *Posttest mean*

$\bar{x}_{pre}$  = *Pretest mean*

SD = *Standard Deviation*

t = The t-test value

$N_e$  = Number of class samples

experiment

$N_k$  = Number of control class samples

In (Anggreni et al., 2019) the interpretation of *Effect Size* is as follows:

0-0,20 = *weak effect* = less

0.21-0. 50= *modest effect* = low

0.51-1. 00 = *moderated effect* = medium

>1,00 = *strong* = high

## RESULT & DISCUSSION

In the study, the total number of education and research journal articles was 24 journal articles. Articles were analyzed from 2015 to 2020.

**Table 2.** *Effect size category of the effect of discovery learning model on physics learning outcomes.*

Article Code	Research Year	Effect Size (ES)	Category
A1	2015	0,11	Less
A2	2018	1,57	High
A3	2019	0,65	Medium
A4	2017	1,24	High
A5	2017	0,80	Medium
A6	2015	0,48	Low
A7	2018	0,63	Medium
A8	2019	0,67	Medium
A9	2020	0,85	Medium
A10	2019	0,53	Medium
A11	2015	0,73	Medium

A12	2018	1,76	High
A13	2019	0,29	Low
A14	2018	0,68	Medium
A15	2018	0,03	Less
A16	2017	2,02	High
A17	2020	1,17	High
A18	2020	0,48	Low
A19	2015	0,39	Low
A20	2016	0,54	Medium
A21	2017	0,95	Medium
A22	2016	0,74	Medium
A23	2018	1,08	High
A24	2019	0,66	Medium

Based on the category of the *effect of the discovery learning* model known from 24 research articles with effect size values, 2 studies have a low *effect size*, namely 0.03 and 0.11. With 4 studies having a low *effect size* with a range of 0.39 to 0.48. Then with a medium category there were 12 studies in the *effect size* range of 0.53 to 0.95. And for the high category there are 6 studies in the range of effect size 1.08 to 2.02.

Then an analysis was conducted to see the effect of the *discovery learning* model on the level of education.

**Table 3.** The effect of *discovery learning* model on education level.

No.	Education Level	Effect Size (ES)	Category
1.	SMP	1,26	High
2.	HIGH SCHOOL	0,72	Medium

The effect of the *discovery learning* model at the education level has a medium effect size at the high school level and a high effect size at the junior high school level.

Then proceed to analyze the effect of the *discovery learning* model on the subject matter which is grouped into four parts.

**Table 4.** The effect of the *discovery learning* model on the subject matter.

No.	Course Content	Effect Size (ES)	Category
1.	Temperature and Heat	0,69	Medium
2.	Momentum and Impulse	1,20	High
3.	Static Fluid	0,67	Medium
4.	Straight Motion	0,82	Medium

Analysis of the effect of the *discovery learning* model on the subject matter has a medium effect size, namely temperature and heat, static fluid, straight motion. While momentum and impulse have a higher effect size.

The results of this study can be seen that the *discovery learning* model can have an effect on student learning outcomes. Of the 24 studies obtained had an influence with a dominant medium effect. While the influence that gives less effect

was found in two studies. Then the low effect was found in four studies and the high effect was found in six studies.

At the education level, the *effect size* is 0.72 with a medium category at the high school level and an *effect size* of 1.26 with a high category at the junior high school level. This is because learning physics at the junior high school level is easier because the discussion is still general.

Meanwhile, the subject of learning material from the *discovery learning* model gives a high category effect, namely on momentum and impulse material with an *effect size* of 1.20. While for the material of temperature and heat, static fluid, straight motion has a moderate effect with an *effect size* range of 0.67 to 0.82. This is because many physics materials are suitable with the *discovery learning* model.

## CONCLUSION

The results of the meta-analysis in this study can be concluded that there is an effect of the *discovery learning* model on physics learning outcomes grouped by education level and subject matter. At the junior high school education level and momentum and impulse material, a high *effect size* was obtained.

The researcher suggests that future research should conduct other groupings such as grouping more material, varied teaching materials, methods or using different learning models.

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