Journal of Innovative Physics Teaching
Volume 1, Issue 2 December 2023, 104 - 112
ISSN: 3021-8551 (Online)
Doi: https://doi.org/10.24036/jipt/vol1-iss2/18
https://jipt.ppj.unp.ac.id/index.php/jipt

Effect Size Analysis of the Influence of Science Teaching Materials Based on Scientific Approach on Students' Learning Outcomes

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Article Info

Article history:

Received July 23, 2023
Revised December 21, 2023
Accepted December 24, 2023

Keywords:

Analysis
Effect Size
Teaching Materials
Scientific Approach
Learning Outcomes

ABSTRACT

This research analyzes the influence of teaching materials in science and physics learning based on a scientific approach on student learning outcomes determined through Effect Size. This research uses a descriptive study method. Research data was obtained from 20 journals regarding the influence of scientific approach-based science and physics teaching materials on student learning outcomes. The study is based on three categories, namely aspects of student learning outcomes, level of education and type of teaching materials. The research results show that in the aspects of student learning outcomes, namely knowledge, attitudes and skills, all three have a high measurement category with an effect size value of 1.05 each; 1.06 and 0.94. The influence of scientific approach-based teaching materials on high school students is better than on middle school students with mean effect sizes of 1.06 (high) and 0.70 (medium) respectively. The use of worksheets with a scientific approach has the greatest influence on student learning outcomes compared to other types of teaching materials with an effect size value of 1.15 (very high).

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INTRODUCTION

Education is a learning process carried out to prepare students to have scientific skills and prepare them to face developments in the 21st century. As science and technology continue to develop this century, the quality of education is also required. So that quality education produces superior human resources (HR). Improving the quality of education can be seen from increasing student learning outcomes in the form of intellectual and skills as expected by 21st century learning such as critical thinking, creativity, problem solving and communication skills.

Physics is a branch of science that discusses natural phenomena. The science studied by physics can be said to be a basic reference in the development of science and technology. Please note that physics is taught as a separate subject at high school level and is taught as a science (natural science) subject at junior high school level combined with biology and chemistry material

Physics and science are basically interesting and fun subjects. This is because there are many physics concepts related to everyday life. However, the reality on the ground still does not agree with this. Students think that physics is a difficult, scary subject and has nothing to do with everyday life. Students often find it difficult to connect the material they study with its application in everyday life (Venny Mulyana, et al 2021; Kurniawan, 2020). Then in the learning process, students' physics and science learning outcomes are also still low (Heru, 2017).

Physics and natural sciences are scientific products, so methods, processes, principles, attitudes and so on must also be scientific. Therefore, physics learning in schools should also be carried out with a scientific approach so that it is more meaningful and contextual (Sumiati, E. 2018). That way, students are able to understand the subject matter well and are able to apply it to everyday life. So that the correct physics and science learning process will certainly produce students who are superior and have character (Satria & Handhika, 2015)

The scientific approach is closely related to the skills and character of students, namely character that is based on scientific attitudes such as hard work, discipline, honesty, openness, democracy, creativity, carefulness, thoroughness, communicativeness and responsibility (Satria & Handhika, 2015). This approach includes: observing, asking, trying, reasoning, and communicating which is a challenge for educators through developing student activities for all subjects (Majid, Abdul.2014). Learning with a scientific approach has the following characteristics: (1) student-centered; (2) involving science process skills in instructing concepts, laws or principles; (3) involving cognitive processes that have the potential to stimulate intellectual development, especially students' higher order thinking skills; (4) can develop student character (Hosman, M. 2014). It is hoped that the learning process with a scientific approach can encourage students' curiosity and find out from various sources of observation, so that students are more active in discovering lesson concepts.

Apart from determining the right approach, learning must also be supported by appropriate learning media such as teaching materials. Teaching materials are learning media for teachers and students which are used as learning resources or as supports in learning. There are various types of teaching materials such as handouts, modules, books, worksheets and so on, each of which has different characteristics and can help teachers in the learning process. The use of this teaching material will also be less effective if it is not used with an approach method that is suitable for the material being presented. Through the use of teaching materials with a scientific approach, it is hoped that it can have an effect on improving students' skills which is illustrated by increasing learning outcomes.

Based on this explanation, the aim of this research was to examine student learning outcomes using scientific approach-based teaching materials in science and physics learning at the junior and senior high school levels. This is done by mapping the results of previous related research so that the scope of discussion is broader. It is hoped that the results of this research can answer the question of whether the use of teaching materials based on a scientific approach has an effective effect on improving student learning outcomes in science and physics learning.

METHODS

The type of research used in this research is survey research. The method for this survey research is to use the meta-analysis method. Meta-analysis is quantitative because it uses numbers and statistics that are used to process information from many sources obtained for this research. The stages in this research are (1) determining the research title, (2) collecting

data through literature in the form of articles, (3) summarizing research data in the form of statistical data by coding the data to make it easier to analyze the data (4) analyzing the effect size (effect size) from the results of research data collection, (5) concluding the results of data analysis in accordance with predetermined criteria.

This research will examine 20 articles contained in national journals. The population of this research is articles that discuss the use of teaching materials with a scientific approach in learning science and physics. With the purposive sampling technique, the samples taken must meet the following criteria: (1) selecting the topic to be researched, namely teaching materials based on a scientific approach, (2) use of teaching materials in science and physics learning, (3) calculate the combined Effect Size, (4) analyze the magnitude of the influence of moderator variables on Effect Size, and (5) write a summary. The data collection technique used in this research is observation with the help of data collection tools.

Effect size is defined as the magnitude of the effect between two or more variables which is expressed in f or ES. The method for obtaining the ES value is presented in Table 1 below:

Table 1. Effect Size Calculation

	Statistic Data	Formula	Code
1	Average and standard deviation in one group (pre test-post test)	$ES = \frac{\overline{X}_{post} - \overline{X}_{pre}}{SD_{pre}}$	Fr-1
2	Average and standard deviation in each group (two group post test only)	$ES = \frac{\overline{X}_{E} - \overline{X}_{C}}{SD_{C}}$	Fr-2
3	Average and standard deviation in each group (two group pre-post test)	$ES = \frac{\left(\overline{X}_{post} - \overline{X}_{pre}\right)_{E} - \left(\overline{X}_{post} - \overline{X}_{pre}\right)_{C}}{SD_{preC} + SD_{preE} + SD_{postC}}$	Fr-3
4	Chi-Square	$ES = \frac{2r}{\sqrt{1-r^2}}\,;\; r = \sqrt{\frac{x^2}{n}}$	Fr-4
5	t count	$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}}$	Fr-5
6	P value	CMA (Comprehensive Meta Analisis Software)	Fr-6

(Becker & Park, 2011)

Based on the method of determining effect size as in Table 1, it can be stated that: ES = effect size, post = posttest average, pre = pretest average, SD = standard deviation, E = experimental group average, C = average control group average, post E = experimental group posttest average, pre E = experimental group pretest average, post C = control group posttest average, pre C = control group pretest average, SDE = experimental group standard deviation , SDC = Standard Deviation of the control group, t = Results of the t test, nE = Number of experimental groups, nC = Number of control groups, r = Correlation value.

With the following effect size criteria:

a. Effect Size $\leq$ 0,15 very low effect
b. 0,15 < Effect Size $\leq$ 0, 40 low effect
c. 0,40 < Effect Size $\leq$ 0,75 medium effect
d. 0,75 < Effect Size $\leq$1,10 high effect
e. Effect Size $\geq$ 1,10 very high effect

RESULTS AND DISCUSSION

This meta-analysis research was carried out by determining the effect size value of 20 articles published in national journals regarding the influence of scientific approach-based teaching materials on student learning outcomes in science and physics learning. With the following grouping of results:

Table 2. General Grouping of Articles

Article Code	Educational Level	Types of Teaching Materials	Measured skills	Effect Size	Category
A1	Junior HS	Student Worksheet	Knowledge	1.24	Very High
A2	Senior HS	Module	Knowledge	0.49	Medium
A3	Senior HS	Module	Skill	0.67	Medium
A4	Senior HS	Book	Knowledge	0.88	High
A5	Senior HS	Book	Attitude	1.34	Very High
A6	Junior HS	Handout	Knowledge	1.11	Very High
A7	Junior HS	Handout	Attitude	0.48	Medium
A8	Junior HS	Handout	Knowledge	0.59	Medium
A9	Junior HS	Teaching Material	Attitude	1.04	High
A10	Junior HS	Teaching Material	Knowledge	0.62	Medium
A11	Junior HS	Teaching Material	Skill	0.54	Medium
A12	Senior HS	Teaching Material	Knowledge	0.58	Medium
A13	Senior HS	Teaching Material	attitude	1.24	Very High
A14	Senior HS	Teaching Material	Knowledge	2.01	Very High
A15	Senior HS	Teaching Material	Skill	0.87	High
A16	Senior HS	Student Worksheet	Knowledge	0.49	Medium
A17	Senior HS	Student Worksheet	Skill	1.51	Very High
A18	Senior HS	Student Worksheet	Knowledge	0.99	High
A19	Senior HS	Student Worksheet	Attitude	1.21	Very High
A20	Senior HS	Student Worksheet	Skill	1.48	Very High
Average				**0.97**	**High**

From Table 2, it can be seen that the average value of the effect size is 0.97 in the high category. These results indicate that there is a strong influence resulting from the use of

teaching materials based on a scientific approach on student learning outcomes. The scientific approach as emphasized in the 2013 curriculum makes students more active. Active behavior in learning is also the result of the learning process, or learning process. Learning outcomes are realized in 3 aspects, namely knowledge, attitudes and skills. If the effect size results in Table 2 above are grouped based on aspects of learning outcomes, the following results will be seen:

Table 3. Effect Size Results of Science and Physics Teaching Materials Based on a Scientific Approach Based on Aspects of Student Learning Outcomes

Aspects of Learning Outcomes	Article Code	Effect Size	Average of Effect Size	Category
Knowledge	A1	1.24	1.05	High
	A2	0.49		
	A4	0.88		
	A6	1.11		
	A10	0.62		
	A12	0.58		
	A14	2.01		
	A16	1.51		
	A18	0.99		
Attitude	A5	1.34	1.06	High
	A7	0.48		
	A9	1.04		
	A13	1.24		
	A19	1.21		
Skill	A3	0.67	0.94	High
	A8	0.59		
	A11	0.54		
	A15	0.87		
	A17	1.51		
	A20	1.48		

Based on the data in Table 3, calculating the effect size of the influence of scientific approach-based science and physics teaching materials on learning outcomes, a value of 1.05 was obtained with a high effect size category for the knowledge aspect; value 1.06 with a high effect size category for the attitude aspect; and a value of 0.97 with a high effect size category for the skills aspect.

From the results of these calculations, the effect size on the three aspects of learning outcomes is in the high category, this shows that the use of scientific approach-based teaching materials is effective in all three aspects. This is in accordance with the results of research conducted by Giffi Febri Yeni (2015) and Yolly Sawitri (2019), which stated that teaching materials with a scientific approach can influence students' authentic assessment consisting of aspects of knowledge, attitudes and skills.

The Influence of Science and Physics Teaching Materials Based on a Scientific Approach Based on Educational Level

The results related to the effect size analysis of the influence of scientific approach-based teaching materials on learning outcomes in terms of educational level are presented in the following Table 4:

Table 4. Effect Size Results for Science and Physics Teaching Materials Based on a Scientific Approach Based on Education Level

Educational Level	Article Code	Effect Size	Average of Effect Size	Category
Junior High School	A1	0.49	0.70	Medium
	A6	1.11		
	A7	0.48		
	A8	0.59		
	A9	1.04		
	A10	0.62		
	A11	0.54		
Senior High School	A2	0.49	1.06	High
	A3	0.67		
	A4	0.88		
	A5	1.34		
	A12	0.58		
	A13	1.24		
	A14	2.01		
	A15	0.87		
	A16	0.49		
	A17	1.51		
	A18	0.99		
	A19	1.21		
	A20	1.48		

From the data in Table 4, calculating the Effect Size of the influence of Science and Physics teaching materials based on the Scientific Approach based on educational level, a value of 0.70 was obtained with a medium effect size category for junior high school level and a value of 1.06 with a high effect size category for high school level. These results indicate that the use of teaching materials based on a scientific approach is more effective and influential at the senior high school level compared to the junior high school level.

According to Andesta (2018) at the age of 11-12 years and above children experience the formal operational phase, namely the phase where children can think about something that will or might happen (hypothesis) and something is abstract. In the teaching and learning process, children in this phase can apply learning with various models for advanced reasoning and require children to actively think, provide ideas and take meaning from empirical and abstract things. This is in accordance with the abstract concept of learning physics and science (Izzah, N. 2021). This statement is in accordance with the Effect Size findings that researchers have studied.

The Influence of Science and Physics Teaching Materials Based on a Scientific Approach Based on the Type of Teaching Materials

The results related to the effect size analysis of the influence of scientific approach-based teaching materials on learning outcomes in terms of the type of teaching materials are presented in the following table:

Table 5. Effect Size Results for Science and Physics Teaching Materials Based on a Scientific Approach Based on Type of Teaching Material

Measured skills	Article Code	Effect Size	Average of Effect Size	Category
Student Worksheet	A1	1,24	1,15	Very High
	A16	0,49		
	A17	1,51		
	A18	0,99		
	A19	1,21		
	A20	1,48		
Module	A2	0,49	0,58	Medium
	A3	0,67		
Book	A4	0,88	1,11	Very High
	A5	1,34		
Handout	A6	1,11	0,73	Medium
	A7	0,48		
	A8	0,59		
Teaching Material	A9	1,04	0,99	High
	A10	0,62		
	A11	0,54		
	A12	0,58		
	A13	1,24		
	A14	2,01		
	A15	0,87		

Based on table 5, calculating the effect size of the influence of scientific approach-based teaching materials on science and physics learning based on the type of teaching material, a value of 1.15 was obtained with a very high effect size category for student worksheet, a value of 0.58 with a medium effect size category for modules. ; a value of 1.11 with a very high effect size category for books; a value of 0.73 with a medium effect size category for handouts and a value of 0.99 with a high effect size category for teaching materials. From this data, it can be seen that the student worksheet type of teaching material has the highest value with a very high effect size category.

Student worksheet are printed teaching materials that are used to give assignments to students and function to help provide learning experiences to students. LKS can be used as a guide for students to help the learning process, especially in learning activities in the form of experiments and discussions. Student learning outcomes using LKS based on a scientific approach are better and more significant, because the characteristics of science lesson material involve a lot of work, both individual and group, such as observing, measuring, comparing and guessing, so that the use of LKS really supports effective learning (Mustika, 2016). Scientific-based worksheets also have an effective influence on physics learning outcomes through a scientific process that makes students further develop their knowledge by independently searching for physics concepts (Heru, 2017). So, this scientific-based worksheet is very suitable to be applied to science and physics learning.

CONCLUSION

Based on the analysis carried out, three results can be stated in this research. First, the use of science and physics teaching materials based on a scientific approach has an effective influence on student learning outcomes both in the aspects of knowledge, attitudes and skills.

Second, the application of teaching materials based on a scientific approach will be more effective if carried out at the high school level. Third, from the subject, the type of teaching material will be more effective if applied in LKS, which has the greatest influence on student learning outcomes compared to other types of teaching material. Suggestions that would be conveyed to readers include: 1) For researchers who wish to conduct further research on this analysis, they are expected to search for more article sources so that the research results are more accurate and significant, and 2) for teachers or prospective teachers, hopefully this article can add insight into the learning process, especially regarding teaching materials and scientific approaches used in learning science and physics.

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