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Meta-Analysis Of The Effect Of Using A Student-Centered Learning Approach On Student Physics Learning Outcomes

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Abstract

This study aims to determine the effect size of the effect of a student-centered learning approach on student physics learning outcomes based on the type of approach (Scientific approach & Contextual Teaching Learning (CTL) approach); determine the effect size of the effect of a student-centered learning approach on student physics learning outcomes based on physics material units and determine the effect size of the effect of a student-centered learning approach on student physics learning outcomes based on physics grade levels. This research method is a Meta-analysis research that summarizes various studies using a quantitative approach. To calculate the Effect Size of the articles studied using the Pre-Post Contrast and Group Contrast formulas. Based on the results and meta-analysis research it can be concluded that, the effect of a student-centered learning approach is very effective on student physics learning outcomes based on the type of scientific approach and contextual teaching learning (CTL) approach with an effect size of 1.484 and 2.253 respectively, both classified as very high. The effect of a student-centered learning approach on student physics learning outcomes based on subject matter, provides the most effective influence on Straight Motion Kinematics material with an effect size of 4.359 and is classified as very high. The effect of the student-centered learning approach on student physics learning outcomes based on class level, provides the most effective influence on class X and class XI with each effect size of 1.834 and 1.502 with very high classified.

Keywords: *Meta Analysis, Student-Centered Approach, Learning Outcomes*

INTRODUCTION

Physics is a subject that can foster students' thinking skills that are useful for solving problems in everyday life. And physics studies are used as a tool to solve everyday problems, while developing thinking skills and scientific attitudes. (Hidayaturrohman et al., 2017). Physics learning emphasizes on providing direct experience to develop students' competencies. Physics learning has a uniqueness that distinguishes it from other subjects. Physics learning has a uniqueness that distinguishes it from other subjects. Where physics examines events or objects found from students and in the environment. In accordance with this character, physics learning takes place like a simple scientific investigation. The implementation of simple

scientific inquiry in physics learning can be realized through the use of a student-centered approach.

In Permendikbud, 2013) No. 65 of 2013 concerning Process Standards Curriculum 2013 uses a scientific approach (scientific). In the Process Standards learning with a scientific approach includes steps: observing, questioning, trying, associating, communicating, and creating. Curriculum 2013 refers to learning that is student centered and not teacher centered. Scientific learning carries out learning that includes the steps of a scientist in building knowledge through the scientific method. This form of learning can be used as one of the solutions to overcome the weaknesses of the classical education system where students only listen to lectures from teachers without knowing clearly whether the subject matter has been mastered by students or not, and what basic competencies have been achieved.

Scientific learning does not only see learning outcomes as the end goal, but the learning process is seen as very important. In this case students are seen as learning subjects rather than learning objects so that students need to be actively involved in learning, the teacher only serves as a facilitator who guides in the learning process.

The reality on the ground does not reflect the expected conditions based on an analysis of the articles collected. There are several real conditions revealed in the articles. The first situation is, according to the findings in the research conducted by (Irawan et al., 2020), In schools, teachers still apply the direct instruction model. In this model, the main role and focus is on the teacher, so students are less actively involved in the learning process. Then the second real condition is that students often feel that physics is a complex subject. Based on the results of a questionnaire given to students about their experience in physics lessons, many consider that physics is a difficult and scary subject. Some even argue that physics is considered more challenging than math. The assumption of most students that physics is a difficult subject to learn results in a lack of formation of a positive attitude towards physics subjects, causing low student learning outcomes. (Diani, 2016).

The third real condition is that the low learning outcomes of physics based on the literature review, stating that learning methods are less varied so that the learning process is less fun, Physics is a subject that is difficult to understand, and students lack understanding in the use of mathematical formulas and calculations. (Kolopahing, 2015) It is also difficult for students to analyze the teacher's explanation and many students are not interested in physics..(Ika et al., 2019) Therefore, students' physics learning outcomes are low or do not reach the Minimum Completeness Criteria (KKM) set by the school.

One way is research using a scientific approach. A scientific approach plays an important role in helping students achieve good results in the physics learning process. (Hardianti et al., 2015). Furthermore, the application of contextual teaching and learning approach can also improve students' physics learning outcomes. (Ayuningtias et al., 2020). In the CTL (Contextual Teaching and Learning) approach, students understand the deep connection between abstract concepts and their application in real situations. This learning process requires team collaboration, so teachers must

create a learning environment that integrates various experiences to achieve the desired learning objectives. (Nurhidayah et al., n.d.). Learning becomes more productive and can foster concept reinforcement because the CTL approach leads students to discover their own knowledge. (Suprianto et al., 2016).

Meta-analysis research was chosen as the method in this research for several reasons. First, there has been no previous research that has conducted a meta-analysis of the influence of a scientific approach to learning by making statistical conclusions. Second, analyze quantitative data from previous research to accept or reject the hypothesis proposed in the research. And the solution is still not general because of the limitations of each study, therefore research needs to be carried out. Meta analysis is a research method that can obtain a broad picture of various research results on a research topic based on the background of the problem that has been explained. Researchers are interested in carrying out this research with the title : "Meta Analysis of the Effect of Using a Student-Centered Learning Approach on Student Physics Learning Outcomes."

METHODS

The type of research used is Meta Analysis research which summarizes various studies using a quantitative approach. According to (Retnawati, 2018) meta-analysis is a form of research, using data from other existing studies (secondary data) derived from 32 articles. Meta-analysis is also a quantitative research method by analyzing quantitative data from previous studies to accept or reject the hypotheses proposed in these studies.

Criteria for Analyzed Articles are Articles Used Recent Publications The articles analyzed are articles published in the range of 2013-2023. Articles that are used as research sources are at least published in 2013 on a national and international scale that has been indexed. Articles used in the field of physics studies. The articles analyzed have a discussion of physics subject matter. In this study, the material used is at the high school education level There is Information that Supports Meta Analysis. Information needed in the meta-analysis is in the form of independent variables, dependent variables, and moderator variables. These variables must be relevant to the research to be carried out There is statistical information to obtain Effect size The information needed to obtain effect size is in the form of the average score of pretest and postest results, the average score of the experimental class and control class, standard deviation, sample size and statistical test data. The score is processed using the equation to obtain the effect size value.

In this study there are three variables categorized into: The independent variable in this study is the student-centered approach; The dependent variable in this study is student learning outcomes; The moderator variable in this study is the type of approach, learning material, and grade level.

The meta-analysis research procedure suggested by David B. Wilson and George A. Kelley (Merriyana, 2006) consists of several stages, namely: 1) Determining the Research Theme, 2) Determining the period and criteria 3) collecting articles

related to the research theme 4) focusing research 5) categorizing research sources 6) recording research source data 7) analyzing and drawing conclusions

In the meta-analysis study, the effect size will show the magnitude of the effect caused by the LKS on students' critical thinking skills. Effect size or ES can be obtained by calculating ES using the Cohen's equation presented in Table 1. And for the effect size can be categorized at the level according to Cohen's which can be seen in Table 2

Table 1. Equation For Determining Effect Size

Statistic data	Formula
Average in one group	$ES\ (d) = \frac{\overline{x}_{post} - \overline{x}_{pre}}{SD_{pre}}$
Average in each group (two groups posttest only)	$ES(d) = \frac{\overline{x}_E - \overline{x}_C}{SD_{within}}$
Average in each group (two groups pre-post test)	$ES(d) = \frac{(\overline{x}_{post} - \overline{x}_{pre})_E - (\overline{x}_{post} - \overline{x}_{pre})_C}{SD_{within}}$
T count	$ES(d) = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}}$

Table 2. Interpretation of Effect size Value and Interpretation of Summary Effect size Value

No.	ES	Category
.	$ES \leq 0{,}15$	Category Negligible
.	$0{,}15 < ES \leq 0{,}40$	Low
.	$0{,}40 < Es \leq 0{,}75$	Medium
.	$0{,}75 < Es \leq 1{,}10$	High
.	$Es > 1{,}10$	Very high

Sumber : (Cohen et al., 2007)

RESULTS AND DISCUSSION

This study is intended to determine the effect of a student-centered approach to student physics learning outcomes based on the Scientific approach, Contextual Teaching Learning approach or based on subject matter and grade level of high school education. This study was conducted to determine the effect of a student-centered learning approach on student physics learning outcomes based on the moderator variables set, namely the type of approach, subject matter and grade level. The analysis conducted is a summary effect size of several articles assuming the

population of each study is uniform or different. The research data used is primary data by tracing articles from national indexed journals at least sinta and international indexed journals or proceedings. After searching for primary data, a total of 32 articles were obtained that met the specified criteria.

After obtaining articles that have been focused, 32 articles are obtained whose effect sizes vary as can be seen in table 3.

Tabel 3. *Effect Size Of Each Article*

No	Article Code	Source Article	*Effect size*	Category
1	JS 1	Fitriana, Syamsu dan Amiruddin Hatibe	1,253	Very High
2	JS 2	Hardianti, Nurhayati, Ahmad Yani	0,020	Negligible
3	JS 3	Orien Ratna Wuri, Sri Mulyaningsih	1,624	Very High
4	JS 4	Umi Fadhilah Ismawati & Sri Mulyaningsih	3.211	Very High
5	JS 5	Rahmat Sabirin, Muris, & Ahmad Yani	0,302	Low
6	JS 6	Rahma Diani	1,541	Very High
7	JS 7	Ayu Nisa Kolopahing	0,064	Negligible
8	JS 8	Silvia Sofyanita Titahsari, Budi Jatmiko	2,49	Very High
9	JS 9	Sabilal Rosyad, Markus Diantoro,& Sentot Kusairi	0,642	Medium
10	JS 10	Irawan, Supriyatman, dan Darsikin	1,22	Very High
11	JS 11	Tiara Purnama1, Abdul Haris, Muhammad Arsyad	0,566	Medium
12	JS 12	Yaspin Yolanda, Ahmad Amin, Riska Sari	9,6	Very High
13	JS 13	Ninda Riyani Ilyas, Melkyanus Kaleka, & Yasinta Embu Ika	0,136	Negligible
14	JS 14	Yasinta Embu Ika & Maria Fridolin Toyo	1,31	Very High
15	JS 15	Linda Aprilia, Sri Mulyaningsih	2,37	Very High
16	JS 16	I Gede Purwana Edi Saputra, Luh Sukariasih, La Ode Nursalam, Susilo Sudarman Desa	1,99	Very High
17	JS 17	Wahyu Arini	0,5	Medium
18	JC 1	I Dewa Putu Nyeneng, Frista Berliana Biwarno, Novinta Nurulsari	2,96	Very High
19	JC 2	Kasmawati, Nur Khalisah Latuconsina, Andi Ika Prasati Abrar	0,484	Medium
20	JC 3	Mailulatul Millah, Arin Wildani	1,46	Very High

21	JC 4	Yogi Prabowo, Hadi Susanto, Nathan Hindarto	1,45	Very High
22	JC 5	Mas'adah, Supriyono	2,61	Very High
23	JC 6	Friska Dhian Utami, Sulhadi, Sugianto	2,58	Very High
24	JC 7	Hardianti	5,76	Very High
25	JC 8	Lestari Taruk Datu, Amiruddin Kade	0,35	Low
26	JC 9	Jan Piter Saragih, Ridwin Purba, Hisarma Saragih	12,66	Very High
27	JC 10	Rini Yunawati, Nathan Hindarto, Sulhadi	1,55	Very High
28	JC 11	Susianti, Darsikin, dan Sahrul Saehana	0,49	Medium
29	JC 12	Nurhidayah, Ahmad Yani, Nurlina	1,5	Very High
30	JC 13	Nurul Huda, Hikmawati, Kosim	1,28	Very High
31	JC 14	Dea Tirsa Yolanda, Patricia Lubis, Sugiarti	2,62	Very High
32	JC 15	Agus Puji Setya Ningsih , Andinasari, Sugiarti	1,72	Very High

Summary Effect size of the influence of the student-centered learning approach on student physics learning outcomes based on the type of scientific approach

The first research is to determine the effect size of the effect of the student-centered learning approach on student physics learning outcomes based on the scientific approach, there are 17 articles out of 32 articles found.

Table 4. Effect Size Of Each Article

Code	*Effect size*
JS 1	1,253
JS 2	0,020
JS 3	1,624
JS 4	3.211
JS 5	0,302
JS 6	1,541
JS 7	0,064
JS 8	2,49
JS 9	0,642
JS 10	1,22
JS 11	0,566
JS 12	9,6
JS 13	0,136
JS 14	1,31
JS 15	2,37
JS 16	1,99
JS 17	0,5

Summary *Effect size*	1,484
Category	Very High

The results of data processing in Table 4 show that the effect of the student-centered learning approach on student physics learning outcomes based on the scientific approach has an effect size of 1.484 in the very high category based on Cohen's size.

The second research is to determine the effect size of the influence of the student-centered learning approach on student physics learning outcomes based on the contextual teaching and learning approach, there are 15 articles from 32 articles found.

Table 5. Effect Size Of Each Article

Code	*Effect size*
JC 1	2,96
JC 2	0,484
JC 3	1,46
JC 4	1,45
JC 5	2,61
JC 6	2,58
JC 7	5,76
JC 8	0,35
JC 9	12,66
JC 10	1,55
JC 11	0,49
JC 12	1,5
JC 13	1,28
JC 14	2,62
JC 15	1,72
Summary *Effect size*	2,253
Category	Very High

The results of data processing in table 5 show that the effect of a student-centered learning approach on student physics learning outcomes based on the contextual teaching learning approach has an effect size of 2.253 in the very high category.

Summary Effect size of the effect of the student-centered learning approach on student physics learning outcomes based on subject matter

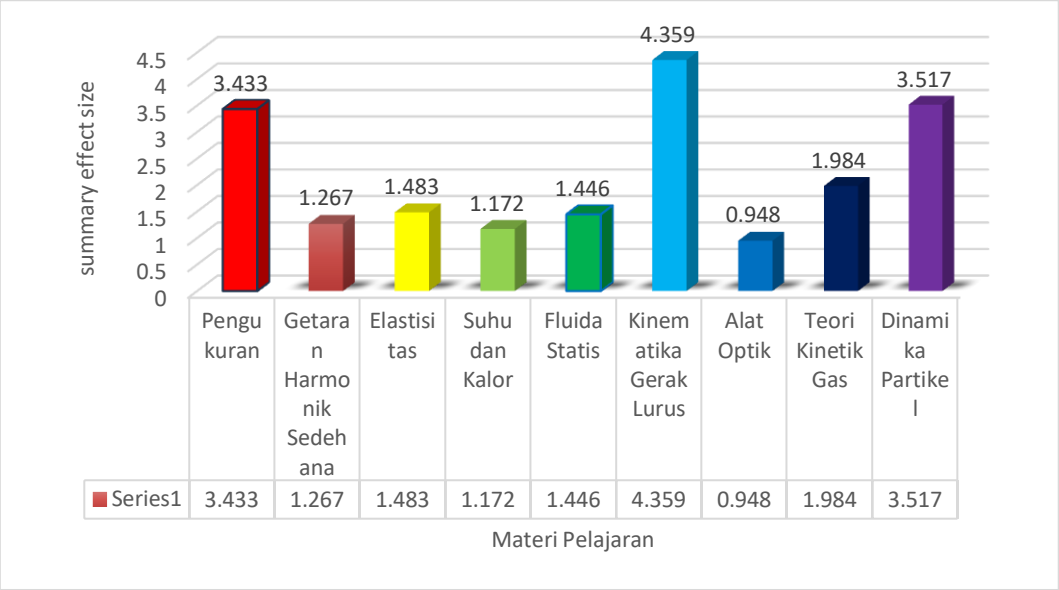
The third result of this study shows the summary effect size of the effect of a student-centered learning approach on student physics learning outcomes based on subject matter. 9 materials were identified. Of the nine materials, it has met the criteria for calculating the summary effect size.

Table 6. The Effect Of A Student-Centered Learning Approach On Student Physics Learning Outcomes Based On Subject Matter

Course Content	Many Articles (N)	Summary Effect (M^*)	Standard Error (SE^*) M	Category	P	α = 0,05 Lower	Upper
Measurement	3	3,433	1,612	Very High	0,017	0,274	6,593
Harmonic Vibration	2	1,267	0,177	Very High	0,000	0,920	1,615
Simple	6	1,483	0,277	Very High	0,002	0,452	2,514
Elasticity	4	1,172	0,493	Very	0,004	0,313	2,672
Temperature and	2	1,446	0,974	High	0,069	-0,463	3,355
Heat	3	4,359	1,643	Very	0,004	1,139	7,579
Fluids	2	0,948	0,471	High	0,022	0,026	1,871
Static	2	1,984	0,498	Very High	0,000	1,007	2,961
Kinematics of Straight Motion	2	3,517	2,015	High	0,043	-0,504	7,538

Summary Effect size of the effect of a student-centered learning approach on student physics learning outcomes on measurement material is 3.433 with a very high category. The lower limit value obtained is 0.274 and the upper limit is 6.593 which is also in the very high category based on Cohen's size.

The following data is presented to see the differences in each summary effect size of the nine subject matter.



Based on the figure above about the summary effect size of each subject matter, it is found that the range of each material is different. The smallest summary effect size is for optical instrument material while the largest is for straight motion kinematics material Summary Effect size of the Effect of Student-Centered Learning Approach on Student Physics Learning Outcomes based on Grade Level The fourth result of this study shows the summary effect size of the effect of a student-centered learning approach on student physics learning outcomes based on grade level. Analysis of the subject matter of 32 articles obtained 24 articles for grade X and 8 articles for grade XI that meet the criteria so that the calculation of summary effect size can be done.

Table 7. The Effect Of Student-Centered Learning Approach On Student Physics Learning Outcomes Based On Grade Level

Lesson Materials	Many Articles (N)	Summary Effect (M^*)	Standard Error (SE^*_M)	Category	P	α = 0,05	
						Lower	Upper
Class X	24	1,834	0,231	Sangat Tinggi	0,000	1,381	2,288
Class XI	8	1,502	0,305	Sangat Tinggi	0,000	0,903	2,100

Summary Effect size of the effect of the student-centered learning approach on student physics learning outcomes at grade X level is 1.834 with a very high category. The lower limit value obtained is 1.381 and the upper limit is 2.288 which is also in the very high category based on Cohen's size. Summary Effect size of the effect of the student-centered learning approach on student physics learning outcomes at grade XI level is 1.502 with a very high category. The lower limit value obtained is 0.903 and the upper limit is 2.100.

So based on the results of the calculation of the effect size of the sample articles used, it can be seen from the results of the average value of the effect size that the use of a student-centered approach with a type of contextual teaching learning approach has a high influence on student physics learning outcomes compared to the scientific approach approach.

CONCLUSION

Based on the results and meta-analysis research it can be concluded that: The effect of a student-centered learning approach is very effective on student physics learning outcomes based on the type of scientific approach and contextual teaching learning (CTL) approach with an effect size of 1.484 and 2.253 respectively, both classified as very high. The effect of the student-centered learning approach on student physics learning outcomes based on subject matter, provides the most effective influence on Straight Motion Kinematics material with an effect size of 4.359 and is classified as very high.

The effect of the student-centered learning approach on student physics learning outcomes based on class level, provides the most effective influence on class X and class XI with each effect size of 1.834 and 1.502 with very high classified.

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