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Research Artikel

META-ANALYSIS OF THE EFFECT OF LEARNING CYCLE 5E MODEL ON PHYSICS LEARNING

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Abstract

Along with the rapid development of science and technology, education is increasing. The improvement of education has encouraged the development of learning methods, techniques, approaches and models that allow students to play an active role in constructing their knowledge. One of them is the 5E learning cycle model. This study aims to analyse the effect of the 5E learning cycle model on physics learning in terms of education level, grade level, research type, subject matter and learning needs. The method used is a quantitative meta-analysis of SINTA accredited national articles, proceedings and international articles with the latest ten years, namely 2013-2023. Data analysis using effect size. The results of the analysis show that overall the learning cycle 5E model has an effect on physics learning with a high effect interpretation. Therefore, the learning cycle 5E model as a whole can improve students' learning achievement and can be used as an alternative in learning, especially physics. Thus, students can learn actively, effectively and can develop their creativity in solving problems. Thus, the 5E learning cycle model is very influential and effective in learning in general, especially in physics learning and can be applied to 21st century skills.

Keywords*: Effect Size; Learning Cycle 5E; Physics Learning; Meta-Analisis.*

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INTRODUCTION

Science develops along with the times. Scientific standards are information systems of the physical world and related phenomena, which require impartial observation and systematic testing (Gregersen, 2020). What was once called scientific truth may change in the present and in the future. So science is dynamic and needs to be developed to reveal the truth and use it in life. There are two pedagogical approaches in teaching natural science: deductive and inductive approaches (Constantinou et.al, 2018). The role of the educator in the deductive approach is to present a concept and its associated logic and provide examples of its application. Learners are positioned as passive learners, meaning that they only get the material delivered by the educator. In contrast, with the research process approach (which is an inductive approach), learners are given many opportunities to make observations, conduct experiments, and educators guide learners to formulate concepts based on their knowledge (Rocard et.al., 2007). Therefore, educators must plan the learning process so that learners perform an activity in acquiring their knowledge.

Physics is one part of science which is a collection of knowledge, ways of thinking, and investigation. Physics is a science that is obtained using methods based on scientific observations related to a systematic understanding of nature (Mundilarto, 2012).The development of science and technology, physics as part of science and technology also experienced the development of theory and its application. According to Johnson (2017), physics and technology become an inseparable unity and become a complementary culture of science and technology, one side of which contains the essence of science and the other side contains the meaning of technology. The development of technology in learning is used to hone students' knowledge in physics lessons, so that students are comfortable and happy when learning physics. A comfortable and happy atmosphere in the learning process will make the material more easily understood by students (Khunaeni et al., 2020). Gilakjani et al. (2013) explain that technology by itself cannot make education more effective, but the right learning model is needed so that educators can provide opportunities for learners to construct their own knowledge. The utilisation of technology can open up new opportunities combined with the development of innovative and effective learning models. Other research results that using technology integrated with learning models can provide opportunities for learners to construct their own knowledge which improves learner achievement (Sari et al., 2017).

Studying physics is a process of acquiring knowledge, understanding of the basic principles and laws that govern the behaviour of matter and energy in the universe. When studying physics, learners must be able to acquire and apply the concepts learnt (Docktor et al., 2016; Etkina, 2015;), and learners must be able to develop their critical skills (Holmes, Wieman, & Bonn, 2015; Kong 2015). This means that to achieve these goals one must have sufficient understanding of physics concepts and then apply them, where in applying physics concepts students need good critical skills. Effective physics learning involves developing a strong foundation in mathematical concepts, critical thinking skills, and problem-solving abilities. It also requires a deep understanding of scientific methodology, including hypothesis testing, experimentation, and data analysis.

Along with the rapid development of science and technology, education is increasing. The improvement of education has encouraged the development of methods, techniques, and approaches that allow learners to play an active role in constructing knowledge. One of the learning models that involves students to actively participate and involve potential cognitive processes in stimulating the intellectual development of students in the learning process is the 5E learning cycle model (Sani et al., 2020). Ngalimun (2014) stated that the application of the 5E learning cycle model can increase learning motivation because students are actively involved, critical, creative in the learning process, help develop scientific attitudes and learning becomes more meaningful. The 5E learning cycle model is effectively applied in learning that can encourage students to develop the ability to think, live science, understand content, apply scientific processes and concepts to authentic situations (Bevenino et al., 1999; Colburn and Clough, 1997).

Kivunja (2015) stated that the 5E learning cycle model became very popular in pedagogy because this model is used to facilitate learning that has been conceptualised by experts such as active learning (Piaget, 1954), constructivist learning (Vygotsky, 1929), discovery learning (Bruner, 1961). This is because the 5E learning cycle model in its implementation stage is effectively designed to support a deep and sustainable learning process.

In learning activities, the 5E learning cycle model helps learners become active and independent individuals in mastering learning. Learners can actively construct knowledge and experience, meaningful learning content by working and thinking independently or in groups during the stages of the 5E learning model, enabling them to master the skills that must be acquired in learning (Sani et al., 2020). The 5E learning cycle model stimulates students to remember previous material and relate it to the material to be learned and convey concepts orally (Nur & Noviardila, 2021). In this case, learners must discover and transform complex information on their own, actively participating in concepts and principles through stages characterised by the generation of new information and how to process it, so that intellectual development occurs based on perceived context. A learner understands concepts by combining new and old knowledge or by combining new knowledge with existing schemes and cognitive frameworks (Anderson & Krathwohl, 2001). The 5E learning cycle model includes aspects of behaviourism and cognitive models (Jobrack, 2013).

The 5E learning cycle model has been widely applied in science education (Çakir & Güven, 2019; Şahin et al., 2017). The model provides conceptual change and discovery learning in a classroom environment (Campbell, 2000) by arousing learners' interest and curiosity (van Garderen et al., 2020). The 5E learning cycle model has a constructivist approach that consists of five stages, namely engagement, exploration, explanation, elaboration/extension, and evaluation. The 5E learning cycle model can be applied in learning 21st century skills. In teaching 21st century skills, we can utilize the 5E learning cycle model with stages: (1) Engagement stage maximises learners' participation in active learning by actively engaging learners in learning tasks, ideas or concepts; (2) Exploration stage focuses on learners and provides opportunities for learners to discover new things and the teacher becomes a guide or facilitator in their search; (3) Explanation stage is new information or information that is not discovered by learners themselves. This stage focuses on explaining ideas and concepts as well as interpretations that extend learners' understanding to new frontiers of knowledge; (4) The elaboration stage provides opportunities for learners to extend their cognitive experiences into increasingly complex matters. This allows learners to connect previously learnt schemas with new learning or newfound knowledge; (5) Evaluation stage gives learners the opportunity to focus on their performance to find out whether or not they are achieving the learning outcomes, and what they can do to improve their performance. This can be an excellent shadow for learner assessment, formative and summative assessment. It will inform the strategies and planning needed to improve learning and assessment (Rodriguez et al., 2019; Namgyel & Buaraphan, 2017; Kivunja, 2015; Dindar, 2012; Madu &Amaechi 2012; Bybee et al., 2009; Ceilan, 2008Lorsbach, 2002).

The use of the 5E learning cycle model in learning has several drawbacks. The disadvantages of the 5E learning cycle model are: (1) low learning effectiveness if teachers lack mastery of the material and learning steps; (2) demanding the seriousness and creativity of teachers in designing and implementing the learning process; (3) requires more planned and organized classroom management; (4) requires more time and energy in preparing plans and implementing learning (Ngalimun, 2014; Shoimin, 2014).

Based on the description above, a meta-analysis research will be conducted related to the effect of the 5E learning cycle model on physics learning. This meta-analysis is carried out by combining several research results that can provide an overview to obtain a strong and comprehensive conclusion about the influence of the 5E learning cycle model on physics learning. The purpose of this meta-analysis is to determine the effectiveness of the 5E learning cycle model on physics learning in terms of education level, grade level, research type, subject matter and learning needs. It is expected that this result can be used as a reference to apply the learning cycle 5E model in learning activities.

METHOD

The method used in this research is quantitative meta-analysis. The data presented in this meta-analysis by searching for scientific articles relevant to the 5E learning cycle model in learning Physics. Data collection was carried out by accessing https://scholar.google.co.id by reviewing several articles in national journals indexed by SINTA 1 to SINTA 5 as well as proceedings and articles in international journals. The keyword used in the search is the effect of the effectiveness of the learning cycle 5E model on physics learning. Based on the search results on Google Scholar, 22 relevant articles were obtained in national journals indexed by SINTA 1 to SINTA 5 as well as proceedings and international journals with the latest ten years, namely 2013 to 2023. Article analysis used coding to facilitate data collection. Coding was done by renaming articles based on the author's name and year, education level, grade level, research type, and learning needs.

Because the articles used use different data analyses so that the effect size derivative formulas are needed (Erpan, et el., 2021; Iskandar et al, 2021; Suhardiman et al., 2022), as in the following Table 1.

Table 1. Effect Size Derivation Formulas

No	Type of Test	Formula	Description
1.	Z-test	$ES = Z\sqrt{\frac{1}{ne}+\frac{1}{nc}}$	Z: score of the z-test value in the initial study ne: number of experimental group samples nc: sample size of control group
2.	t-test	$ES = \sqrt{\frac{2t}{n}}\ dan$ $ES = Z\sqrt{\frac{1}{ne}+\frac{1}{nc}}$	t: scores from the t-test values in the baseline study n: sample size ne: the number of experimental group samples
3.	r – test	$ES = \frac{\{2_r\}}{\{\sqrt{(1-r)}\}}$	r: score from the r-test in the initial study (Sutrisno, Kresnadi, & Kartono, 2007)
4.	F-test	$ES = F\sqrt{\frac{2}{n}}$	F: scores from the F-test in the initial study n: sample size
5.	X^2-test	$ES = \frac{\sqrt{X^2}}{n}$	X^2: scores from the X^2-test in the original study n: sample size (Wilkinson, and APA Task Force on statistical Inference, 1999)

To find the effect size value, data analysis techniques are used using the following equation.

$$ES = \frac{\overline{X_1} - \overline{X_2}}{SD}$$

Description:
ES = *Effect size*
$\overline{X_1}$ = *Posttest average*
$\overline{X_2}$ = *Pretest average*
SD = *Standard deviation*

Meanwhile, to determine the average effect size, the following equation can be used:

$$\overline{EZ} = \frac{\sum EZ}{n}$$

Description:
$\overline{EZ}$ = *Average effect size*
$\sum EZ$ = *Total effect size*
n = *Number of samples*

Effect size data for each article is categorised based on the criteria according to Cohen (1988) presented in Table 2.

Table 2. Classification for interpreting the effect size

No	Size Effect Value	Interpretation

1.	-0.15 ≤ ES ≤ 0.15	Insignificant effect
2.	0.15 < ES ≤ 0.40	Low Effect
3.	0.40 < ES ≤ 0.75	Medium Effect
4.	0.75 < ES ≤ 1.10	High Effect
5.	1.10 < ES ≤ 1.45	Very high effect
6.	1.45 < ES	Perfect Effect

RESULTS AND DISCUSSIONS

The results of the article analysis used coding to facilitate data collection. Coding is done by renaming the articles analysed with codes A1 to A22. The results of the article analysis can be presented in Table 3 below.

Table 3. Distribution Data of the effect of Learning Cycle 5E Model on Physics Learning

No	Author	Source	Code	Level of Education	Class	Type Research	Effect Size	Interpretation
1.	Salam et al., 2013	Journal of Physics Education	A1	SMA	X	Quasi Experimnt	0.828	High Effect
2.	Nainggolan & Sihombing, 2013	Journal INPAFI (Physics Learning Innovation)	A2	SMA	X	Quasi Experiment	0.738	Medium Effect
3.	Anisah & Purwanto, 2014	Journal INPAFI (Physics Learning Innovation)	A3	SMA	XI	Quasi Experiment	0.632	Medium Effect
4.	Parhusip & Ginting, 2014	Journal INPAFI (Physics Learning Innovation)	A4	SMA	X	Quasi Experiment	0.584	Medium Effect
5.	Senindra et al., 2016	Journal of Innovation and Learning Physics	A5	MAN	X	Quasi Experiment	0.617	Medium Effect
6.	Sari et al., 2016	Scientific Journal of Physics Education Al-BiRuNi	A6	SMP	VII	Quasi Experiment	1.908	Perfect Effect
7.	Asriyadin et al., 2016	Journal of Mathematics and Natural Sciences Education	A7	SMA	X	Quasi Experiment	0.830	High Effect
8.	Irhamna et al., 2017	Journal of Physics FLUX	A8	SMP	VIII	Quasi Experiment	0.776	High Effect
9.	Maida & Sirait, 2017	Journal INPAFI (Physics Learning Innovation)	A9	SMA	XI	Quasi Experiment	1.171	Very High Effect
10.	Latifa et al., 2017	Journal of Physics and Technology Education	A10	SMA	X	Quasi Experiment	0.457	Medium Effect
11.	Sari et al., 2017	International Journal of Innovation in Science and Mathematics Education	A11	SMA	XI	Quasi Experiment	0.712	Medium Effect
12.	Namgyel & Buaraphan, 2017	Prosiding Asia-Pacific Forum on Science Learning & Teaching	A12	SMA	XII	Quasi Experiment	1.411	Perfect Effect
13.	Razak, 2018	E-Journal of Science Education	A13	SMP	VIII	Pra-eksperimen	0.771	High Effect
14.	Isnani et al., 2018	Journal of Physics Learning	A14	SMA	XI	Quasi Experiment	0.963	High Effect

15.	Sakdiah, 2018	Journal of Physics Learning Innovation Research	A15	SMA	X	Quasi Experiment	0.857	High Effect
16.	Rafiqah et al., 2019	Journal of Physics Education	A16	SMA	X	Pra-eksperimen	1.197	Very High Effect
17.	Lusiana et al., 2019	International Conference on Learning Innovation	A17	SMP	VII	Mix Methods	3.420	Perfect Effect
18.	Hartawati et al., 2020	Journal of Education and Physical Sciences	A18	SMA	X	Quasi Experiment	0.606	Medium Effect
19.	Fuadi et al., 2020	Journal of Mathematics and Natural Sciences Education	A19	SMA	XI	Quasi Experiment	0.762	High Effect
20.	Armys & Derlina, 2021	Journal INPAFI (Physics Learning Innovation)	A20	SMA	X	Quasi Experiment	1.647	Perfect Effect
21.	Setyowidi et al., 2021	Journal of Physics Learning	A21	SMK	XI	Quasi Experiment	0.935	High Effect
22.	Purfiyansyah at al., 2023	Jurnal Pillar of Physics Education	A22	SMA	XI	True-Eksperimen	1.464	Perfect Effect
						Average Effect Size	**1.058**	**High Effect**

Table 3 describes the research samples on the 5E learning cycle model on physics learning obtained from articles from national journals, proceedings and articles in international journals. The 22 articles were then analysed based on the level of education, grade level, type of research, subject matter and based on the needs in physics learning.

First, the results of the analysis of the effect of the 5E learning cycle model on physics learning based on the education. By calculating the number of effect size against the number of samples, the average effect size can be presented in Table 4.

Table 4. Effect Size by Education Level

Code	Level of Education	Total	Effect Size	Interpretation
A6; A8; A13; A17	SMP	4	1.719	Perfect Effect
A1; A2; A3; A4; A5; A6; A7; A9; A10; A11; A12; A14; A15; A16; A19; A20; A21 A22	SMA/MA/SMK	18	0.912	High Effect

Based on Table 4, it can be seen that the use of learning cycle 5E model in physics learning both in junior high school (SMP) and senior high school (SMA) has an effect on physics learning. In junior high school, the average effect size value is 1.719 where the learning cycle 5E model has a very good influence on physics learning, while the effect size of 0.912 at the high school level has a good influence. Therefore, the learning cycle 5E model has a high implication on physics learning. From the data, it is known that the junior high school education level has a very good influence compared to high school education. The high average effect size at the junior high school level is because the number of articles at the junior high school level is due to the number of articles identified 4 articles at the junior high school level compared to 18 articles identified at the senior high school level. The high average effect at both levels of education has implications for children's cognitive development, where psychologically students at the secondary school level are at the formal operational stage based on Piaget's cognitive development theory, namely at the age of 11 years or more (Mutammam & Budiarto, 2013). At this stage, students can already think logically about various things, including rather complicated things, but on condition that these things are presented concretely or presented in a form that can be captured by the five senses (Suhardiman et al., 2022). Therefore, at the formal operational stage when faced with a problem, they can formulate conjectures/hypotheses from the problem and can solve problems and reach conclusions systematically. This is in accordance with the characteristics of the 5E learning cycle model applied to the learning process. Thus, the 5E learning cycle model has a high influence effect at the education level on physics learning.

Second, the results of the analysis of the effect of the 5E learning cycle model on physics learning based on grade level with the average effect size can be presented in Table 5.

Table 5. Effect Size by grade level

Code	Class	Total	Effect Size	Interpretation
A6; A17	VII	2	2.664	Perfect Effect
A8; A13	VIII	2	0.774	High Effect
A1; A2; A4; A5; A7; A10; A15; A16; A18; A20	X	10	0.836	High Effect
A3; A9; A11; A14; A19; A21; A22	XI	7	0.948	High Effect
A12	XII	1	1.411	Perfect Effect

Based on table 5, it shows that the average effect size at grade level with perfect or excellent effect category occurs in class VII while class XII with very high effect category and high effect category occurs in class VIII, X, XI. This is in accordance with the results of research by Akar (2005) who explained that the 5E learning cycle model is a good learning strategy for teaching science in secondary schools at all grade levels because it is successful, flexible, and places realistic demands on teachers and students. In addition, the 5E learning cycle model in learning activities is effectively applied at every grade level (Ates, 2005; Ebrahim, 2005). Thus, overall, the 5E learning cycle model for physics learning is effective at all grade levels.

Third, the results of the analysis of the effect of the 5E learning cycle model on physics learning based on the type of research with the average effect size can be presented in Table 6.

Table 6. Effect Size by Research Type

Code	Research Type	Total	Effect Size	Interpretation
A13; A16	Pre-eksperimen	2	0.785	High Effect
A17	Mix Methods	1	3.420	Perpect Effect
A22	True-Eksperimen	1	1.464	Perfect Effect
A1; A2; A3; A4; A5; A6; A7; A8; A9; A10; A11; A12; A14; A15; A18; A19; A20 A21	Quasi Eksperimen	18	0.893	High Effect

Based on table 6, it shows that the average effect size value of the effect of the 5E learning cycle model on physics learning based on the type of research with a perfect influence category is the type of true-experiment and Mix Methods. While in the type of pre-experiment and quasi-experiment research provides a high effect, this indicates that the effect of the 5E learning cycle model on physics learning provides a high effect. The magnitude of the effect size value in the type of true-experiment and mixed methods research is due to only one sample of articles identified compared to the type of true-experiment research which identified 2 sample articles and the type of quasi-experiment research identified as many as 18 sample articles or 81.81%. Because this type of quasi-experimental research is a development of true experimental design, which is difficult to implement. This design has a control group, but cannot function fully to control outside variables that affect the implementation of the experiment. Quasi experimental design used because it is difficult to get a control group used for research (Sugiyono, 2017). This finding indicates that the treatment given in this type of research has a very good impact on the learning cycle 5E model on physics learning. Thus, the effect of Learning Cycle 5E model on physics learning based on the type of research provides a high effect.

Fourth, the analysis of the effect of learning cycle 5E model on physics learning in terms of subject matter with the average effect size can be presented in Table 7.

Table 7. Effect Size by Subject Matter

Code	Course Content	Total	Effect Size	Interpretation
A5; A6	Principal and Derivative Measures	2	1.265	Very High Effect
A7	Measurement	1	0.830	High Effect
A13	Substance Pressure	1	0.771	High Effect
A17	Solar System	1	3.420	Perfect Effect
A8; A9	Static Fluid	2	0.974	High Effect
A14	Dynamic Fluid	1	0.963	High Effect
A1	Newton's Law	1	0.828	High Effect
A10; A20	Work and Energy	2	1.052	High Effect
A2; A4; A15	Dynamic Electricity	3	0.726	Medium Effect
A3	Thermodynamic	1	0.632	Medium Effect
A18	Momentum and Impulse	1	0.606	Medium Effect
A11	Geometric Optics	1	0.712	Medium Effect
A22	Sound Waves	1	1.464	Perfect Effect
A12	Photoelectric Effect	1	1.411	Very High Effect
A16; A19; A21	Not Identified	3	0.965	High Effect

Based on Table 7, the average effect size of the learning cycle 5E model shows that the perfect effect category is found in the solar system and sound waves. Then the category of very high effect on the material of principal and derived quantities and photoelectric effects. While the moderate effect category is in dynamic electricity, thermodynamics, momentum and impulse, geometric optics, and subject matter that has a large category in measurement, substance pressure, static fluid, dynamic fluid, Newton's law, effort and energy and three materials that are not identified. This is in accordance with the research results that the application of the 5E learning cycle model leads to better science achievement, subject matter mastery, improved reasoning ability and better process skills than those obtained by conventional learning (Ateş, 2005; Bybee, 2009; Campbell, 2000; Duran, Duran, Haney, & Scheuermann, 2011; Şahin et al., 2017). Thus, the effect of the 5E learning cycle model on physics learning provides a high effect on physics subject matter in general.

Fifth, the analysis of the effect of learning cycle 5E model on physics learning in terms of learning needs with the average effect size can be presented in Table 8.

Table 8. Effect Size based on Needs in Learning

Code	Needs	Total	Effect Size	Interpretation
A1; A2; A3; A4; A5; A6; A7; A9; A11; A12; A15; A19; A21	Learning Outcomes	13	0.922	High Effect
A14	Science Process Skills	1	0.963	High Effect
A13; A16	Concept Understanding	2	0.984	High Effect
A20	Problem Solving	1	1.647	Perfect Effect
A8; A17; A22	Critical Thinking Skills	3	1.887	Perfect Effect
A10; A18	Critical Thinking Ability	2	0.532	Medium Effect

Based on table 8, it shows that the effect size of using the learning cycle 5E model on physics learning based on the needs in learning provides a perfect influence on problem solving and critical thinking skills. This shows that the 5E learning cycle model is very well applied in science learning activities, especially physics. The achievement of the effectiveness of the use of the 5E learning cycle model on problem solving and critical thinking skills that provide a perfect or very good effect in learning because the contribution of the 5E learning cycle model steps is very well implemented in the process of learning activities. While the effect size in the high category is on learning outcomes, science process skills and concept understanding and in the medium category is on critical thinking skills. In this case, the aspects of critical thinking skills that must be achieved by students are more applied in the application of the 5E learning cycle model.

Thus, the effect of the learning cycle 5E model on physics learning in terms of needs is on the target of student learning outcomes with a total of 13 articles or 61.90%. This shows that the learning cycle 5E model is an effective teaching strategy in improving students' understanding and achievement (Taşlıdere, 2015; Duran et al., 2011; Bybee, 2009). This is in accordance with research by Sari at al., (2017) showing that learners have better concept understanding, greater science achievement, better reasoning ability, and superior process skills than those obtained by conventional teaching. While the results of the analysis conducted by Çakir and Güven (2019) showed that the 5E learning cycle model affects academic achievement in physics learning. These results show a significant interaction between learning models on learning outcomes, science process skills, concept understanding, problem solving, critical thinking skills and critical thinking ability. In general, the effect of learning cycle 5E model on physics learning gives high effect on physics learning. It shows that the use of learning cycle 5E model in physics learning as a whole gives an influence especially in delivering learning materials in improving learning outcomes, concept understanding, problem solving, science process skills, critical thinking skills and critical thinking ability.

The 5E learning cycle model provides opportunities for students to practice more process abilities and skills and is able to provide meaningful learning experiences for students so that it is easier for them to understand the subject matter. This 5E learning cycle model shows that most of the influence has on the achievement of student learning outcomes. This is in accordance with the results of research conducted by Senindra et al., (2016) explaining that there is a very good influence by using the 5E learning cycle model on students' physics learning outcomes. Then the 5E learning cycle model has an excellent effect on students' learning achievement (Sarac, 2017; Ural & Bumen, 2016; Anıl & Batdi, 2015; Ayaz & Sekerci, 2015). In addition, Prayogi, et al (2013) which stated that the use of the 5E learning cycle model can provide challenges to students so that they can get satisfaction by discovering new knowledge for themselves and developing the critical thinking skills of each student. The activities in the 5E learning cycle model are a more appropriate and effective means of achieving 21st century skill indicators. The application of the 5E learning cycle model is effective in developing 21st century skills (Kivunja, 2015).

The overall analysis shows that the 5E learning cycle model is effectively applied in physics learning activities. This can be seen from the analysis of articles in national journals and articles in international journals. The 5E learning cycle model is an effective way and strategy in improving the educational process at all levels of education. The effectiveness of the 5E learning cycle model can improve the achievement of students at any level, both at the education level and at the grade level, for the content taught, attitudes and interests in science and learning science, reasoning skills, and mastery of subject matter (van Garderen et al., 2020). Problems in teaching science knowledge, especially physics, through the 5E learning cycle model can help to solve the problem. It can facilitate learners to learn actively, creatively, effectively in understanding knowledge in a meaningful way. Therefore, an important role will be played by professional developers so that educators can develop learning models in the curriculum that applies in educational units.

Thus, the 5E learning cycle model is very influential and effective to be applied in current learning. The 5E learning cycle model is effective in developing one or more 21st century skills among various different groups of learners (Kivunja, 2015; Bybee, 2009). The 5E learning cycle model will be better when enriched with technology to get a good instrument for teachers to teach predetermined concepts and learners to gain 21st century skills (Senan, 2013). This model supports the efficacy in developing conceptual understanding and skills very strongly, especially considering the evidence as the basis for applying the 5E learning cycle model.

CONCLUSION

The learning cycle 5E model in physics learning as a whole gives an effect with a high interpretation with an average effect size of 1.058. This shows that the learning cycle 5E model has a positive influence on the level of education, grade level, type of research, subject matter and needs in physics learning activities. The learning cycle 5E model can be used as an alternative learning model that is effective in improving students' learning achievement both in terms of knowledge, skills and attitudes or values. The 5E learning cycle model is a model oriented towards constructivist learning approach, active learning, discovery learning which can involve students directly in the process of learning activities. The 5E learning cycle model is effective for developing one or more 21st century skills. The results of this analysis are expected to provide useful input for educators or practitioners in the education unit to apply the 5E learning cycle model in learning activities, especially science learning.

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