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The Effect of The Problem Based Learning on Students Science Process Skills in Learning Physics: A Meta Analysis

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Abstract: Revolution 4.0 requires humans to have 21st century skills. The 21st century guides human resources that are able to compete with the wider community, so the government seeks to improve human resources through education. Thinking skills that are expected to achieve optimal learning outcomes are science process skills, because with these thinking skills students will be able to build meaning and confirm their understanding of a physical concept symptom and emphasize the importance of direct experience involvement in the learning process. The learning model that emphasizes learning as a process that involves solving problems in an actual context is the Problem based Learning model. Based on the description above, it can be stated that there are several researchers who have conducted research on the effect of problem based learning models on students' science process skills. So a meta-analysis of 15 articles was carried out, there was a significant effect of the problem based learning model on students' science process skills in learning physics based on grade level, physics subject matter and student learning outcomes.

Keywords: problem based learning, science process skills, physics.

Abstrak: *Revolusi 4.0 menuntut manusia untuk memiliki keterampilan abad-21. Abad-21 menuntun sumber daya manusia yang mampu bersaing dengan masyarakat luas, sehingga pemerintah berupaya meningkatkan sumber daya manusi melalui pendidikan. Keterampilan berpikir yang diharapkan dalam mencapai hasil belajar yang optimal adalah keterampilan proses sains, karena dengan keterampilan berpikir ini siswa akan dapat membangun makna dan mengkonfirmasikan pemahamannya mengenai sesuatu gejala konsep fisika serta memberikan penekanan pada pentingnya keterlibatan pengalaman langsung dalam proses pembelajaran. Model pembelajaran yang menekankan belajar sebagai proses yang melibatkan pemecahan masalah dalam konteks yang sebenarnya yaitu model Problem based Learnin. Berdasarkan uraian diatas dapat dikemukakan bahwa terdapat beberapa peneliti telah melakukan peneitian tentang pengaruh model problem based learning terhadap keteampilan proses sains siswa. Jadi dilakukan meta analisis dari 15 artikel terdapat pengaruh yang berarti penerapan model problem based learning terhadap keterampilan proses sains siswa dalam pembelajaran fisika berdasarkan tingkat kelas, materi pelajaran fisika dan hasil belajar siswa.*

Kata kunci: *problem based learning, keterampilan proses sains, fisika.*

▪ INTRODUCTION

Revolution 4.0 requires humans to have 21st century skills. At this time the development of information and technology is so rapid, even information can be obtained anytime, anywhere and by all people in all corners of the world. The rapid development of science and technology has led to competition between people and people, people with groups, and even competition between countries. In this way, Indonesia guides human resources who are able to compete with the wider community,

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develop professional competencesuperior knowledge, skills, attitudes and values (Asrizal, 2018) can be done through education.

Education is a conscious, planned effort to realize optimal learning processes and learning outcomes according to the characteristics of students (Septriana 2006). National education functions to develop capabilities and shape the character and civilization of a dignified nation in the context of educating the nation's life, aiming at developing the potential of students to become human beings who believe and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent. , and become democratic and responsible citizens (Depdiknas, 2003).

Learning in the classroom is still dominated by teachers, so they are less able to build better perceptions, interests, and attitudes of students. Students only memorize formulas, terms without knowing their uses and applications in everyday life, so that physics becomes synonymous with formulas. In learning physics, it should be able to be taught to students in a fun and enjoyable way because physics subjects are closely related to everyday life. This is possible because one of the causes is the use of inappropriate learning models or approaches by teachers in teaching. Learning like this will certainly create a class atmosphere that is rigid, monotonous, and boring.

One of the thinking skills that are expected to achieve optimal learning outcomes is science process skills, because with these thinking skills students will be able to construct meaning and confirm their understanding of a physical concept symptom and emphasize the importance of direct experience involvement in the learning process (Ibrahim, 2005). Various learning innovations were developed to anticipate the rapid development of science and technology. One of them is a problem-based learning model, or what is generally known as a problem-based learning model.

The Problem Based Learning (PBL) model is a learning model that emphasizes learning as a process that involves problem solving in an actual context (Rupika, 2018). The PBL model is well applied in the learning model, because in the PBL model students must learn to understand the material and construct knowledge, from understanding this material students can solve problems. The PBL model emphasizes more on the process, so that by using the PBL model students will acquire new knowledge independently to achieve the goals that have been set through the investigation process.

The initial study was conducted to obtain a different reality between ideal conditions and conditions in the field. The reality on the ground does not describe the expected conditions. Initial studies have been carried out in research, namely by reading from several journals related to the problem based learning model on students' science process skills. The reality on the ground is that teaching and learning activities in the classroom are teacher-centered. Where teachers are more active in the classroom while students are more passive. This is because most teachers only think about how to make the material taught can be completed on time without paying attention to whether students understand or not, so that when teaching and learning activities take place students only record concepts and memorize concepts. As a result, students do not understand the concepts they have learned which have an impact on student learning outcomes. So important is understanding in the learning process so that understanding is the key word in learning (Santyasa, 2008). Understanding is an absolute prerequisite for

a high level of cognitive ability, application, analysis, synthesis, and evaluation (Sakti, 2012).

The second fact in the learning process is that students are less active, when the question and answer process carried out by teachers and students takes place, students tend to be passive to ask questions to the teacher, students do not dare to ask questions related to the material being studied and do not dare to express opinions in front of the class. , only 4 students were willing and actively involved during the question and answer process and the others just watched silently. the lack of science process skills possessed by students, where from several indicators that exist in science process skills it appears that students are less skilled in making observations or observing, classifying, formulating hypotheses,

Based on the description above, it can be stated that there are several researchers who have conducted research on the effect of the problem based learning model on students' science process skills. The formulation of the problem is how the effect of the problem based learning model on students' science process skills based on learning materials and indicators of students' science process skills. Contrary to this explanation, the researcher is interested in conducting research on the size analysis of the effect of the problem based learning model on students' science process skills. This study analyzes several studies that discuss the effect of problem based learning models on students' science process skills. The aim of this research is1) determine the effect sizeproblem based learning model on students' science process skillsbased on grade level, 2) determine effect sizeproblem based learning model on students' science process skillsbased on learning material, and 3)determine effect sizeproblem based learning model on science process skills.

▪ METHOD

The research method used is the article review method by reviewing several articles in international and national journals. Article review is carried out in several steps. The steps for reviewing the article are determining and studying the research topic, choosing the type of article publication, collecting articles, analyzing moderator variables, recording statistical data, calculating effect sizes, drawing conclusions, and interpreting the results of article reviews (Tumangkeng, 2018). The review article aims to see how big the difference is between variables or how strong the relationship between research variables is.

The data in this study were obtained from articles relevant to the effect of problem based learning models on students' science process skills. The articles analyzed in this study amounted to 15 articles published in 2014-2021, the articles analyzed can be seen in Table 1.

Table 1. Analysis articles

Article Code	Author	Publication Year
J1	Andriani, K	2017
J2	Purba, F.J	2017
J3	Bahri, S. & Bakri,F	2018
J4	Handayani, U	2016

J5	Prameswari,A et al.	2019
J6	Rusmiyati, A et al.	2009
J7	Wira, W et al.	2015
J8	Sellavia, P et al.	2018
J9	Lutfa, A	2014
J10	Hidayati, K et al.	2014
J11	Mayanty, S et al.	2018
J12	Mayanty, S et al.	2020
J13	Andriani, K et al.	2021
J14	Darmaji, D et al.	2019
J15	Serevina, V	2018

The data in this study is secondary data because it is obtained from the results of previous research. Analysis of 15 articles in terms of the effect of the problem based learning model on students' science process skills from high school level, physics material, and students' science process skills. Determining the magnitude of the effect or effect size can use statistical parameters (Glass, 1981). Effect size category is divided into 3 parts. effect size in the low low category with an average value of 0 to 0.2 effect size with an average value from 0.2 to 0.8 is included in the sedan category. While the effect size with an average value of more than 0.8 is included in the high category (Becker, 2011).

▪ RESULT AND DISSCUSSION

The first result in this study is related to the effect of the problem based learning model on students' science process skills in terms of grade level. Of the 15 related articles, there are articles at the X, XI and XII grade levels. The average value of the effect size on students' science process skills can be seen in Table 2.

Table 2. The average value of effect size on students' science process skills

Class	Article Code	Effect Size	Average Effect Size	Category
X	J1	2.31	1.53	High
	J3	0.78		
	J8	3.02		
	J10	1.53		
	J13	0.70		
	J14	0.86		
XI	J4	1.01	1.00	High
	J5	0.73		
	J6	0.72		
	J7	0.86		
	J9	1.81		
	J11	1.11		
	J12	0.98		
	J15	0.74		

XII	J2	1.34	1.34	High

Based on Table 4 above, it can be described that the problem-based learning model provides a measure of the effect on students' science process skills in learning physics in class X with an average of 1.53 in the very high category. In class XI the average value of the effect size on students' science process skills is 1.00 which is categorized as high and in Class XII the average value of effect size on students' science process skills is 1.34 in the high category. This shows that the problem based learning model in learning physics has an effect on students' science process skills.

The results of these two meta-analyses are related to the effect of the problem based learning model on students' science process skills based on learning materials. The average value of the effect size obtained from the learning materials was obtained by calculating the effect size of 10 articles. The average value of the effect size is based on physics learning material at the high school education level. The average value of the effect size of the problem based learning model on the science process skills of physics learning students in terms of the subject matter used can be seen in Figure 1.

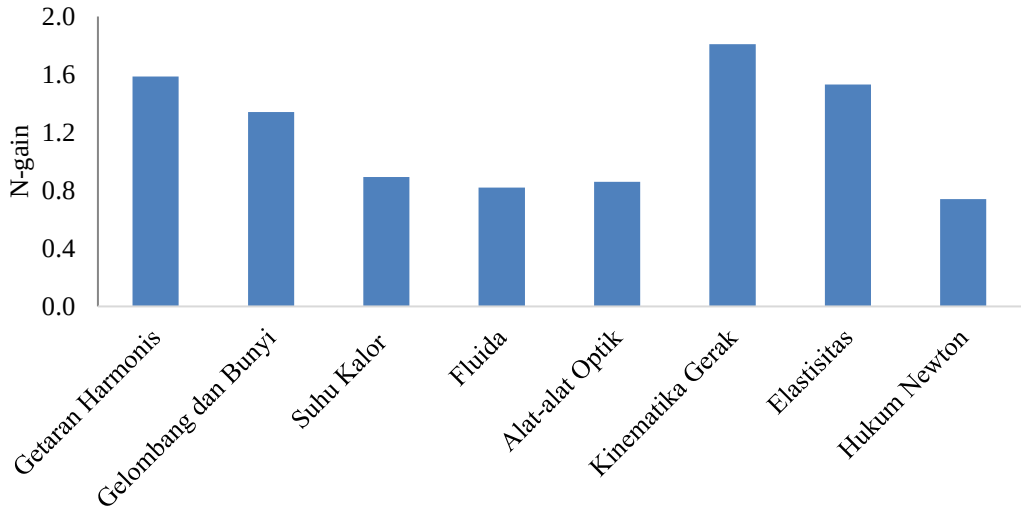

Figure 1. Effect size of the problem-based learning on the science process skills based on physics subject matter

From the data in Figure 1, it can be described that the use of problem based learning models on students' science process skills based on subject matter with different effect size values in several subjects. The use of problem based learning models in physics learning has a high effect on the material of harmonic vibrations, sound waves, motion kinematics and elasticity. the effect size of the use of problem-based learning models in physics learning in the high category is found in heat, fluids and optical devices.

Learning physics is one way to teach students to have a scientific attitude and scientific method to obtain scientific products. The scientific products are in the form of concepts, principles, principles, laws and physical theories. In addition to being able to produce scientific products, through learning physics students are also expected to be

able to apply these scientific products into everyday life, technology, industry and for higher education levels (Mundilarto, 2010). Learning physics will be more memorable if the effects of learning physics make students able to develop their experience to see and understand the real world by using science process skills.

The third result in this study is related to the effect of the problem based learning model on students' science process skills. There are 15 articles that fit the first objective. The average value of the effect size is obtained from the calculation of the effect size of each article. The value of the effect size of the problem based learning model on students' science process skills can be seen in Table 3.

Table 3. The value of effect size effect of problem based learning model on students' science process skills

Article Code	Effect Size	Average Effect Size	Category
J1	2.31		
J2	1.34		
J3	0.78		
J4	1.01		
J5	0.73		
J6	0.72		
J7	0.86		
J8	3.02	1.23	High
J9	1.81		
J10	1.53		
J11	1.11		
J12	0.98		
J13	0.70		
J14	0.86		
J15	0.74		

Based on the data in Table 5, it is stated that there are 15 articles with different average effect sizes. The overall average effect size of the problem based learning model on students' science process skills is 1.41. The average effect size describes that the problem based learning model has a high effect on students' science process skills. This shows that the model is effective for improving students' science process skills in learning physics.

The selection of learning models is one of the most decisive parts in an effort to find innovative learning alternatives that can improve students' scientific process skills. Problem-based learning is using problems as a basis for students to acquire knowledge (Inel, 2010). Learning with a problem based learning model is the interaction between stimulus and response, a relationship between two directions, namely learning and the environment. The environment provides input to students in the form of assistance and problems, while learning is centered on the brain's nervous system which functions to interpret aid effectively so that the problems encountered can be investigated, assessed, analyzed and resolved properly (Trianto, 2009).

Science Process Skills can be interpreted as insight or role models for the development of intellectual, social, and physical skills originating from basic abilities

which in principle exist within students (Tawil, 2014). Science process skills are all skills used to obtain and study various information about natural phenomena. Through science process skills, children can learn about science as scientists do, such as observing, classifying, conducting experiments and so on.

Basic skills are the basis or foundation to be able to train more complex integrated skills. To measure the success of students' basic science process skills, several indicators of basic science process skills must be considered. According to Funk (Dimyati, 2013), indicators of basic science process skills include: observing, classifying, communicating, measuring, predicting, concluding. The indicator component of science process skills has also undergone modifications and there are integrated skills including: controlling variables, interpreting data, formulating hypotheses, developing operational definitions, and conducting experiments.

▪ CONCLUSION

Based on the data that has been analyzed, conclusions can be drawn from this study. The conclusions of this study are: 1) the problem based learning model is effective for improving students' science process skills in learning physics in high school at different grade levels 2) the problem based learning model is effective for improving students' science process skills on physics material, with the results of the analysis on harmonic vibrations. 3) the problem based learning model is effective for improving students' science process skills in learning physics with an average effect size of 1.41 in the high category. So it can be concluded that learning with a problem based learning model to improve students' science process skills is effective in learning physics.

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