

Influence of Project-Based Learning Models on Students' Physics Knowledge and Critical Thinking Skills: Meta Analysis

Feby Febrianti¹, Asrizal^{1*}, Emiliannur¹

¹Department of Physics, Universitas Negeri Padang, Jl. Prof. Dr. Hamka Air Tawar Padang 25131, Indonesia
Corresponding author. Email: asrizal@fnipa.unp.ac.id

ABSTRACT

Education is expected to be able to improve students' knowledge and critical thinking skills. The first real condition in the field shows that students' skills in the knowledge aspect are in the low category and the second real condition shows that students' skills for critical thinking are low. The solution given to the gap that exists in real conditions and ideal conditions is to apply a project-based learning model to the classroom learning process. The aim of this research is to investigate the influence of the project-based learning model on students' physics knowledge and critical thinking skills, as well as investigate its influence on each variable at grade level. The research method used in this research is meta analysis. The sample from this research was 29 articles. The data analysis technique used in this research uses effect size calculations from each article. The research results show that there is a significant influence of the project-based learning model on the knowledge aspect skills and critical thinking skills, where the calculated effect size values obtained are 1.161 and 0.632. Data from hypothesis testing on each variable at class level, namely class X and XI. The results of hypothesis testing for both class X and class XI show that the project-based learning model does not have a significant positive influence on class X students, or the $p > \alpha$ value. Data from hypothesis testing for class XI shows that there is a significant positive influence of the project-based learning model on critical thinking skills, where the p value $< \alpha$.

Keywords : Meta Analysis, Knowledge Aspects, Critical Thinking



Pillar of Physics Education is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

I. INTRODUCTION

Character education in schools must be able to develop students' personalities so that they have the skills to think critically, creatively, communicate, collaborate and be competitive in the 21st century. This is in accordance with the four skills needed by students in the 21st century, known as 4C, namely critical thinking and problem solving, creativity, communication skills and the ability to work together [1]. The development of 21st century skills can of course be applied to physics learning which is included in the science learning family. These 21st century skills are certainly very important to apply in the learning process today where students really need to develop life skills and soft skills.

The goals of 21st century education can be achieved by changing the national curriculum from the 2006 Education Unit Level Curriculum to the 2013 curriculum. The 2013 curriculum is a curriculum that prioritizes 21st century skills-based learning. Students' 21st century skills need to be prepared to face digital challenges directly. Critical thinking skills are one of the 21st century skills that students must master. Critical thinking skills can provide an increase in student success in the learning process, besides that critical thinking involves several processes such as reasoning, predicting, analyzing, evaluating, and so on [2]. Critical thinking skills need to be instilled in the world of science to be taught both in schools and universities.

The first real condition is that students' physics critical thinking skills are still low. This can happen because physics learning is often carried out in schools using direct learning or the lecture method [3]. In the teaching and learning process students find it difficult to understand the material and apply it in life, in general teachers already have the habit of using conventional learning models in learning such as using the lecture method for all

types or characteristics of subject matter, even though the physics material itself is different [2, 4, 5]. This certainly has a big impact on students' critical thinking abilities due to a lack of curiosity because they are used to receiving knowledge limited to what the teacher gives in front of the class. Students only get material and concepts through regular group discussions, so only some students understand the concept of the material [6–8]. The second real condition found was that students' knowledge was still low because students thought that physics was complicated and were focused on memorizing formulas, causing students' enthusiasm for learning to decrease [4, 5, 9]. Students' knowledge which is guided by students' daily test scores is also low because practical activities are rarely carried out at school [6, 10, 11].

The gap that occurs between real and ideal conditions requires a solution to overcome this problem. Previous researchers offered a project-based learning (PjBL) model used in the physics teaching process in schools. Various variations of research results show that applying the project-based learning model (PjBL) can improve students' physics learning outcomes. The results of research conducted by researchers on articles in international and national journals related to the influence of the project-based learning model (PjBL) have different influences and are only limited to one aspect and one class level.

The limitations and weaknesses of previous researchers in analyzing the influence of the project-based learning model were that initially the researchers only studied certain material that was considered difficult. Second, the limitations only concern one aspect of knowledge or critical thinking skills. Third, the large number of empirical verification or replication efforts on a topic allows for studies of the suitability or inconsistency of research results. Fourth, the more research there is, the more different the research results or conclusions will be. Researchers need a method of combining two or more similar studies to obtain a combination of quantitative data. Meta-analysis is an attempt to quantitatively summarize the findings of different studies. This means that meta-analysis is a technique that aims to re-analyze research results that have been statistically processed based on primary data collection. Meta-analysis must be carried out due to the fact that no study is free from research weaknesses, even though researchers have tried to minimize research errors.

The general aims of meta-analysis research are as follows. First, to get the effect size value, which is a result indicator that shows the strength of the relationship or the size of the difference between variables. Second, conduct inference from the data in the sample to the population, either by hypothesis testing or estimation. Third, to control potential variables so that they do not become confounders so as not to interfere with the statistical significance of the relationship or difference [12]. Meta-analysis research has several advantages. The advantages of meta-analysis research are (1) meta-analysis research makes it possible to combine several types of research results quantitatively, (2) it can show relationships between studies which can then be a solution to differences in results between studies, (3) meta-analysis research is more concrete because it focuses on data while other literature reviews focus on conclusions from various kinds of research, (4) meta-analysis research focuses on effect size, and (5) meta-analysis research is carried out quantitatively which makes it easier for researchers to carry out research [13]. By considering these advantages, many researchers use meta-analysis methods in their research.

Despite the many advantages of using the meta-analysis method, this method also has disadvantages, first, this analysis takes quite a long time to complete compared to conventional qualitative research reviews. Second, researchers must have special knowledge in selecting and computing the correct effect size in statistical analysis. Third, there is bias in sampling and publication. Fourth, the studies used in the meta-analysis were not comparable. Fifth, there are errors in methodology [14]. The benefit of meta-analysis research is that it is a shortcut to obtain explanations, summaries and reinforcement of previous research. Thus the results can be used as a tool to search for the truth to explain the relationship between a phenomenon. Each learning model has its own characteristics, as does the project-based learning model. There are eight characteristics and characteristics of the project-based learning model proposed by the Buck Institute for Education, namely, (1) students make decisions and frameworks, (2) there are problems whose solutions are not determined beforehand, (3) students design processes to achieve results, (4) responsible for obtaining and managing the information collected, (5) students carry out continuous evaluations, (6) regularly look back at what they have done, (7) the final result is a product and its quality is evaluated, (8) learning situation very tolerant of mistakes and change [15]. The project-based learning model (PjBL) includes problem solving activities, decision making, investigative skills and skills in making creative and innovative work. Based on the background of the problem that has been described, the aim of this research is to calculate the magnitude of the influence of the project-based learning model on students' physics knowledge and critical thinking skills, and its influence at grade level.

II. METHOD

The type of research used is meta analysis which aims to review several studies that have previously used a quantitative approach. A quantitative approach is used because in meta-analysis research, data analysis activities are carried out by analyzing quantitative data derived from the results of previous research to conclude whether or not the hypothesis proposed in the research is accepted [14]. The sample in this research was 29 articles that met the criteria and matched the keywords in the research, consisting of several national and international journals. The data to be analyzed comes from several articles. This data was collected by searching several articles on online journal sites such as Google Scholar and Sinta.

The articles used in this research have several provisions. The terms of the article are as follows, (1) the articles used are related to keywords, (2) the articles used are articles published nationally and internationally, (3) the articles selected in this research were published within the last 10 years, in 2013-2023, (4) the selected articles are articles that discuss physics learning, (5) the selected articles discuss the influence of project-based learning models so that they can increase students' knowledge, improve critical thinking skills, (6) the selected articles are journals that contain research variables that are relevant to the focus of the research to be carried out, (7) selected articles contain statistical information that can be used to determine effect calculations. In order to find articles that meet the above criteria, searches are carried out based on keywords such as project-based learning models, thinking skills, cognitive aspects, etc. Then several articles will appear that relate to the keywords used in the search. Articles that meet the criteria will then be used in this research.

A variable is a term that cannot be forgotten or left behind in a study. A good and correct research must contain variables. A variable is something that has variations or types that are determined by the researcher himself to be studied and then draw conclusions. For research that has been determined 3 variables are needed, (1) the independent variable is a variable that acts as an influence or is the reason for the dependent variable to change, the independent variable in this research is 29 articles related to the project-based learning model, (2) the dependent variable is the variable which is influenced by the independent variable, the dependent variable is used as a result of the independent variable, the dependent variable in this research is students' knowledge and students' critical thinking skills, (3) moderating or intermediary variables are variables that strengthen or weaken the relationship between one variable and another, the intermediary variable in this research is class level.

Meta analysis research has stages that must be carried out. Many experts and researchers have put forward the stages of meta-analysis research. The stages of meta analysis research can be seen in Figure 1 below [16],

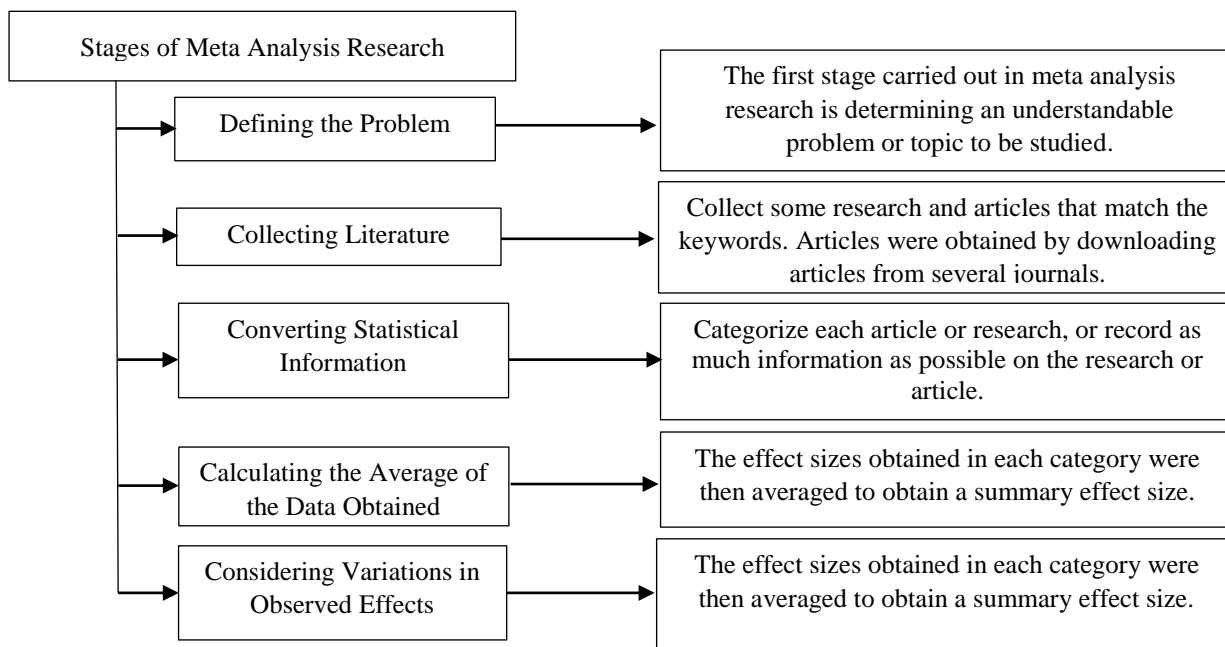


Figure 1. Stages of Meta Analysis Research

The effect size can be calculated by a conversion formula based on statistical data available in each journal. After calculating the effect size, hypothesis testing is carried out. To calculate the effect size value, the following equation is used [17],

$$ES(d) = \frac{\bar{X}_{posttest} - \bar{X}_{pretest}}{SD_{within}} \quad (1)$$

Hypothesis testing is carried out using the following p test,

$$p^* = 1 - \phi(\pm |Z^*|) \quad (2)$$

- ES = Effect size
 XpreE = Pretest average of the experimental group
 XpreC = Control group pretest average
 XpostE = Experimental group posttest average
 XpostC = Control group posttest average
 SDwithin = Standard Deviation of combined samples
 t = t test results
 nE = Number of experimental group samples
 nC = Number of control group samples

Based on the categories of effect sizes referring to Table 1 below,

ES	Category
ES ≤ 0.15	Not important
0.15 < ES ≤ 0.40	Small Level
0.40 < ES ≤ 0.75	Intermediate Level
0.75 < ES ≤ 1.10	Extensive Level
1.10 < ES ≤ 1.45	Very wide
1.45 ≤ ES	Excellent Level

(Source: Ref[18])

III. RESULTS AND DISCUSSION

A. Results

The total of articles used was 29 articles, where the articles analyzed were articles published in the period 2013-2023. Articles within the last 10 years selected in the research are coded A1-A29. Each journal has variables to determine the size of the effect on knowledge aspect skills and critical thinking skills, and the influence at each grade level. The first result of this meta-analysis research is the influence of the project-based learning model on knowledge aspect skills. The average effect size value for the knowledge aspect obtained from 22 articles can be seen in Table 2.

Article Code	Effect Size Yi	Average Effect Size	Category	p
A1	0.618			
A2	0.007			
A3	3,960			
A4	3,317			
A5	3,710			
A6	0.941			
A7	1,541			
A8	1,024	1,161	Excellent Level	0,000
A9	0.454			
A10	1,794			
A11	1,716			
A13	0.861			
A14	0.780			
A15	0.734			
A16	2,418			

A18	2,453
A19	0,422
A20	3,885
A21	1,317
A22p	0,903
A24	3,037
A25p	0,574

Based on the results of hypothesis testing and calculation of effect size values on aspects of students' physics knowledge which were processed based on data from 22 articles that have met the categories for use in this meta-analysis research, it shows that the project-based learning model has a significant positive influence on student learning outcomes in the knowledge aspect. The effect size results obtained from several of these articles were 1.161, indicating that the learning model was in the category at a very good level, with a lower confidence interval of 0.563 and an upper confidence interval of 1.760. The results of hypothesis testing also show that the p value $< \alpha$, meaning that the results of hypothesis testing are rejected. The rejected hypothesis can be interpreted as meaning that as many as 22 similar articles have an influence on the project-based learning model on learning outcomes in aspects of students' physics knowledge. This test data shows that the project-based learning model is effective for use in the learning process in schools, because it is considered to have an effect on improving students' skills in the knowledge aspect.

The second research result in this research is the influence of the project-based learning model on students' critical thinking skills. Effect size values and hypothesis testing were carried out on the results of this study. The calculation of effect size values was obtained from 9 articles that met the criteria. The data resulting from the effect size calculation can be seen in Table 3.

Table 3. Influence on Critical Thinking Skills

Article Code	Effect Size Y_i	Average Effect Size	Category	p
A12	0.925			
A17	0.967			
A22k	0.525			
A23	0.506			
A25k	1,308	0.632	Intermediate Level	0.030
A26	0.728			
A27	0.118			
A28	2,242			
A29	0.643			

Hypothesis testing was carried out on 9 articles obtained from national journals and international journals. Based on the hypothesis test data, a p value of 0.030 was obtained, where this value is greater than the α value, namely 0.05 or the p value $> \alpha$, meaning the hypothesis is rejected. If it is rejected, it can be said that as many as 9 similar articles have an influence on the project-based learning model on students' physics critical thinking skills. Calculating the effect size value on students' critical thinking skills in Table 3, it can be seen that the effect size value obtained is 0.632, indicating that the learning model is in the middle level category, meaning that the project-based learning model can be used in the learning process because it is considered quite effective in improve students' critical thinking skills in physics.

The third result in research regarding the influence of the project-based learning model on knowledge aspects is based on the moderator variable, namely class level. For class level, the researchers only took samples from classes X and XI. The number of articles obtained for class X was 11 research articles and for class XI was 11 research articles. Data from the third research can be seen in Table 4.

Table 4. Effect Size Data on Knowledge Aspect Skills

Article Code	Effect Size Y_i	Average Effect Size	Category	P	Class
A3	3,960				
A5	3,710				
A6	0.941	1,288	Very Wide Level	0.003	X
A13	0.861				
A15	0.734				

A18	2,453				
A19	0.422				
A20	3,885				
A21	1,317				
A22p	0.903				
A25p	0.574				
<hr/>					
A1	0.618				
A2	0.007				
A4	3,317				
A7	1,541				
A8	1,024				
A9	0.454	1,057	On a Broad Level	0.005	XI
A10	1,794				
A11	1,716				
A14	0.780				
A16	2,418				
A24	3,037				

Data from calculating the effect size value of the influence of the project-based learning model on aspects of knowledge based on class level were calculated for class X and class XI. There are 11 articles discussing class X and 11 articles discussing class XI. The results of calculating the effect size values can be seen in Table 5 above. In the table it can be seen that the average effect size value is 1,288 for class X and 1,057 for class Based on the results of hypothesis testing from each class level, it shows that both class levels show an influence on learning outcomes in aspects of students' knowledge. Hypothesis test data for class X and class XI shows that the p value for class significant positive influence for both class X and class XI students. The project-based learning model can be used to increase the level of physics knowledge.

The fourth result of this meta-analysis research is the influence of the project-based learning model on students' critical thinking skills at class level, namely class X and class XI. This research data was obtained from 9 similar articles, of which there were 6 articles for class X and 3 articles for class XI. Data for calculating effect size values can be seen in Table 5.

Table 5. Calculation Data on Effect Sizes on Critical Thinking Skills

Article Code	Effect Size Yi	Average Effect Size	Category	P	Class
A17	0.967				
A22k	0.525				
A23	0.506	0.454	At Intermediate Level	0.089	X
A25k	1,308				
A26	0.728				
A27	0.118				
<hr/>					
A12	0.925				
A28	2,242	1,058	On a Broad Level	0.001	XI
A29	0.643				

The data listed in Table 5 above shows the results of calculating the effect size value of the project-based learning model on critical thinking skills at grade level. This data was obtained through calculating the effect size of 9 articles, of which 6 articles were for class X data and 3 articles were for class XI data. Based on the data in Table 5, it can be seen that the calculation results of the effect size values in classes X and Apart from calculating the effect size value, a hypothesis test was also carried out. Hypothesis testing data obtained a p value for class Hypothesis test data for class.

B. Discussion

This research was conducted to see the size of the effect of the project-based learning model on aspects of students' knowledge and critical thinking skills in physics, as well as on the moderator variables that have been

determined. The first research results relate to the influence of the project-based learning model on aspects of student knowledge. Based on the results of hypothesis testing, it shows that there is a positive and significant influence between the project-based learning model on aspects of students' physics knowledge. The effect size results show that the project-based learning model provides effects that are categorized at a very good level. The project-based learning model has an impact on aspects of students' knowledge, and is effectively used in the physics learning process. These results are supported by research [19]. The knowledge of students in classes that apply project-based learning is higher than the knowledge in classes that do not apply the project-based learning model. This project-based learning model provides a significant positive influence on learning outcomes in aspects of students' knowledge.

The second result discusses the influence of the project-based learning model applied in learning on students' critical thinking skills. Referring to research data, it shows that there is an influence of the project-based learning model on students' critical thinking skills, where if seen from the research results, the effect size values obtained from several of these articles are included in the middle level category. This shows that there is a positive influence between the project-based learning model and students' critical thinking skills. These results are also strengthened by research [20], where the results of data analysis show that the implementation of the project-based learning model has an influence on students' critical thinking skills, the influence on students' critical thinking skills is higher in the implementation of PjBL compared to conventional classes. Based on several research results that have been carried out previously, it supports the results of hypothesis testing carried out by researchers in this study, where there is a significant positive influence of the project-based learning model on students' physics critical thinking skills.

The third research result is regarding the influence of the project-based learning model on aspects of student knowledge at grade level. Based on the test results of the third hypothesis, it shows that the class levels studied, namely Class X and Class XI, show a significant positive influence between the project-based learning model and learning outcomes in aspects of student knowledge. The effect size of the class level shows that class X has a greater effect on aspects of students' knowledge where the effect size category obtained from class X means that based on the results of the analysis of several journals in this research, the project-based learning model is suitable for class X and XI students. A similar thing was also stated by [21], the project-based learning model is an alternative in developing critical thinking skills and improving learning outcomes in the knowledge aspect of class X students in high school. The results of this researcher's research are strongly supported by the results of research from previous researchers that the project-based learning model has a significant positive effect on class X and class XI.

The results of further research are the influence of the project-based learning model on critical thinking skills at grade level. Guided by the results of testing the fourth hypothesis, it can be seen that the project-based learning model has a significant influence on students' critical thinking skills in class XI critical thinking skills effect size, where the effect size values obtained belong to categories at a broad level. The data for class X The results of hypothesis testing are in line with Piaget's theory which states that cognitive development is closely related to a person's physical maturity, because the older a person gets, the better their way of thinking will be. [22]. Based on theory and the results of this research, it strengthens the results of research conducted by researchers where the older a person gets, the more their critical thinking skills develop.

The research that has been conducted has several limitations in its implementation. It is hoped that limitations that occur during the research process will become experiences and lessons for the future. The following are several limitations in this research:

First, the articles analyzed in this research were only limited to 29 articles, of which 22 articles were found that discussed the influence of the project-based learning model on learning outcomes in the knowledge aspect, and 9 articles discussed the influence of the project-based learning model on students' critical thinking skills. The articles used are national articles and international articles. An alternative solution to overcome this problem is to look for other articles that discuss project-based learning models on more aspects of student knowledge and critical thinking skills and are no longer focused on the high school level alone.

The two project-based learning models on aspects of student knowledge and students' critical thinking skills based on class level only research at 2 class levels, namely class X and XI. This is also one of the limitations of this research, where the research was only carried out at 2 grade levels. An alternative solution to this problem is that researchers should be able to find more articles related to this research, especially for the variable of critical thinking skills in students.

Third, the skills aspect analyzed in this research includes only two aspects, namely the knowledge aspect and the critical thinking skills aspect only. This is because there are difficulties in finding articles that analyze

other aspects of skills and limited time in analyzing articles. Alternative solutions for researchers should be designed as well as possible before conducting research so that the research produces perfect results.

Fourth, the moderator variables examined in this study are only limited to grade level. This is because it is difficult to find articles with moderator variables that vary quite a lot. Examples of other moderator variables that can be used include education level, learning materials, media used in learning, etc. The alternative solution to this problem is the same as the solution to the previous problems, namely by finding more articles that are appropriate to the research topic that will be carried out, so that the results of the research carried out are more optimal and more perfect than previous research.

IV. CONCLUSION

Referring to the results of this meta-analysis research, several research conclusions can be drawn. The first conclusion is that the project-based learning model provides a significant positive influence both on the knowledge aspect and on students' critical thinking skills. The effect size value for the knowledge aspect is 1,161, which is in the very good level category and the effect size value for critical thinking skills is obtained. a value of 0.632 is in the middle level category. Second, the project-based learning model has a significant influence on aspects of students' physics knowledge in class X and class broad level for class XI. The third conclusion is that the project-based learning model does not have a significant positive influence on aspects of students' physics critical thinking skills in class significant with a p value $< \alpha$, and the obtained effect size value of 1.058 is in the broad level category. Based on the research results that have been obtained, there are obstacles faced when conducting research. The following are suggestions put forward by the author, first suggestion, meta-analysis research should be carried out carefully and in detail. In order to minimize the occurrence of data bias. The selection of articles should also be done carefully and the research summarized must be complete so that the meta-analysis research carried out can be categorized as good. Second suggestion, sampling should be taken from many sources of articles published online. The more samples used in research, the better the quality of the research. Last suggestion, learning outcomes analyzed in research should not only be limited to aspects of knowledge and critical thinking skills.

ACKNOWLEDGMENT

This thesis is submitted to fulfill one of the requirements for obtaining a Bachelor of Education degree, Department of Physics, Faculty of Mathematics and Natural Sciences, Padang State University. The preparation and completion of this thesis could not be separated from the help, advice and support of many parties. On this basis, the author would like to express his thanks to the lecturers and teaching staff who work in the Department of Physics, FMIPA UNP, and the researcher would like to express his gratitude to the parents and family. who always provided encouragement during the process of completing this thesis and thank you to friends who always supported and encouraged me throughout the process of writing this thesis. Thank you to all parties who have helped plan, implement, compile and complete this thesis. Hopefully all the advice, assistance and attention given to the author will be a good deed for everyone and will receive double rewards from Allah SWT.

REFERENCES

- [1] AM Sayekti and Suparman, "Description of PJBL-Based LKPD with a Stem Approach to Improve Critical Thinking Abilities," *Sendika Proceedings*, vol. 5, no. 1, p. 601–609, 2019.
- [2] Sumardiana, "The Influence of Students' Critical Thinking Ability with Project Based Learning on Temperature and Heat Material," *Global Education Scientific Journal*, vol. 1, no. 2, p. 04–09, Oct 2020.
- [3] E. Susilawati, A. Agustinasari, A. Samsudin, and P. Siahaan, "Analysis of the Level of Critical Thinking Skills of High School Students," *Journal of Physics and Technology Education*, vol. 6, no. 1, p. 11–16, 2020.
- [4] A. Nora and Asrizal, "Meta Analysis of Problem Based Learning Models in High School Physics Students on Student Learning Outcomes," *Pillars of Physics Education*, p. 494–501, Dec 2020.
- [5] S. Aminah, "Application of the Project Based Learning Model to Improve Physics Learning Outcomes and Science Process Skills of Class X Mia 3 Students at Pare-Pare State High School," *BUM Education Journal*, vol. 2, no. 1, p. 318–333, Feb 2018.
- [6] S. Ismail, "The Effect of Using the 'Project Based Learning' Project Based Learning Model on the Physics Learning Outcomes of Class X Science Students at SMA Negeri 35 South Halmahera on the Concept of Straight Motion," *Wahana Pendidikan Scientific Journal*, vol. 8, no. 5, p. 256–268, Apr. 2022.

- [7] C. Siregar, M, and Motlan, "The Effect"Of Project Based Learning Model On Student's Learning Achievement Off Fluid Topic In Class XI SMA N 1 Matauli Pandan Academic Year 2013/2014," *Inpafi Journal*, vol. 2, no. 4, p. 31–36, 2014.
- [8] N. Salmi, A. A, and A. P, "Application of the Project-Based Learning Model to the Physics Learning Motivation and Science Process Skills of Students at SMAN 4 Makassar," *Journal of Sciences and Physics Education*, vol. 13, no. 3, p. 238–247, 2017.
- [9] T. Wijayanto, B. Supriadi, and L. Nuraini, "The Effect of Project Based Learning Models with a STEM Approach on High School Student Learning Outcomes," *Journal of Physics Learning*, vol. 9, no. 3, p. 113–120, Sep 2020.
- [10] DN Rohmawati, "Project Based Learning Model by Utilizing the Surrounding Environment on Students' Physics Learning Results and Activities," *SCHOLASTICA*, vol. 1, no. 1, p. 71–80, Nov 2019.
- [11] R. Siti, Subiki, and A. Harijanto, "The Influence of the Project-Based Learning Model by Utilizing the Surrounding Environment on Student Physics Learning Outcomes and Learning Activities (Studies on Fluid Materials at SMK Negeri 2 Jember)," *Journal of Physics Learning*, vol. 5, no. 4, p. 404–411, 2017.
- [12] RD Nindrea, *Introduction to Practical Steps in Meta-Analysis Studies*. Yogyakarta: Gosyen Publishing, 2016.
- [13] W. King, "Understanding The Role and Methods of Meta-Analysis in IS Research," *Communication of The AIS*, p. 665–658, 2005.
- [14] H. Retnawati, F. Apino, H. Djidu, and RD Anazifa, *Introduction to Meta Analysis*. Yogyakarta: Parama Publishing, 2018.
- [15] LI Sari, H. Satrijono, and S. Sihono, "Application of the Project Based Learning Model to Improve Learning Outcomes in Speaking Skills for Class VA Students at SDN Ajung 03," *Education Journal*, vol. 2, no. 1, p. 11–14, 2015.
- [16] J. Decoster, *Meta-Analysis Notes*. Albama: University Of Albama, 2009.
- [17] K. Becker and K. Park, "Effects of Integrative Approaches Among Science, Technology, Engineering, and Mathematics (STEM) Subjects on Students' Learning: A Preliminary," *Journal of STEM Education*, vol. 12, no. 5, p. 23–38, 2011.
- [18] S. Dincer, "Türkiye'de Yapılan Bilgisayar Destekli Öğretimin Öğrenci Başarısına Etkisi ve Diğer Ülkelerle Karşılaştırılması : Bir Meta-Analiz Çalışması," *Journal of Turkish Science Education*, vol. 12, no. 1, p. 99–118, 2015.
- [19] R. Doski Yance, E. Ramli, and Fatni Mufit, "The Effect of Implementing the Project Based Learning (Pbl) Model on the Physics Learning Outcomes of Class XI Science Students at SMA Negeri 1 Batipuh, Tanah Datar Regency," 2013.
- [20] S. Suci, J. Siburian, U. Yelianti, and P. Biology, "Jambi-Muara Bulian No.KM. 15, Mendalo Darat."
- [21] Hijrawati, M. Arsyad, and B. Dara, "The Effect of Project-Based Learning Models on Critical Thinking Skills and Physics Learning Outcomes of Class X Students of SMA Negeri 9 Makassar," *Journal of Physics Education*, 2019.
- [22] L. Marinda Postgraduate Program IAIN Jember PGMI Study Program, "Jean Piaget's Theory of Cognitive Development and Its Problems in Elementary School Age Children."