Jurnal Ilmiah Pendidikan Fisika
https://ppjp.ulm.ac.id/journals/index.php/jipf/index
e-ISSN: 2549-9963 p-ISSN: 2549-9955
Vol 10 No 2 2026
DOI: https://doi.org/10.20527/jipf.v10i2.18326

The Effect of Project-based Learning on Self-efficacy and Learning Outcomes of Physics Students in High School on Momentum and Impulse Learning Material

Muhammad Rizki Febrian*, Bambang Supriadi, and Firda Kusuma Ayu Anggraeni
Physics Education, Universitas Jember, Jember, Indonesia
*rizkifebrianmuhammad99@gmail.com

Article Info

Article history:
Received: December 19, 2025
Accepted: April 20, 2026
Published: July 26, 2026

Keywords:
Learning outcomes
Momentum and impulse
Physics
Project-based learning
Self-efficacy

Abstract

Physics learning at the high school level is typically characterized by a predominance of teacher-led activities over student engagement, resulting in suboptimal student confidence and learning outcomes. This study aims to examine the effect of the application of the project-based learning (PjBL) learning model on student learning outcomes, especially in the learning material of momentum and impulse. This study is based on the need for innovative transformation of learning management to improve the quality of human resources and the active involvement of students as learning subjects. The employed research method is quantitative with a control-only design. The research sample comprised 10th-grade science students at Ibrahimy High School, categorized into Science 1 as the experimental group employing the project-based learning model and Science 2 as the control group utilizing the conventional model. The homogeneity test yielded a significance value of 0.620, which exceeds 0.05, indicating that the pre-test data for both the experimental and control classes are homogeneous. The normality test of the self-efficacy questionnaire data was conducted on 31 data samples using the Shapiro-Wilk method. The questionnaire and post-test normality test demonstrated that the data distribution in both the experimental and control groups was normal. The t-test on the questionnaire scores revealed a significance value of 0.002, which is below 0.05, indicating that the null hypothesis (Ho) was rejected and the alternative hypothesis (Ha) was accepted. Thus, there was a significant difference in self-efficacy between students in the experimental class and the control class. Moreover, the t-test on the post-test scores showed a significance value of 0.000, less than 0.05, meaning that (H_o) was rejected and (H_a) was accepted. Thus, the learning outcomes between both classes were significantly different. This study concludes that the implementation of the project-based learning model significantly enhances student self-efficacy and learning outcomes in comparison to conventional learning models. PjBL has demonstrated the capacity to foster more dynamic and solution-focused learning via real-world problem-solving and innovative product development.

To cite this article: Febrian, M. R., Supriadi, B., & Anggraeni, F. K. A. (2026). The effect of project based learning on self-efficicy and learning outcomes of physics students in high school on momentum and impulse learning material. *Jurnal Ilmiah Pendidikan Fisika, 10*(2), 196-206.

INTRODUCTION

Physics education at the senior high school level is generally characterized by learning environments dominated more by teacher-led activities than by student-oriented activities. As a result, physics education in schools has typically been less engaging for students (Ekatushabe et al., 2021; Brakhage et al., 2023), because the delivery of material focuses primarily on formula memorization and mathematical calculation, often neglecting physics concepts relevant to daily life applications. Students also encounter challenges regarding self-efficacy, frequently experiencing doubt in their own abilities during the learning process, which leads to a decline in academic performance.

To address these challenges, a transformation in instructional management is required through more innovative educational planning capable of enhancing student self-efficacy. Consequently, the Project-based Learning (PjBL) model is essential, as it enhances student self-efficacy by facilitating active engagement in the discovery and execution of projects. The application of the Project-Based Learning model in the physics classroom offers numerous advantages, addressing curricular requirements while facilitating the attainment of long-term educational objectives (Goldstein, 2016; Misbah et al., 2024; Sinaga et al., 2023; Syaifuddin et al., 2025).

PjBL is an educational methodology that allows students to design learning activities, collaborate on projects, and eventually produce work that can be presented to others (Arifianti et al., 2020). This model designates students as the central figures in the learning process, guiding them to address real-world issues through research activities, cooperation, and the development of innovative products. PjBL activities enable students to comprehend the application of knowledge in a comprehensive and systematic way, rather than only memorizing theories. PjBL is defined as a collaborative, progressive, student-centered, interactive, and comprehensive instructional style (Harizah et al., 2022). It is expected that the PjBL can enhance student understanding of complex concepts through active involvement in exploring real-world issues (Handayani et al., 2025). As an example of a PjBL activity, students are tasked with constructing a water rocket to improve their understanding of physics, specifically regarding the topic of momentum and impulse.

PjBL is a model that encourages students to engage actively in the learning process (Setiyadi & Wahyu, 2023). Consistent application of this model can enhance both self-efficacy (confidence) and learning outcomes compared to conventional methods. It provides students with meaningful experiences by allowing them to develop their own knowledge. This strategy has several advantages: (1) fostering student independence, (2) increasing responsibility for their own learning, (3) developing problem-solving skills and self-efficacy, and (4) expanding learning access (Abdi & Airlanda, 2023).

PjBL can be conducted individually or in groups. Each assigned task may differ from one another, or a single problem may be resolved by each student or group, eventually creating similar or differing perspectives that are subsequently assessed through teacher evaluation (Padji et al., 2024). The effective implementation of PjBL necessitates comprehensive preparation, including adequate time management, facility provision, and objective assessment mechanisms. In the absence of thorough preparation and planning, this project-based paradigm forfeits its fundamental objective. Therefore, this study aims to examine the significant influence of PjBL implementation on the improvement of self-efficacy and learning outcomes of students in the subjects of momentum and impulse. The PjBL necessitates active student engagement throughout the whole educational process. The active participation of students in the learning process is intrinsically linked to their self-efficacy in addressing diverse situations and uncovering concepts throughout instruction (Ulfah et al., 2020).

Physics is perceived as a very difficult subject by students, particularly the topic of momentum and impulse. Therefore, teachers should implement the PjBL model to improve student self-efficacy. Self-efficacy is a student's belief in their own ability to perform school tasks to achieve specific results (Wahyudiati & Qurniati, 2022). Self-efficacy is highly necessary for students because it significantly influences their learning outcomes. This instructional approach also demands that students integrate various types of knowledge to construct an understanding of physics concepts (Sasmita & Hartoyo, 2020). Aprilia et al. (2026) asserted that self-efficacy pertains to the degree to which an individual evaluates their personal confidence in executing diverse learning activities and fulfilling the associated tasks. It pertains to students' confidence in their ability to do tasks and attain educational goals (Santos et al., 2025). Self-efficacy is a crucial determinant of the success of the learning process (Hariani et al., 2024). The execution of this strategy is tailored to the students and the competencies to be examined (Rohim et al., 2023). This proves that the utilization of the PjBL model is more influential in increasing student self-efficacy (Rahmawati & Maryani, 2025).

PjBL can significantly enhance students' self-confidence, as they are provided with opportunities to construct understanding and resolve real-world problems through projects (Watoni et al., 2025). The project-based learning model is capable of improving student learning outcomes. The experimental class was treated using the PjBL model, while the control class received no treatment, utilizing conventional learning; based on the final test (post-test) results, a significant difference was found between the experimental and control classes (Apsoh et al., 2023). According to Ramadianti (2021) the PjBL model is capable of increasing learning outcomes. The implementation of the PjBL model exerts an influence on student learning outcomes (Fatimah & Makki, 2023). In this study, PjBL is expected to increase both student self-efficacy and learning outcomes. From the results of the data analysis, it can be concluded that there is a significant influence of the PjBL model on student learning outcomes (Mawarini et al., 2022).

PjBL is one of the instructional models that can help students improve the learning outcomes required in the current era of globalization (Dwiantoro & Basuki, 2021). This study necessitates the application of several pedagogical approaches, especially the PjBL model, which can enhance student learning outcomes and greatly bolster students' self-efficacy in their educational pursuits (Abidin et al., 2021). This study employed the PjBL approach to assess its impact on student self-efficacy and academic performance. PjBL is anticipated to enhance both student self-efficacy and academic performance.

METHODS

Type and Design of Research

This study employed experimental research using an after-only control design to assess the impact of the PjBL model on high school students' self-efficacy and learning outcomes on momentum and impulse. This study was primarily characterized by its quasi-experimental design. A quasi-experiment utilized samples from an existing population for both the experimental and control groups. Data collection for the research was performed at SMA Ibrahimy during the second semester of the 2025/2026 school year. This study employed Grade X Science classes, notably X IPA 1 and X IPA 2, as control variables. The independent variable utilized the PjBL instructional model. The dependent variables in this study were self-efficacy and academic performance. The research design employing the after-only control design is illustrated in Table 1.

Table 1 After-only control design research

E	X	O_1
K	-	O_2

K = Control class
E = Experimental class
X = Treatment in the experimental class using the Project-Based Learning model
O_1 = Experimental class tested with a post-test and self-efficacy questionnaire
O_2 = Control class tested with a post-test and self-efficacy questionnaire

Research Procedures

The research procedure involves several steps as outlined in the following Table 2.

Table 2 Research procedure

No	Activity description
1.	Preparing research instruments and drafting the proposal
2.	Selecting the school for the research site using a true experimental design type
3.	Conducting observations and interviews with the physics teacher
4.	Determining the population and research location
5.	Performing homogeneity tests using data from the previous chapter
6.	Establishing research samples for the experimental and control classes
7.	Implementing teaching and learning activities using the Project-Based Learning model in the experimental class and the teacher-centered model in the control class
8.	Conducting observations and assessments during the learning process in both classes
9.	Administering the post-test and self-efficacy questionnaire to both classes
10.	Analyzing the data obtained from observation results
11.	Discussing the analysis of research data and interview results
12.	Drawing conclusions from the conducted research results

Data Analysis Techniques

Data collection techniques represent the methods used by researchers to obtain research data. The researcher conducted interviews at SMA Ibrahimy to facilitate the acquisition of information regarding the school. The researcher interviewed the Grade X Science physics teacher with 10 questions and posed 5 questions to the students. In this study, the researcher distributed 10 pre-test questions to the Grade X Science classes to determine which classes possessed homogeneous data variance groups. After determining the population and variables, Grade X Science 1 and Science 2 were tested for homogeneity using pre-test scores from the previous chapter to determine research respondents through a one-way test using SPSS 23. Homogeneity tests were used to determine whether several population variances were equal (Usmadi, 2020). Variance homogeneity testing was essential before comparing two or more groups to ensure that existing differences were not caused by baseline data differences (Sianturi, 2022). After distributing pre-test questions, the researcher identified Grade X Science classes with equal variance values for the study. The formula for finding the variance/deviation of variables X and Y is as follows.

$$S_X^2 = \sqrt{\frac{n.\sum X^2 - (\sum X)^2}{n(n-1)}} \qquad \ldots (1)$$

To determine homogeneity, the F-count is used from the variances of X and Y with the following formula.

$$F = \frac{S_x}{S_y} \qquad \ldots (2)$$

Subsequently, after performing the homogeneity test, the researcher designated Grade X IPA 1 to use the Project-Based Learning model, while Grade X IPA 2 used the teacher-centered model as research subjects. Several techniques were employed for collecting data on self-efficacy and learning outcomes.

Self-efficacy

Self-efficacy data collection utilized a questionnaire consisting of 12 questions to determine the level of student self-efficacy toward the Project-Based Learning model. The self-efficacy questionnaire was distributed to respondents in classes X IPA 1 and X IPA 2. The distribution occurred after the learning process was completed to determine the influence of the Project-Based Learning model on student self-efficacy in momentum and impulse. Self-efficacy was measured using indicators developed from three dimensions, as presented in Table 3.

Table 3 Self-efficacy indicators

Dimension	Indicators
Magnitude of Confidence	• Optimistic view in completing tasks • Confidence in task completion • Viewing difficult tasks as challenges • Ability to plan task resolution
Ways to Increase Confidence	• Commitment to task completion • Belief in the ability to finish tasks • Persistence in task completion • Good self-motivation to complete tasks
Facing Situations with Confidence	• Responding well to different situations and thinking positively • Using experience to increase confidence • Ability to handle situations effectively • Trying new challenges

Based on Table 3, the teachers developed a self-efficacy questionnaire for distribution to students. Before distribution, the questionnaire required validation by experts. This validation process was conducted by the supervising lecturer and physics teacher to ensure the instrument was appropriate for the students. Following validation, self-efficacy data were analyzed using a Likert scale to determine student respondent scores. Each question was scored from 1 to 4, followed by analysis using the Likert formula.

$$R = T \times Pn \qquad \ldots (3)$$

To determine score interpretation, the highest score (X) and lowest score (Y) were calculated using a specific formula as follow.

$$\beta = \frac{total\ score}{Y} \times 100\% \qquad \ldots (4)$$

An interval formula for the self-efficacy questionnaire was also required.

$$I = \frac{100}{jumlah\ skor(likert)} \qquad \ldots (5)$$

A normality test was performed using SPSS 23 after obtaining the desired data via the Likert scale. The normality test aimed to analyze research data regarding student self-efficacy. Normality tests ensure that data distribution does not deviate significantly from a normal distribution, while homogeneity tests ensure that variances between groups are equivalent. High-quality research data must be normally distributed. Once the data were confirmed as normal, a t-test was conducted to prove whether the Project-Based Learning model in the experimental class was significantly more effective in increasing student self-efficacy compared to the teacher-centered model in the control class.

Learning Outcomes

Data collection for student learning outcomes in momentum and impulse utilized a post-test. Students were given 20 post-test questions, each valued at 5 points. This study utilized the Project-Based Learning model, through which students can face problems by connecting instructional material to daily life. The research data consisted of quantitative data in the form of post-test scores. Research instruments, including Project-Based Learning lesson plans and post-test assessment rubrics, underwent validation by the supervisor and physics teacher to ensure suitability, relevance, and content validity before being tested on students. The teachers delivered the momentum and impulse lessons, after which the post-test was administered to determine the relationship between the Project-Based Learning model and student learning outcomes. After students completed the post-test, the teachers graded the responses and performed normality tests. If the data were normal, a t-test was conducted to determine the relationship between Project-Based Learning and student learning outcomes.

RESULTS AND DISCUSSION

This study sought to determine the influence of the PjBL model on the self-efficacy and learning outcomes of high school physics students regarding momentum and impulse. The population used in this study consisted of Grade X high school students. Prior to the research, the researcher interviewed SMA Ibrahimy to facilitate information gathering about the school. A pre-test was distributed to Grade X Science classes to identify groups with homogeneous data variance. After confirming homogeneity, research variables were determined. The variables were categorized into three types: control, independent, and dependent. The control variable was the Grade X Science students, the independent variable was the PjBL model, and the dependent variables were self-efficacy and learning outcomes. Homogeneity was tested using scores from the previous chapter via a one-way test in SPSS 23. The results of the homogeneity test are shown in Table 4.

Table 4 Homogeneity test results

Levene Statistic	**df1**	**df2**	**Sig.**
0.480	2	95	0.620

Based on Table 4, the homogeneity test yielded a significance value much larger than the determined level of 0.05. Thus, the null hypothesis (H_0) was accepted, and the alternative hypothesis (Ha) was rejected. This convincingly proves that the data between the control and experimental classes are homogeneous. With a significance value of 0.620 (> 0.05), the data are declared homogeneous and suitable for further analysis using parametric statistics. Following the homogeneity test, the researcher employed an after-only control design, where IPA 1 was designated as the experimental class, and IPA 2 was the control class receiving no special treatment.

Analysis of Project-Based Learning's Influence on Student Self-Efficacy

This study investigated the impact of the PjBL paradigm on self-efficacy to ascertain the existence of a positive link. Prior to the study, the researcher validated the instructional module on momentum and impulse, together with the self-efficacy questionnaire. The validation approach confirmed the instruments' appropriateness for student utilization. Upon the completion of lessons in both sessions, the instructor disseminated the questionnaire. Students filled out the questionnaire to supply data regarding their self-efficacy responses during the learning process. Subsequently, scores were assessed for normalcy utilizing SPSS 23. The results of the normality test for self-efficacy data are listed in Table 5.

Table 5 Normality test results for self-efficacy data

	Kolmogorov-smirnon[a]			**Shapiro –wilk**		
	Statistic	**Df**	**Sig**	**Statistic**	**Df**	**Sig**
Experimental class	0.142	31	0.12	0.915	31	0.17
Control class	0.138	31	0.14	0.927	31	0.36

Based on Table 5, the normality analysis of 31 data samples using the Shapiro-Wilk method showed a significance value of 0.17 for the experimental class and 0.36 for the control class. Since both significance values consistently exceed the 0.05 threshold ($p > 0.05$), it is empirically proven that the data distribution for both classes is normal. Following the normality test, an independent sample t-test was conducted on the self-efficacy scores. The T-test results for the self-efficacy questionnaire scores are listed in Table 6.

Table 6 T-test results for self-efficacy questionnaire scores

		Levene's test for equality of Variance						
		F	Sig.	t	Df	Sig (2-tailed)	Mean	Std Erro Difference
Self-efficacy Questionnaire	Equal Variance Assumed	22.92	0.000	4.470	60	0.002	7.29	1.630
	Equal Variance Not Assumed			4.470	50.7	0.002	7.29	1.630

Based on Table 6, the fulfillment of data analysis requirements through normality testing indicated that the data in both groups were normally distributed. The study proceeded with an independent sample t-test to compare the self-efficacy questionnaire scores between the experimental and control classes. The research hypothesis H_0, which stated "there is no influence of the PjBL model on student self-efficacy," was rejected, and Ha, stating "there is an influence of the PjBL model on student self-efficacy," was accepted. Statistical calculations for the 31 samples yielded a significance value (2-tailed) of 0.002. Given this value is much smaller than 0.05, the statistical decision was to reject H_0 and accept Ha. This convincingly proves a very significant difference in self-efficacy levels between the experimental class and the control class. These findings confirm that the intervention effectively provided a real impact in increasing the self-efficacy of research subjects compared to the conventional methods used in the control class.

Analysis of Project-Based Learning's Influence on Student Learning Outcomes

This study examined the influence of the PjBL model on learning outcomes. Learning outcome data were obtained from post-test scores in physics on momentum and impulse. Statistical tests were required to determine the model's influence on students' learning outcomes. A normality test was performed first. The results of the normality test analysis on learning outcomes are listed in Table 7.

Table 7 Normality test analysis results on learning outcomes

	Kolmogorov-smirnon[a]			**Shapiro –wilk**		
	Statistic	**Df**	**Sig**	**Statistic**	**Df**	**Sig**
Experimental class	0.14	31	0.12	0.93	31	0.06
Control class	0.15	31	0.05	0.93	31	0.05

Based on Table 7, normality analysis of 31 samples using the Shapiro-Wilk method showed a significance value of 0.06 for the experimental class and 0.05 for the control class. As both values are at or above the 0.05 threshold ($p \geq 0.05$), H_0 is accepted, and Ha is rejected. This empirically proves that the data distribution for both classes is normal. Following the normality test, an independent-samples t-test was conducted on the post-test data.

The T-test results for the post-test data are listed in Table 8. Based on Table 8, after the analysis requirements were met through normality testing, which indicated that the data in both groups were normally distributed, the study proceeded with hypothesis testing using an independent-samples t-test to compare the post-test scores between the experimental and control classes. The hypothesis H_0, stating "there is no influence of the PjBL model on student learning outcomes," was rejected, while Ha, stating "there is an influence," was accepted. Statistical calculations for the 31 samples yielded a significance value (2-tailed) of 0.000. Because this value is much smaller than 0.05, H_0 was rejected, and Ha was accepted. This proves a very significant difference in learning outcome levels between the experimental class and the control class. The findings confirm that the intervention effectively impacted learning outcomes compared to conventional methods.

Table 8 T-test results for post-test data

		Levene's test for equality of Variance						
		F	**Sig.**	**t**	**Df**	**Sig (2-tailed)**	**Mean**	**Std Erro Difference**
Postest results	Equal Variance Assumed	7.69	0.007	3.78	60	0.000	6.097	1.614
	Equal Variance Not Assumed	7.69	0.007	3.78	50,7	0.000	6.097	1.614

The t-test results indicate that PjBL significantly enhances student self-efficacy and learning outcomes. The consistent implementation of this technique can improve student confidence and academic performance compared to conventional methods. Through PjBL, students gain meaningful learning experiences by developing their own knowledge (Rasidah et al., 2022). According to Ratu (2021), there is a positive and significant correlation between the implementation of the PjBL model and self-efficacy. Furthermore, the PjBL model exerts a significant influence on student learning outcomes (Ruddin, 2024). Previous research has also been conducted to measure the extent of the increase in student learning outcomes resulting from the application of the PjBL model (Fadilasari et al., 2024).

CONCLUSION

This study concludes that PjBL significantly improves students' self-efficacy and learning outcomes in momentum and impulse compared with conventional learning. Students who participated in PjBL showed greater confidence in completing physics learning tasks and achieved higher post-test scores than those in the control group. These results indicate that involving students in authentic problem-solving activities and product development can create a more active, meaningful, and solution-oriented physics learning environment. Therefore, PjBL can be considered an effective instructional model for supporting both cognitive achievement and students' confidence in learning physics. The study contributes empirical evidence supporting PjBL as an effective approach for promoting active, meaningful, and problem-oriented physics learning. However, the findings are limited by the small sample from a single school, the use of non-randomized classes and self-report measures, and the focus on only one physics topic, which restricts their broader generalizability.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS STATEMENT

The first author conceived the research. All authors collaboratively designed the methodology, data collection, and analysis. The primary author composed the initial draft of the piece, whereas the secondary and tertiary authors evaluated, revised, and polished the manuscript to its final form. All authors have reviewed and endorsed the final manuscript.

AI DISCLOSURE STATEMENT

The authors declare that artificial intelligence (AI) tools were used only to assist with language improvement and manuscript editing. The authors remained fully responsible for the conceptualization of the study, methodology, data analysis, interpretation of findings, and the final content of the manuscript.

REFERENCES

Abdi, G. P., & Airlanda, G. S. (2023). Peningkatan kreativitas belajar peserta didik melalui model pembelajaran Project Based Learning. *Jurnal Penelitian dan Evaluasi Pendidikan Indonesia*, *13*(2), 139-146.

Abidin, Z., Karyono, H., & Rahayu, M (2021). Pengaruh model project based learning dan motivasi belajar terhadap hasil belajar pada mata pelajaran produktif di SMK. *JIPI (Jurnal Ilmiah Penelitian dan Pembelajaran Informatika), 6*(1), 58-64.

Aprilia, B., Kurniawan, I. S., & Yulianto, E. (2026). Pengaruh gaya kepemimpinan transformasional, self-efficacy, dan kedisiplinan terhadap organizational citizenship behavior pada pt sahasrabhanu cipta karya yogyakarta. *Jambura Economic Education Journal*, *8*(1), 261–279.

Apsoh, S., Setiawan, A., & Marsela, M. (2023). Pengaruh model project based learning terhadap kemampuan berpikir kritis siswa. *JUPEIS: Jurnal Pendidikan Dan Ilmu Sosial*, *2*(3), 174-185.

Arifianti, U., Islam, S. D., & Firdaus, A. (2020). Project based learning dalam pembelajaran IPA. *Social, Humanities, and Educational Studies (SHES): Conference Series*, 3(3), 2079-2082.

Brakhage, H., Gröschner, A., Gläser-Zikuda, M., & Hagenauer, G. (2023). Fostering students’ situational interest in physics: Results from a classroom-based intervention study. *Research in Science Education, 53*, 993–1008. doi:10.1007/s11165-023-10120-x

Dwiantoro, A., & Basuki, I. (2021). *Analisis Pengaruh Model Pembelajaran Project Based Learning*.

Ekatushabe, M., Kwarikunda, D., Muwonge, C. M., Ssenyonga, J., & Schiefele, U. (2021). Relations between perceived teacher’s autonomy support, cognitive appraisals and boredom in physics learning among lower secondary school students. *International Journal of STEM Education, 8,* Article 8. doi:10.1186/s40594-021-00272-5

Fadilasari, E., Pramudita, O., Aeni, K., & Azizah, W. A. (2024). Penerapan model pembelajaran project-based learning dalam mata pelajaran pendidikan pancasila untuk meningkatkan hasil belajar dan pengamalan makna nilai-nilai pancasila. *INNOVATIVE, 4*(1), 6887–6901.

Fatimah, P., & Makki, M. (2023). Pengaruh model pembelajaran project based learning (pjbl) terhadap hasil belajar matematika. *Journal of Clasroom Action Research*, *5*, 51–57. https://doi.org/10.29303/jcar.v5iSpecialIssue.3932

Goldstein, O. (2016). A project-based learning approach to teaching physics for pre-service elementary school teacher education students. *Cogent Education*, *3*(1), 1200833.

Handayani, S., Danil, M., & Aldyza, N. (2025). Pengaruh model project based learning (pjbl)terhadap hasil belajar kognitif siswa pada materi perkembangbiakan hewan. *Jurnal JIPDAS*, *5*(1), 338–349. https://doi.org/10.37081/jipdas.v5i1.2541

Hariani, F., Hidayati, V. R., & Mardiana, N. (2024). Peningkatan kepercayaan diri (self efficacy) siswa kelas iv melalui penerapan model project based learning (pjbl) di sdn 31 mataram. *Pendas*, *9*(3), 246–257.

Harizah, H., Sumarmi, S., & Bachri S. (2022). Pengaruh model pembelajaran project based learning terhadap hasil belajar geografi siswa sman 5 pamekasan. *J-PIPS*, *8*(2), 104–113. https://doi.org/10.18860/jpips.v8i1.13020

Mawarini, D., Cahyadi, F., & Rahmawati, I. (2022). Pengaruh model pembelajaran project based learning terhadap hasil belajar kognitif siswa materi bangun ruang kubus dan balok kelas v. *Wawasan Pendidikan*, *2*(2), 459–468. https://doi.org/10.26877/wp.v2i2.9885

Misbah, M., Hakam, A. B., Qamariah, Umar, F., Harto, M., & Muhammad, N. (2024, November). Project based learning (pjbl) model in science learning: A bibliometric analysis. *E3S Web of Conferences,* 482, 04031.

Nurhaswinda, N. (2026). Uji normalitas dan homogenitas dalam analisis statistik. *Didaktik*, *12*(1), 98–105.

Padji, M. F. D., Nuhamara, Y. T. I., & Wadu, D. I. (2024). Pengaruh model project based learning terhadap hasil belajar matematika siswa smp. *Prima Magistra*, *5*(1), 38–45. https://doi.org/10.37478/jpm.v5i1.3593

Rahmawati, N. S., & Maryani, I. (2025). Pengaruh model project-based learning terhadap efikasi diri dan keterampilan berpikir kritis peserta didik pada mata pelajaran ipa sd kelas v. *Proceeding Seminar Nasional IPA,* 54-68.

Ramadianti, A. A. (2021). Efektivitas model pembelajaran project based learning terhadap hasil belajar matematika sekolah dasar. *Jurnal Primatika,* 10(2).

Rasidah, R., Wahyuningsih, T., Suhartini, E., Dwiyono, Y., & Arafah, A. A. (2022). Pengaruh penggunaan model pembelajaran project based learning terhadap penguasaan materi ipa pada siswa. *Jurnal Pendidikan Mipa*, *12*(4), 1072–1078. https://doi.org/10.37630/jpm.v12i4.730

Ratu, T. (2021). Efektivitas project based learning terhadap efikasi diri dan kemampuan berpikir kritis peserta didik. *Jurnal Konstan*, *6*(1), 1–10. http://jurnalkonstan.ac.id/index.php/jurnal

Rohim, D. C., Nugraha, Y. A., Rozaq, M. A., & Kudus, U. M. (2023). Pengaruh model project based learning terhadap kemampuan numerasi siswa di sd jatiroto 01. *Jurnal Review Pendidikan Dasar*, *9*(3), 183–189.

Ruddin, R. H. (2024). Pengaruh model pembelajaran pjbl terhadap hasil belajar siswa di smk negeri 7 makassar. *Jurnal MediaTIK*, *7*(3), 41–47.

Santos, P., El Aadmi, K., Calvera-Isabal, M., & Rodríguez, A. (2025). Fostering students' motivation and self-efficacy in science, technology, engineering, and design through design thinking and making in project-based learning: a gender-perspective study in primary education. *International Journal of Technology and Design Education*, *35*(4), 1293–1319. https://doi.org/10.1007/s10798-025-10001-6

Sasmita, P. R., & Hartoyo, Z. (2020). Pengaruh pendekatan pembelajaran stem project based learning terhadap pemahaman konsep fisika siswa. *Silampari Jurnal Pendidikan Ilmu Fisika*, *2*(2), 136–148. https://doi.org/10.31540/sjpif.v2i2.1081

Setiyadi, S., & Wahyu, M. (2023). Implementation of the project-based learning model to improve sefl efficacy and student learning outcomes. *Wawasan Pendidikan*, *18*(5), 687–691. https://doi.org/10.29303/jpm.v18i5.5479

Sianturi, R. (2022). Uji homogenitas sebagai syarat pengujian analisis. *Jurnal Pendidikan, Sains Sosial, Dan Agama*, *8*(1), 386–397. https://doi.org/10.53565/pssa.v8i1.507

Sinaga, S. J., Najamuddin, N., Dewi, D. A., Widodo, U., Siahaan, K. W. A., Misbah, M., ... & Mobo, F. D. (2023). Implementation of PBL model on strengthening students' numerical literacy and digital literacy skills. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *7*(1), 575-586.

Syaifuddin, S., Sarwi, S., Hartono, H., & Nuswowati, M. (2025). Mapping research trends on STEM-integrated project-based learning in physics education: a bibliometric review. *Journal of Education and Learning (EduLearn)*, *19*(4), 1859-1872.

Ulfah, A., Hamid, A., Brigjend Hasan Basry Banjarmasin, J. H., & Selatan Indonesia, K. (2020). Meningkatkan self-efficacy dan kemampuan berpikir kreatif siswa melalui model project based learning pada materi koloid. *Journal of Chemistry And Education*, *3*(3), 90–96.

Usmadi, U. (2020). Uji homogenitas dan uji normalitas. *Inovasi Pendidikan*, *7*(1), 50–52.

Wahyudiati, D., & Qurniati, D. (2022). Effect of project-based learning on pre-service chemistry teachers' self-efficacy and critical thinking skills. *Jurnal Penelitian Pendidikan IPA*, *8*(5), 2307–2311. https://doi.org/10.29303/jppipa.v8i5.1834

Watoni, K., Tahir, M., & Suciani, B. R. (2025). Peningkatan kepercayaan diri peserta didik melalui pembelajaran berbasis proyek (project-based learning) di sdn 31 mataram. *Jurnal Pendidikan, Sains, Geologi, Dan Geofisika (GeoScienceEd Journal)*, *6*(3), 1846–1851. https://doi.org/10.29303/goescienceed.v6i3.869

AUTHOR PROFILES

Muhammad Rizki Febrian, rizkifebrianmuhammad@gmail.com,
Pendidikan fisika, Universitas Jember.

Bambang Supriadi, bambangsupriadi.fkip@unej.ac.id, Pendidikan Fisika,Universitas jember.
https://scholar.google.co.id/citations?user=gxkDmywAAAAJ&hl=en&oi=ao
,
https://sinta.kemdiktisaintek.go.id/authors/profile/5995438,
https://orcid.org/0000-0002-0308-986X
https://sinta.kemdiktisaintek.go.id/authors/profile/5995438

Firda Kusuma Ayu Anggraeni, firdhakusuma@unej.ac.id, Pendidikan Fisika,Universitas jember.
https://scholar.google.com/citations?user=hYi4vFwAAAAJ&hl=en,
https://sinta.kemdiktisaintek.go.id/authors/profile/6159017,
https://orcid.org/0000-0002-8250-4602,
https://sinta.kemdiktisaintek.go.id/authors/profile/6159017,