The Effect of The Project Based Learning (Pjbl) Model on Students' Physics Learning Outcomes

Nurul Aini[1]*, Jannatin 'Ardhuha[1], & Muh. Makhrus[1]
[1]Physics Education Study Program, University of Mataram, Indonesia
*Corresponding Author: aini61120@gmail.com

Received: 16th September 2025; **Accepted**: 26th November 2025; **Published**: 8th December 2025
DOI: https://dx.doi.org/10.29303/jpft.v11i2.10225

Abstract *– This study aims to determine the effect of the Project Based Learning (PjBL) model on the physics learning outcomes of eleventh-grade students on the topic of dynamic fluids. This research employed a quasi-experimental method with a pretest–posttest control group design. The population consisted of all eleventh-grade students of SMAN 2 Praya, totaling 170 students across five classes. The sample was selected using cluster random sampling and consisted of class XI-5 as the experimental class, which received the PjBL treatment, and class XI-3 as the control group, which received conventional instruction, with 34 students in each group. Cognitive learning outcomes were assessed using a multiple-choice test consisting of 20 validated and reliable items, while affective and psychomotor outcomes were measured using observation sheets. The hypothesis tested concerned the influence of the PjBL model on students' physics learning outcomes. Data analysis began with prerequisite tests (normality and homogeneity). Since the data were not homogeneous and not normally distributed, the Mann–Whitney test was used for hypothesis testing. In addition, the N-Gain test was conducted to determine the improvement in learning outcomes. The Mann–Whitney test produced a significance value of <0.001, which is lower than 0.05, indicating that H_0 was rejected and H_a was accepted. The N-Gain results showed that the experimental group achieved a high category, while the control group fell into the low category. These findings indicate that the Project Based Learning (PjBL) model has a significant effect on students' physics learning outcomes.*

Keywords: *Physics; Learning Outcome; Project Based Learning*

INTRODUCTION

The development of scientific knowledge is essential for preparing high-quality and competitive human resources who can contribute to national intelligence (Mudarya, 2024). The government has introduced the Merdeka Curriculum as a significant educational reform aimed at improving the quality and flexibility of learning (May Putra Agustang, 2023). This curriculum provides students with more creative learning experiences that help develop soft skills and character (Gumilar et al., 2023). According to Dewi (2022), this objective is achieved through the use of learning models such as Project Based Learning (PjBL), which is one of the priority approaches in the Merdeka Curriculum.

Through the Project Based Learning model, students actively solve problems either in groups or individually by following scientific procedures within a set timeframe, and the results are presented to others in the form of a project (Dinawati, 2022). This model encourages students to take a more active role in problem-solving, helping them develop critical thinking skills, collaboration, and the ability to design and manage projects (Dwiantoro & Basuki, 2021). Similarly, Sakilah et al. (2020) state that Project Based Learning offers several advantages, including improving learning outcomes and strengthening critical thinking, communication, collaboration, and problem-solving skills.

Initial observations conducted at SMAN 2 Praya during the 2024–2025 academic year, through interviews with a physics teacher, revealed that physics learning often used methods that were not interactive. During lessons, students showed low levels of engagement and struggled to meet learning targets due to the lack of tools that could help clarify the material or support concept application. They experienced difficulty understanding physics concepts due to limited hands-on experiences, had low motivation because physics was perceived as complex and abstract, and tended to be passive and easily bored.

These issues indicate several problems, including the lack of optimal teamwork among students and poor management of learning activities, causing the learning process to fall short of the expected goals. As a result, student learning outcomes did not reach the required standards. This condition is reflected in the mid-semester examination scores of the eleventh-grade students.

The odd-semester midterm exam scores for physics in class XI F1 at SMAN 2 Praya in the 2024–2025 academic year showed that across the five classes, class XI F1.1 had an average score of 53.70; XI F1.2 scored 54.30; XI F1.3 scored 50.26; XI F1.4 scored 55.08; and XI F1.5 scored 50.63. None of these classes met the minimum competency criteria (KKTP), which was set at 75. The narrow range of scores across classes indicates that the overall achievement of learning objectives in physics remained low.

The average score of class XI F1.1 shows that even after remedial sessions, students still fell short of the KKTP standard. This reflects low learning outcomes in physics. One alternative that may address this issue is the use of the Project Based Learning model, which has been shown to improve learning outcomes (Jamilah et al., 2024). Through PjBL, students can become more active, creative, and independent during learning activities, as this model emphasizes student-centered instruction (Fathonah et al., 2023).

Project Based Learning is a student-centered approach that engages learners in in-depth investigation to find relevant solutions and produce a tangible final product (Ismail, 2022). With PjBL, students become more active in collaboration and develop critical thinking, communication, and creativity through meaningful learning experiences (Riskayanti, 2021). The PjBL approach is effective in helping students think critically, solve problems, and understand scientific concepts more deeply (Qahfi et al., 2024). Implementing this model can also promote independence in problem-solving, which contributes to improved cognitive, affective, and psychomotor learning outcomes (Hikmawati et al., 2023).

Studies conducted by Hutapea & Simanjuntak (2017), Barus et al. (2023), and Fahrunnisa & Handayani (2024) show that PjBL enhances student activity through participation in group discussions, teamwork, and the development of critical and creative thinking skills, which positively influence learning outcomes, particularly in physics conceptual mastery. Teacher competence also improves when teachers provide active guidance during project creation, enabling students to produce high-quality products aligned with the learning material (Wayan Suastra, 2022).

However, the extent to which this model influences physics learning outcomes across the cognitive, affective, and psychomotor domains is not yet fully understood. Therefore, further research is needed to examine the effect of the Project Based Learning model on students' physics learning outcomes in eleventh-grade classes at SMAN 2 Praya.

RESEARCH METHODS

The type of research used in this study was a quasi-experimental design involving two classes. The experimental group was taught using the Project Based Learning model, while the control group received conventional instruction. The study was conducted at SMAN 2 Praya. The population consisted of all eleventh-grade students in the XI F.1 program, which included five classes, with the main topic being dynamic fluids. The sample was selected using a cluster random sampling technique, resulting in two groups being chosen: class XI F1.5 as the experimental group and class XI F1.3 as the control group, each consisting of 34 students. The research design employed was the pretest–posttest control group design, as shown in Table 1.

Table 1. Research Design *pretest-posttest group design*

Group	*Prettest*	Treatment	*Posttest*
Experimental	O_1	X	O_2
Control	O_3	-	O_4

(Sugiyono, 2020)

The explanation of Table 1 is as follows: O1 represents the pretest administered to the experimental group; O2 represents the posttest administered to the experimental group; O3 represents the pretest administered to the control group; O4 represents the posttest administered to the control group; X represents instruction in the experimental group using the Project Based Learning model; and (–) represents conventional instruction in the control group.

Learning outcomes in this study were measured using a multiple-choice test consisting of 20 items. The indicators were based on Anderson and Krathwohl's cognitive taxonomy levels: C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating), and C6 (creating). Meanwhile, affective and psychomotor learning outcomes were assessed using observation sheets as supporting data.

This study aimed to determine the influence of the Project Based Learning model on students' physics learning outcomes. Therefore, the hypotheses were: H_0: there is no effect of the Project Based Learning (PjBL) model on students' physics learning outcomes; H_a: there is an effect of the Project Based Learning (PjBL) model on students' physics learning outcomes. The prerequisite tests for hypothesis testing consisted of the normality test and homogeneity test. SPSS 27 was used for data analysis with a significance level of 0.05.

Normality was tested using the Shapiro–Wilk test with the decision criterion that if the significance value (2-tailed) is greater than 0.05, the data are normally distributed, and vice versa (Sukarelawan et al., 2024). Homogeneity was tested using Levene's test with the criterion that if the significance value (2-tailed) is greater than 0.05, the data variance is homogeneous, and vice versa (Wulansari, 2018). The hypothesis test used the Mann–Whitney test, with the decision criterion that if the significance value (2-tailed) is greater than or equal to 0.05, H_a is rejected, and vice versa (Yani et al., 2023). Additional analysis using the N-Gain test was conducted to determine increases or decreases in learning outcomes, categorized as high, moderate, low, stable, or declining (Supriadi, 2021).

RESULTS AND DISCUSSION

Results

Based on the findings, students' cognitive learning outcomes were obtained through pretests and posttests administered to both the experimental and control groups. In addition, normality and homogeneity tests were conducted to ensure the appropriateness of the data, while psychomotor and affective domains were assessed using observation sheets during the learning process. The pretest results for both groups are presented in Table 2.

Table 2. Pretest Learning Outcomes

	Pretest	
	Experimental	Control
Max Score	65	55
Min Score	10	15
Average	34,71	33,24
Criteria	Low	Low

Table 2 shows that the average pretest score of the experimental group on the topic of dynamic fluids was 34.71, while the control group achieved an average score of 33.24. The pretest results for each indicator are shown in Figure 1.

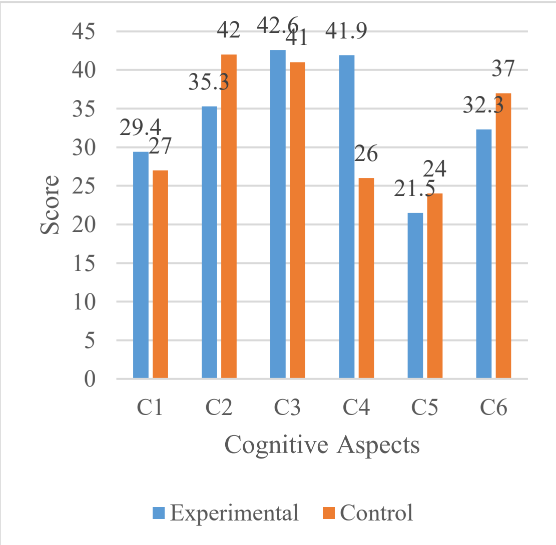

Figure 1. Pretest Result for Experimental and Control Group

Figure 1 illustrates an inconsistent pattern between the experimental and control groups, indicating that both groups had varied initial abilities and that no group demonstrated overall mastery of the material prior to treatment. This confirms that the two groups were relatively equivalent before the intervention was administered.

The experimental group received instruction using the Project Based Learning model, whereas the control group was taught using a conventional learning model. Affective and psychomotor domains were assessed in both groups. In the experimental group, psychomotor assessment was based on students' performance in carrying out the project, including the creation phase, observing results, participating in discussions, and delivering presentations. The highest score was obtained in the project creation phase, with an average of 100, while the lowest average score was in the presentation phase, at 85.88.

In the control group, psychomotor assessment was based on discussion activities and presentations of problem-solving results, without involving any hands-on project creation. The average score obtained was 79.41. The difference in assessment between the two groups shows that the experimental group emphasized the application of learning concepts through practical activities, while the control group focused solely on conceptual understanding. The affective learning outcomes are presented in Table 3.

Table 3. Data hasil belajar ranah afektif

Kelas	Rata-rata	Kriteria
Eksperimen	88,48	Sangat baik
Kontrol	80,64	Baik

Table 3 indicates that the experimental group had an average score of 88.48, while the control group had an average score of 80.64. The highest score in the experimental group was observed in the indicator of student discipline, which was significantly better than that of the control group. After treatment was applied to both groups, a post-test was administered. The posttest results for the experimental and control groups are shown in Table 4.

Table 4. *Posttest* Learning Outcomes

	Post-test	
	Experimental	Control
Max Score	100	90
Min Score	50	30
Rata-rata	88,82	56,18
Criteria	Very Good	Fairly Good

Table 4 shows that the experimental class achieved an average posttest score of 88.82, while the control class obtained an average of 56.18. Based on the posttest results, it can be concluded that there was an increase in the average score compared with the pretest in both the experimental and control classes. The post-test results for both classes are also illustrated in Figure 2.

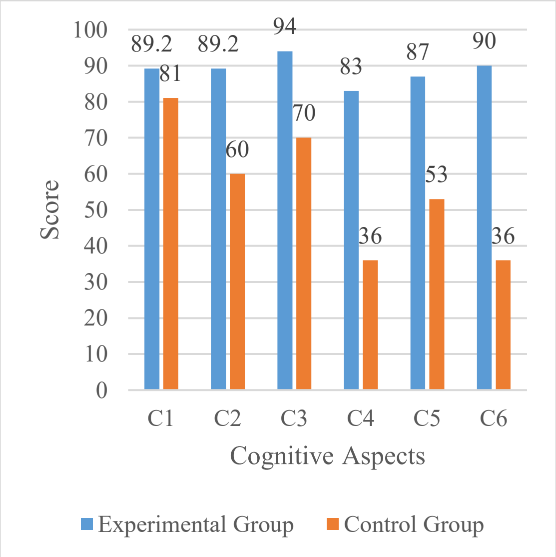

Figure 2. Post-test Result for Experiment and Control Group

Based on Figure 2, the posttest results for the six cognitive indicators in the experimental class show a substantially higher increase compared with the control class, ranging from 83 to 94, while the control class scores range only from 36 to 81. The most striking differences appear in indicators C4, C5, and C6, where the gaps between the two classes are the largest. The highest improvement occurs in indicator C3 (applying), indicating that the Project Based Learning model effectively enhances students' ability to apply the concepts they have learned.

The pretest and posttest scores obtained from both the experimental and control classes were analyzed using normality and homogeneity tests. The normality test results for the pretest scores of both classes are presented in Table 5.

Tabel 5. Normality test of Pre-test

Group	Shapiro-Wilk		
	N	Sig.	Criteria
Experimental	34	0,699	Normally Distributed
Control	34	0,202	

Table 5 shows that the normality test results for the pretest produced significance values of 0.699 and 0.202 for the experimental and control classes, respectively, which are greater than 0.05. This indicates that the data are normally distributed. The posttest normality test results for the two classes are provided in Table 6.

Table 6. Normality test of Post-test

Group	Shapiro-Wilk		
	N	Sig.	Criteria
Experimental	34	<0,001	Not Normally Distributed
Control	34	0,068	Normally Distributed

Table 6 shows that the posttest scores in the experimental class have a significance value of less than 0.001, which is below 0.05, indicating that the data are not normally distributed. Meanwhile, the control class has a significance value of 0.068, which is above 0.05, indicating that the data are normally distributed. After the normality test, a homogeneity test was conducted. The homogeneity results for the pretest scores of both classes are presented in Table 7.

Table 7. Homogeneity Results Of Pretest

Group	Levene Statistic	Sig.	Criteria
Experimental Control	0,583	0,448	Homogeneous

Table 7 shows that the significance value of 0.448 is greater than 0.05, indicating that the data variance is homogeneous. The posttest homogeneity results for the two classes are provided in Table 8.

Table 8. The homogeneity results of posttest

Group	Levene Statistic	Sig.	Kriteria
Experimental Control	4,270	0,043	Not homogeneous

Table 8 shows a significance value of 0.043, which is below 0.05, indicating that the data variance is not homogeneous. Since the prerequisite tests for normality and homogeneity had been assessed, hypothesis testing was then carried out using the Mann–Whitney test. The results of the hypothesis test are presented in Table 9.

Table 9. The result of *Mann-Whitney* Test

Group	*Mann-Whitney*	Asymp. Sig. (2-tailed)
Experiment Control	95,500	<0,001

Table 9 shows that the Mann–Whitney significance value is less than 0.001, which is below 0.05. Therefore, H_0 is rejected and H_a is accepted. This means that the Project Based Learning (PjBL) model has a significant effect on students' physics learning outcomes. A subsequent N-Gain analysis was conducted to determine the extent of improvement or decline in the learning outcomes of the experimental and control classes. The N-Gain results for both classes are shown in Figure 3.

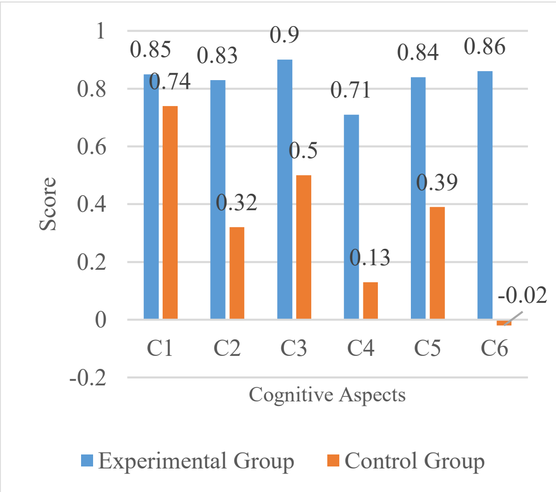

Figure 3. N-Gain results diagram for the experimental and control groups.

Based on Figure 3, the N-Gain scores for the six cognitive indicators in the experimental class show a much higher improvement compared with the control class, ranging from 0.71 to 0.90, whereas the control class ranges only from −0.02 to 0.74. The negative N-Gain score of −0.02 for indicator C6 in the control class occurred because the pretest score was higher than the posttest score. The greatest improvement appears in indicator C3, indicating that the use of the Project Based Learning model is more effective in improving students' learning outcomes on the topic of dynamic fluids than the conventional learning model.

Discussion

This study aimed to examine the effect of the Project Based Learning model on students' physics learning outcomes. The Project Based Learning model was implemented in class XI F1.5 as the experimental group, while the conventional learning model was applied in class XI F1.3 as the control group, with each class consisting of 34 students. The study was conducted over three meetings using the topic of dynamic fluids. Both classes were given a pretest to assess their initial knowledge, followed by a posttest to evaluate their learning outcomes.

The average pretest score for the experimental class was 34.71 and for the control class was 33.24, both of which fall into the "low" category. The pretest results for each cognitive indicator (C1–C6), based on the revised Bloom's taxonomy, also showed low average scores across all indicators. All indicators were categorized as low for both groups, indicating that students' cognitive abilities were still weak before instruction, particularly in factual and conceptual knowledge as well as higher-order thinking skills.

The pretest outcomes showed that students in both the experimental and control classes had limited initial understanding of dynamic fluid concepts. This suggests that they had not yet fully grasped the fundamental principles of fluid mechanics, such as the continuity equation and Bernoulli's principle. For this reason, the experimental class was taught using a different model, which was expected to improve students' conceptual understanding of physics.

Students in the experimental class were taught using the Project Based Learning model, while those in the control class received conventional instruction. In the experimental class, students were actively involved in the learning process by creating real projects directly related to the physics concepts being studied, such as Bernoulli's principle, the continuity equation, and fluid flow rate. The projects produced by students included simple devices such as a basic water sprayer, a simple water wheel, and a simple water rocket, which enabled them to observe physics concepts in action and connect them with the theoretical material.

Through the project activities, students were guided not only to memorize formulas but also to understand the underlying physics principles through hands-on experience. For example, when creating the simple water sprayer, students observed how changes in velocity and pressure within a narrow tube illustrate the continuity equation. The project activities were structured to represent core concepts in dynamic fluids following the PjBL syntax. The learning process began with presenting a real and relevant problem, followed by dividing students into seven groups of four to five members to design and build their respective projects. One of the students' project outcomes is shown in Figure 4.

(a)

(b)

Figure 4. The relationship between the water sprayer project product (a) and the continuity concept (b) (Abdullah, 2016).

A comparison between the image of the water sprayer and the continuity-concept illustration shows a direct connection between real-world application and theoretical explanation. The water sprayer is a concrete implementation of the continuity equation, which is generally introduced through fluid flow theory. When a fluid flows through a section of pipe with a larger cross-sectional area (A_1) and velocity (v_1) into a narrower section with a smaller cross-sectional area (A_2) and velocity (v_2), the flow speed increases. This means that as the cross-sectional area decreases, the fluid velocity rises. This increase in speed ensures that the flow rate remains constant.

The project-making process engages students across three domains of learning: cognitive, affective, and psychomotor. This involvement is evident through activities such as designing, constructing, and testing simple demonstration tools related to dynamic fluid concepts. The learning process focuses on understanding concepts such as Bernoulli's principle, the continuity equation, fluid discharge, and their applications in daily life.

In contrast, the control class was taught using a conventional approach through lectures, question-and-answer sessions, practice exercises, and discussions. Instruction focused only on mastering dynamic fluid concepts and solving procedural problems. Without project activities, the development of the psychomotor domain was not optimal, as students had no opportunity to engage in hands-on tasks such as constructing, observing, and presenting a project. They only solved problems and presented their answers. The affective domain also showed limited development, as confidence, responsibility, and discipline did not emerge strongly. Student participation was passive, interactions were limited, and opportunities to grow their potential were restricted.

The affective and psychomotor assessment results for the experimental and control classes indicate that the Project Based Learning model supports the development of all three domains—cognitive, affective, and psychomotor—in learning dynamic fluids. After the treatment, both classes completed a posttest. The average posttest score for the experimental class was 88.82, categorized as very good, while the control class earned an average score of 56.18, categorized as fair.

Posttest scores across all cognitive indicators (C1–C6) in the experimental class showed an improvement. The increase reached the "very good" category for indicators C1, C2, C3, C5, and C6, and the "good" category for C4. The greatest improvement occurred in indicator C3 (applying), demonstrating that the Project Based Learning model effectively strengthened students' ability to apply the physics concepts they had learned.

This improvement indicates that the treatment in the experimental class successfully enhanced students' understanding of the fundamental principles of dynamic fluids, such as the continuity equation and Bernoulli's principle. The continuity equation explains that fluid velocity changes depending on the cross-sectional area of the pipe, while Bernoulli's principle describes the relationship between pressure, velocity, and potential energy in a moving fluid. Students' improved understanding was also evident in their ability to link dynamic fluid concepts to real-world phenomena, such as narrowing water channels and the working principle of airplane wings.

Students in the experimental class demonstrated better understanding than those in the control class, not only in answering posttest questions but also in applying dynamic fluid concepts to everyday situations. This suggests that the learning approach used in the experimental class was more effective in strengthening conceptual understanding and improving learning outcomes in physics. The model used in the experimental class showed that physics learning is not limited to memorizing formulas but requires students to strengthen their understanding through direct experiences they encounter in daily life.

The results of the study show that the experimental class taught with Project Based Learning achieved higher learning outcomes compared to the control class taught using a conventional model. This success is supported by the effective implementation of PjBL throughout the learning process. The relationship between PjBL and students' physics learning outcomes can be seen from the cognitive indicators, which demonstrated very high improvement across all indicators, supported by gains in the affective and psychomotor domains. This aligns with constructivist theory, which emphasizes that students actively build and develop their own understanding based on their learning experiences (Nerita et al., 2023). A constructivist approach can enhance student engagement, collaboration, problem-solving, creativity, and learning outcomes (Pratami, 2024).

This is consistent with findings by Aprilina (2024), who notes that PjBL provides opportunities for students to engage actively in solving real-world problems by working in groups, designing projects, and presenting results, all of which train critical, collaborative, and creative thinking skills. Project Based Learning can enhance physics learning outcomes across levels of thinking, from lower-order thinking skills to higher-order thinking skills (Erniyanti et al., 2020). According to Hasani et al. (2024), project activities can strengthen students' critical-thinking skills by helping them identify problems and work toward solutions during the project process.

One of the challenges encountered during the implementation of PjBL was limited instructional time, which made it difficult to cover all learning materials thoroughly. A suggested solution is to include several additional questions related to the unaddressed material at the end of the student worksheet.

CONCLUSION

Based on the findings and the discussion, it can be concluded that the Project Based Learning model has a significant influence on students' physics learning outcomes at SMAN 2 Praya. The results of this study can serve as an alternative solution for teachers to improve teamwork among students, ensuring that learning activities are carried out as planned and that learning outcomes improve.

ACKNOWLEDGEMENT

The author extends gratitude to Dr. M. Mustanadi, S.Ag., M.Si., as the principal, to Mrs. Sari Endah Utami, S.Si., as the physics teacher, and to the eleventh-grade students of SMAN 2 Praya for providing the opportunity to carry out this research.

REFERENCES

Aprilina, F. N. A. (2024). Pengaruh Model Pembelajaran Project Based Learning Terhadap Keterampilan Berpikir Kreatif Peserta Didik. *Jurnal Pembelajaran, Bimbingan, dan Pengelolaan Pendidikan*, *4*(5), 4. https://doi.org/10.17977/um065.v4.i5.2024.4

Abdullah, M. (2016). *Fisika Dasar I*. Bandung: Institut Teknologi Bandung.

Barus, C. S. A., Simanjuntak, E., & Helmi, D. (2023). Pengaruh Model Pembeljaran Berbasis Proyek Terhadap Hasil Belajar Siswa Pada Materi Fluida Dinamis Kelas XI SMA Negeri 1 Bangun Purba. *Jurnal Ilmiah Profesi Pendidikan*, *8*(4), 1951–1958. https://doi.org/10.29303/jipp.v8i4.1555

Dewi, M. R. (2022). Kelebihan dan kekurangan Project-based Learning untuk penguatan Profil Pelajar Pancasila Kurikulum Merdeka. *Inovasi Kurikulum*, *19*(2), 213–226. https://doi.org/10.17509/jik.v19i2.44226

Dinawati, E. P. (2022). *Project Based Lerning (PJBL) Solusi Ampuh Pembelajaran Masa Kini*. Lombok Tengah: Pusat pengembangan Pendidikan dan penelitian Indonesia.

Dwiantoro, A., & Basuki, I. (2021). Analisis Pengaruh Model Pembelajaran Project Based Learning Terhadap Peningkatan Hasil Belajar Siswa Pada Mata

Pelajaran Instalasi Penerangan Listrik Di Smk. *Jurnal Pendidikan Teknik Elektro*, *10*(01), 81–88. https://doi.org/10.26740/jpte.v10n01.p81-88

Erniyanti, Junus, M., & Syam, M. (2020). Analisis Ranah Kognitif Soal Latihan Berdasarkan Taksonomi Bloom Revisi Pada Buku Fisika Kelas X (Studi Pada Buku Karya Ni Ketut Lasmi). *Jurnal Literasi Pendidikan Fisika*, *1*(02), 115–123. https://doi.org/10.30872/jlpf.v1i2.337

Fahrunnisa, F., & Handayani, Y. (2024). Penerapan Model Project Based Learning (Pjbl) Terhadap Hasil Belajar Fisika Peserta Didik Pada Materi Usaha Dan Energi Kelas X Di Sman 13 Makassar. *OPTIKA: Jurnal Pendidikan Fisika*, *8*(2), 258–265. https://doi.org/10.37478/optika.v8i2.4255

Fathonah, R. A., Handayani, T. O., & Indrapangastuti, D. (2023). The Role of Project Based Learning (PjBL) in Improving Elementary School Students. *Social, Humanities, and Educational Studies (SHES): Conference Series*, *6*(1), 350. https://doi.org/10.20961/shes.v6i1.71114

Gumilar, G., Rosid, D. P. S., Sumardjoko, B., & Ghufron, A. (2023). Urgensi Penggantian Kurikulum 2013 menjadi Kurikulum Merdeka. *Jurnal Papeda: Jurnal Publikasi Pendidikan Dasar*, *5*(2), 148–155. https://doi.org/10.36232/jurnalpendidikandasar.v5i2.4528

Hasani, R., 'Ardhuha, J., Harjono, A., & Kosim, K. (2024). The Effect of STEAM-Based Project-Based Learning Model on the Critical Thinking Skills of Eleventh-Grade Students in the Topics of Elasticity and Hooke's Law. *Jurnal Pendidikan Fisika dan Teknologi*, *10*(2), 395–403. https://doi.org/10.29303/jpft.v10i2.7960

Hikmawati, H., Verawati, N. N. S. P., & Ayub, S. (2023). Hasil Belajar Mahasiswa Prodi Pendidikan Fisika Pada Perkuliahan Dengan Project Based Learning. *ORBITA: Jurnal Pendidikan dan Ilmu Fisika*, *9*(2), 194. https://doi.org/10.31764/orbita.v9i2.14925

Hutapea, J., & Simanjuntak, M. P. (2017). Pengaruh Model Pembelajaran *Project Based Learning* (PjBL) Terhadap Hasil Belajar Siswa SMA. *Jurnal Inovasi Pembelajaran Fisika (INPAFI)*, 5(1), 48-55. https://doi.org/10.24114/inpafi.v5i6597

Ismail, S. (2022). Pengaruh Penggunaan Model Pembelajaran Berbasis Proyek "Project Based Learning" Terhadap Hasil Belajar Fisika Peserta Didik Kelas X IPA SMA Negeri 35 Halmahera Selatan Pada Konsep Gerak Lurus". *Jurnal Ilmiah Wahana Pendidikan*, *8*(5), 256–269. https://doi.org/10.5281/zenodo.6466594

Jamilah, S., Astuti, A. F., Alifah, N., Firmansyah, D., & Kurnia, B. (2024). Penerapan Model Project Based Learning untuk Meningkatkan Minat Belajar Siswa. *Jurnal Kiprah Pendidikan*, *3*(2), 106–113. https://doi.org/10.33578/kpd.v3i2.234

May putra Agustang, A. D. (2023). Mengintip Revolusi Pendidikan Di Indonesia: Tantangan Dan Peluang Dalam Implementasi Kurikulum Merdeka. *Phinisi Integration Review*, *6*(3), 500. https://doi.org/10.26858/pir.v6i3.53749

Mudarya, I. N. (2024). Sumber Daya Manusia Dalam Perspektif Pendidikan. *Daiwi Widya*, *11*(2), 41-48. https://doi.org/10.37637/dw.v11i2.316

Nerita, S., Ananda, A., & Mukhaiyar, M. (2023). Pemikiran Konstruktivisme

Dan Implementasinya Dalam Pembelajaran. *Jurnal Education and Development*, *11*(2), 292–297. https://doi.org/10.37081/ed.v11i2.4634

Pratami, R. (2024). Pendekatan Konstruktivisme dalam Kebijakan Pembelajaran Berbasis Proyek: Transformasi Pendidikan Menuju Kreativitas dan Kolaborasi. *Jejaring Administrasi Publik*, *16*(2), 76–87. https://doi.org/10.20473/jap.v16i2.60539

Qahfi, B. A., Doyan, A., & Makhrus, M. (2024). The Effect of Project Based Learning (PjBL) Integrated by STEM on Students' Generik Science Abilities. *Journal of Science and Science Education*, *5*(1), 36–41. https://doi.org/10.29303/jossed.v5i1.6962

Riskayanti, Y. (2021). Peningkatan Keterampilan Berpikir Kritis, Komunikasi, Kolaborasi Dan Kreativitas Melalui Model Pembelajaran Project Based Learning Di Sma Negeri 1 Seteluk. *SECONDARY: Jurnal Inovasi Pendidikan Menengah*, *1*(2), 19–26. https://doi.org/10.51878/secondary.v1i2.117

Sakilah, S., Yulis, A., Nursalim, N., Vebrianto, R., Anwar, A., Amir, Z., & Sari, I. K. (2020). Pengaruh Project Based Learning Terhadap Motivasi Belajar Sekolah Dasar Negeri 167 Pekanbaru. *JMIE (Journal of Madrasah Ibtidaiyah Education)*, *4*(1), 127. https://doi.org/10.32934/jmie.v4i1.175

Sukarelawan, M. I., Indratno, T. K., & Ayu, S. M. (2024). N-Gai vs Stacking. Yogyakarta: Suryacahya.

Supriadi, G. (2021). *Statistik Penelitian Pendidikan*. Yogyakarta: Uny Press.

Wayan Suastra, I. (2022). Implementasi Model Project Based Learning untuk Meningkatkann Keterampilan Dasar Mengajar yang Dimiliki oleh Mahasiswa Calon Guru. *Desember 2022*, *6*(2), 2549–2950. http://e-journal.hamzanwadi.ac.id/index.php/kpj/index

Wulansari, A. D. (2018). Aplikasi Statistika Parametrik Dalam Penelitian. Yogyakarta: Pustaka Felicha.

Yani, R. W. E., Permatasari, E., & Armiyanti, Y. (2023). Biostatistika. Jember: UPT Penerbit Universitas Jember.