SAINTIFIK@: JURNAL PENDIDIKAN MIPA
E-ISSN: 2598-3822 | P-ISSN: 2087-3816
Available online at https://ejournal.unkhair.ac.id/Saintifik

Pengaruh Model *Project Based Learning* pada Materi Sistem Peredaran Darah Terhadap Hasil Belajar dan Kemampuan Berpikir Kreatif Peserta Didik Kelas XI

(The Effect of the Project-Based Learning Model on the Circulatory System Topic Toward Students' Learning Outcomes and Creative Thinking Ability in Class XI)

Muhammad Rizaldi*, Aminuddin Prahatama Putra, Sri Amintarti
Biology Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Banjarmasin, Indonesia, 70123
**Corresponding author: zadi6585@gmail.com*

Received 13-09-2025, Revised 21-09-2025, Accepted 16-10-2025, Published 18-10-2025

Keywords:
Project-Based Learning; Learning outcomes; Creative thinking ability; Blood circulatory system.

ABSTRACT. *This study aims to evaluate the impact of using the Project-Based Learning (PBL) model in teaching the Circulatory System material on the learning outcomes and Creative thinking ability of 11th-grade students at SMA Negeri 8 Banjarmasin. The objectives of this research are to: (1) assess the influence of the PjBL model on students' learning outcomes and (2) evaluate its impact on their Creative thinking ability. The research employed a quasi-experimental design with a posttest nonequivalent control group. The experimental group implemented the PjBL model, while the control group used the Direct Instruction model. Data were collected using both test and non-test techniques, and the analysis used the Mann-Whitney nonparametric test and descriptive statistics. The findings of the study reveal that: (1) There is no significant influence of implementing the PjBL model on the Circulatory System material on the learning outcomes of 11th-grade students at SMA Negeri 8 Banjarmasin, with an Asymp.Sig. (2-tailed) value of 0.335. (2) There is a significant impact of applying the PjBL model on the Circulatory System material on the Creative thinking ability of the students, with an Asymp.Sig (2-tailed) value of 0.000.*

INTRODUCTION

The Merdeka Curriculum, as a flexible educational framework, emphasizes essential content, character development, and student competencies, reflecting the idea that education is an inseparable part of human life from birth to death [1]. In the context of learning recovery, this curriculum adopts project-based learning to strengthen soft skills, shape character in accordance with the Pancasila Student Profile, and focus on essential content. Its primary goal is to provide sufficient time for in-depth learning of fundamental competencies such as literacy and numeracy. Student learning outcomes are a key goal of the educational process. Therefore, teachers must apply effective methods and media to enhance students' cognitive development, while the curriculum emphasizes applying knowledge to real-life situations as a core learning approach [2] [3].

According to [4] [5], the project-based learning model is an instructional approach that emphasizes project activities or tasks involving learners in the process, encouraging them to create projects related to real-life problems and thereby providing more meaningful outcomes. This view is also supported by [6] and [7], who noted that the project learning model requires considerable time investment, with the learning focus placed on students' active participation in exploring concepts or principles in depth. The initial step in engaging students in a project is to assign them meaningful tasks, enabling them to collect and integrate new knowledge from their practical experiences. This process involves design, investigation, problem-solving, decision-making, and opportunities for both independent and collaborative work. Through this approach, learners can undergo valuable learning processes and construct their own knowledge.

Creative thinking ability is defined as the capacity to solve problems appropriately, demonstrate sensitivity to situations where issues are identified, and discover new ways of resolving them [8]; [9]. This definition is further supported by [10] and [11], who argue that creative thinking represents an advanced ability in self-development, problem-solving, structuring, and innovation aimed at generating solutions.

The comprehension of the circulatory system is often a challenge for students because it involves complex structures and processes, along with numerous facts that must be mastered [12]. To address this, project-based learning methods such as PjBL are implemented in the teaching process. This approach is chosen because project-based learning emphasizes complex and real-life activities, with the expectation of increasing students' interest and engagement [13].

RESEARCH METHOD

This research is categorized as a quasi-experimental study designed to test the impact of one variable on another and to examine cause-and-effect relationships. The research design employed was a nonequivalent control group design. According to [14], this design is used to evaluate students' cognitive learning outcomes. State that before treatment is administered, both groups are first given a pre-test to assess their initial skills regarding the material to be taught. After treatment, a post-test is conducted to evaluate improvements in students' problem-solving skills.

The study was conducted over six months, from July to December 2022, during the odd semester of the 2023/2024 academic year, at SMA Negeri 8 Banjarmasin. This research consisted of three meetings focused on the circulatory system material. The experimental group (Class XI-8) received treatment through the PjBL learning model, while the control group (Class XI-10) was taught using the Direct Instruction model.

The data collection techniques in this study were as follows:

1. Cognitive product learning outcomes and students' creative thinking ability were obtained from pre-test results conducted before the lessons and posttest results conducted afterward.
2. Cognitive process learning outcomes were obtained from LKPD worksheets.
3. Affective and psychomotor learning outcomes were obtained from observation sheets.

According to [15], instruments for learning outcomes are based on cognitive tests to assess students' abilities after participating in a learning activity; therefore, these instruments are valid for measuring student performance and must undergo validation.

The test of cognitive product learning outcomes and students' creative thinking ability employed hypothesis testing and the N-gain score using SPSS. Meanwhile, the results of cognitive, affective, and psychomotor learning outcomes were analyzed descriptively. Affective learning assessment of character-related and social behaviors used a 1–4 scale, which indicated that the outcomes were qualitative data. The scoring categories for affective learning outcomes followed [16]: very good (90.1–100), good (70.1–90), sufficient (60.1–70), and poor (≤60).

The data analysis techniques applied were both test-based and non-test-based. Cognitive product learning outcomes were analyzed using SPSS with N-gain analysis.

RESULTS AND DISCUSSION

Results

1. Learning Outcomes

Students' Learning outcomes involve cognitive aspects (both product and process), affective aspects, and psychomotor aspects. The evaluation of cognitive product learning is based on students' pre-test and posttest scores. In contrast, cognitive process learning is measured through the assessment of student worksheets (LKPD) and project outputs. The assessment of affective and psychomotor learning outcomes was conducted through observation sheets throughout the learning process. The following are the research results regarding cognitive product, cognitive process, affective, and psychomotor learning.

1.1. Students' Cognitive Product Learning Outcomes

The average cognitive product Learning outcomes for the control and experimental groups were obtained from pre-test and posttest scores. A summary of the average cognitive product learning outcomes is presented in the following table.

Table 1. Average Scores of Students' Cognitive Product Learning Outcomes

Cognitive Product Learning Outcomes	Control group (XI 10)	Experimental group (XI 8)
Pre-test	25.71	21.90
Posttest	44.05	43.33

From the data above, normality and homogeneity tests were conducted, and the results indicated that the data were not normally distributed (sig. > 0.05) or homogeneous (sig. > 0.05). Based on these findings, a non-parametric test, namely the Mann-Whitney test, was applied. Based on this analysis, it can be concluded that the application of the Project-Based Learning model had no significant effect.

1.1.1 Hypothesis Testing

The hypothesis was tested to assess differences in students' knowledge learning outcomes between the experimental and control classes, after undergoing homogeneity and normality testing. The Mann-Whitney test was applied to posttest data from the two classes. The results of the Mann-Whitney test are presented in the following table.

Table 2. Hypothesis Testing Results of Students' Learning Outcomes

Data	Significance	Conclusion
Posttest	0.335	No significant effect

Based on Table 2, the Mann-Whitney test yielded a significance value (2-tailed) of 0.335 > 0.05, which means the significance value is greater than the threshold value. This indicates that there is no significant difference in knowledge learning outcomes between the experimental group and the control class. Because the value (Sig.) = 0.335 > 0.05, H0 is accepted and H1 is rejected. Thus, it can be concluded that there is no difference in cognitive product posttest learning outcomes between the control class and the experimental group.

1.1.2 N-gain Score

To determine the improvement in students' cognitive product learning outcomes in the experimental group, the N-gain score was calculated, and the results are shown in the following table.

Table 3. N-Gain Score Results of Students' Cognitive Product Learning Outcomes

Class	N-gain Score	Category
Experimental	0.33	Moderate
Control	0.23	Low

As shown in Table 3, the N-gain score in the experimental group was 0.33, within the range 0.30 < N-gain < 0.70, indicating a moderate improvement. In contrast, the control group achieved an N-gain score of 0.23, within the range 0.00 < N-gain < 0.30, indicating low improvement.

1.2. Students' Cognitive Process Learning Outcomes

The average cognitive process. Learning outcomes were evaluated based on students' ability to complete the Student Worksheets (LKPD) in the experimental and control classes. A summary of the average cognitive process learning outcomes is presented in the table below.

Table 4. Students' Cognitive Process Learning Outcomes

Class	Score	Category
Experimental	77.20	Good
Control	74.15	Good

As presented in Table 4, the average cognitive process learning outcome of the experimental group was higher than that of the control group. Nevertheless, the overall average LKPD score for both groups was already categorized as 'Good'.

1.3. Students' Affective Learning Outcomes

Students' affective Learning outcomes were obtained through observations conducted during the learning process. A summary of the average affective learning outcomes is presented in the tables below.

Table 5. Affective Learning Outcomes (Character Behavior)

Affective Aspect (Character Behavior)	Experimental	Category	Control	Category
Politeness	74.07	Good	77.38	Good
Responsibility	85.18	Good	73.36	Good

Table 6 Affective Learning Outcomes (Social Behavior)

Affective Aspect (Character Behavior)	Experimental	Category	Control	Category
Cooperation	73.15	Good	77.38	Good
Developing Ideas/Opinions	72.22	Good	73.43	Good

As shown in Table 5, the average affective learning outcomes for character behavior were categorized as ‘Good’ in both the experimental group and the control group. Similarly, Table 6 indicates that the average affective learning outcomes for social behavior were also in the ‘Good’ category for both groups. The detailed categories of students’ attitudes are presented in the subsequent tables.

Table 7. Detailed Categories of Affective Learning Outcomes (Character Behavior)

Variable	Category	Control (%)	Experimental (%)
Politeness	Very Good	14.29	27.78
	Good	57.14	44.44
	Fairly Good	4.76	33.33
	Poor	23.81	11.11
Responsibility	Very Good	0.00	38.89
	Good	72.73	61.11
	Fairly Good	22.73	0.00
	Poor	4.55	0.00

Table 8. Detailed Categories of Affective Learning Outcomes (Social Behavior)

Variable	Category	Control (%)	Experimental (%)
Politeness	Cooperation	Very Good	9.09
	Good	Good	68.18
	Fairly Good	Fairly Good	13.64
	Poor	Poor	9.09
Responsibility	Developing Ideas/Opinions	Very Good	14.29
	Good	Good	57.14
	Fairly Good	Fairly Good	19.05
	Poor	Poor	19.05

1.4. Students’ Psychomotor Learning Outcomes

Students’ psychomotor learning outcomes were obtained from observations conducted during the learning process. The results of the psychomotor learning outcomes are presented in the following tables:

Table 9. Psychomotor Learning Outcomes of the Experimental Group

Psychomotor Learning Outcomes	Percentage	Category
Organizing tools and materials	86.57	Good
Identifying tools according to their functions	77.31	Good
Conducting experiments	75.46	Good
Average	**79.78**	**Good**

Table 10. Psychomotor Learning Outcomes of the Control Class

Psychomotor Learning Outcomes	Percentage	Category
Searching for information from textbooks or relevant internet sources	74.60	Good
Performing activities based on predetermined work steps	78.17	Good
Collecting products from group discussions	82.93	Good
Average	**78.57**	**Good**

As presented in Tables 9 and 10, the average psychomotor learning outcomes were categorized as 'Good' in both the experimental group and the control group. However, the experimental group achieved a higher average score than the control group. The detailed categories of students' psychomotor learning outcomes are provided in the following table.

Table 11. Detailed Categories of Students' Psychomotor Learning Outcomes

Class	Variable	Category	Percentage
Control	Performing activities based on predetermined work steps	Very Good	19.05
		Good	52.38
		Fairly Good	19.05
		Poor	14.29
	Searching for information in textbooks or on the internet	Very Good	4.17
		Good	87.50
		Fairly Good	0.00
		Poor	8.33
	Collecting products from group discussions	Very Good	29.17
		Good	62.50
		Fairly Good	8.33
		Poor	0.00
Experimental	Identifying tools according to their functions	Very Good	58.82
		Good	41.18
		Fairly Good	0.00
		Poor	0.00
	Organizing tools and materials	Very Good	15.00
		Good	65.00
		Fairly Good	15.00
		Poor	5.00
	Conducting experiments	Very Good	5.26
		Good	57.89
		Fairly Good	36.84
		Poor	0.00

2. Students' Creative Thinking Ability

Students' creative thinking ability in the control and experimental groups was obtained from pre-test and posttest scores. The average values of students' creative thinking ability are presented in the following table:

Table 12. Average Scores of Students' Creative Thinking Ability

Creative Thinking Ability	Control Group (XI 10)	Experimental group (XI 8)
Pre-test	15.67	20.61
Posttest	45.86	51.61

As shown in Table 12, there was a significant difference in average creative thinking ability between the experimental and control groups after implementing the PjBL model. The average posttest score of the experimental group was significantly higher than that of the control group. Further analysis of students' creative thinking ability was conducted by testing the prerequisites of normality and homogeneity, followed by hypothesis testing using the Mann–Whitney test in SPSS.

The results of the normality and homogeneity tests indicated that the data were not normally distributed (sig. > 0.05) but were homogeneous (sig. > 0.05). Therefore, a non-parametric test, namely the Mann–Whitney test, was applied. The findings confirmed that implementing the Project-Based Learning (PBL) model significantly improved students' creative thinking.

2.1. Hypothesis Testing

Hypothesis testing was conducted to evaluate differences in students' creative thinking ability between the experimental and control classes after testing for homogeneity and normality. The Mann-Whitney test was applied, with the posttest data between the two classes analyzed. The results of the Mann-Whitney test are presented in the following table:

Table 13. Hypothesis Testing of Students' Creative Thinking Ability

Data	Significance	Conclusion
Posttest	0.000	Significant influence

As presented in Table 13, the Mann–Whitney test yielded a significance value (2-tailed) of 0.000 < 0.05, indicating a difference in creative thinking ability between the experimental group and the control group. Since the significance value was below the threshold, H_0 was rejected and H_1 was accepted. Thus, it can be concluded that the PjBL model significantly influenced students' posttest creative thinking ability.

2.2. N-gain Score

To determine the improvement of creative thinking ability in the experimental group, the N-gain score was calculated, as shown in the following table:

Table 14. N-gain Score Results of Students' Creative Thinking Ability

Class	N-gain Score	Category
Experimental	0.38	Moderate
Control	0.35	Moderate

As shown in Table 14, the N-gain score in the experimental group was 0.38, which falls within the range of 0.30 < N-gain < 0.70, indicating a moderate level. Similarly, the control group obtained an N-gain score of 0.35, which also lies within the same range, indicating a moderate level.

Discussion

1. Students' Product Learning Outcomes

In this study, cognitive product assessment was based on pre-test and posttest scores in both the control and experimental groups. The pre-test and posttest data from the experimental group were tested for normality and homogeneity. However, the test results showed that the data were neither normally distributed nor homogeneous. Therefore, a non-parametric test, namely the Mann-Whitney test, was applied. [17] explains that if the data are not normally distributed, parametric statistics cannot be used, so nonparametric statistics are necessary.

Although the experimental group used the PjBL model, which is student-centered, and the control Group used the Direct Instruction model, which is teacher-centered, the cognitive product learning outcomes did not show a significant difference (Sig.). (2-tailed) value of 0.335, greater than 0.05. The improvement in cognitive product learning outcomes in the experimental group is evident in the pre-test average score (21.90) increasing to the posttest average score (43.33). The lack of a significant difference may have been caused by evaluation items that did not reflect the learning process, allowing both groups to answer. [18] noted that well-constructed test items should be balanced, not too easy or too difficult, to motivate students to attempt to solve them.

The improvement in cognitive product learning outcomes was measured using the N-gain, with the experimental group achieving a score of 0.33 (moderate category) and the control Group achieving a score of 0.23 (low category). The application of the PjBL model in the experimental group was associated with student-centered learning activities, which increased student engagement and understanding of the material. These findings align with previous studies stating that PjBL can improve both learning outcomes and student creativity [19]; [20].

2. Students' Cognitive Process Learning Outcomes

The cognitive process learning outcomes in the experimental group showed a higher average score than in the control group, with the experimental group achieving an average of 77.20 in the "Good" category. In contrast, the control Group obtained an average of 74.15, also in the "Good" category. The evaluation of cognitive process learning outcomes in the experimental group was based on Student Worksheet (LKPD) scores (50%) and project outputs (50%). In contrast, the evaluation of cognitive-process learning outcomes in the control class was based solely on LKPD scores.

The improvement in process learning outcomes was strongly influenced by the implementation of the PjBL model in the experimental group. The PjBL model guided students in problem-solving and creativity, which were likely the main factors in improving the average process learning outcomes in the experimental group. [21] stated that project-based learning is a model that uses projects or activities as learning tools to achieve competency in attitudes, knowledge, and skills. Projects in this context are defined as activities that involve multiple tasks, require coordination, and often demand specialized supporting skills to be completed.

3. Students' Affective Learning Outcomes

The affective learning outcomes in this study were assessed through observation sheets that measured students' affective behaviors during the learning process. The affective learning outcomes evaluated included students' character and social behavior. Character behavior assessment consisted of two aspects: politeness and responsibility. Social behavior assessment also included two aspects: cooperation and the ability to develop ideas or opinions. According to [22], the affective domain outlines learning objectives that emphasize feelings, emotions, or levels of acceptance and rejection. The affective domain has various objectives ranging from simple attention to complex responses toward a phenomenon.

a. Students' Character Behavior

Based on the study, both the experimental and control classes were categorized as "Good." However, in affective learning (character behavior), the politeness aspect in the control class showed higher results than in the experimental group. This indicates that students in the control group demonstrated better politeness behavior when the Direct Instruction model was applied. Conversely, in the responsibility aspect of affective learning (character behavior), the experimental group outperformed the control class. This suggests that students in the experimental group developed stronger responsibility behavior when the PjBL model was implemented.

The experimental group, which used the student-oriented PjBL model, had a positive impact, making students more active. In contrast, the control class, with its teacher-centered approach, resulted in lower student participation. According to [23] and [24], the use of PjBL can enhance students' affective skills. Research supports that PjBL can increase motivation, self-confidence, engagement, and learning satisfaction. The importance of selecting projects that genuinely interest students lies in stimulating active participation, encouraging discussion, and fostering students' responsibility in completing the project.

b. Students' Social Behavior

The findings showed that both the experimental and control classes achieved "Good" levels in affective learning outcomes. However, in the cooperation aspect of social behavior, the control class performed better than the experimental group. This suggests that students in the control group exhibited stronger cooperation skills under the Direct Instruction model. Similarly, in the aspect of developing ideas/opinions, the control group also scored higher than the experimental group. This indicates that students in the control group demonstrated stronger skills in generating and developing ideas when using Direct Instruction.

The experimental group, which used the student-oriented PjBL model, showed that students were more active than in the control class, which used a teacher-centered approach that tended to make students more passive. Consequently, in terms of cooperation and idea development, students in the experimental group demonstrated greater enthusiasm. In addition, student enthusiasm was also stimulated by the novelty of the PjBL model, which had not previously been used for this subject matter. According to [25] and [26], the PjBL method is known to improve learning outcomes by fostering multidimensional interaction in the learning process and enhancing students' social skills, including cooperation, communication, and leadership.

4. Students' Psychomotor Learning Outcomes

The psychomotor learning outcomes in the experimental group focused on organizing tools and materials, identifying tools by function, and conducting experiments. Meanwhile, the psychomotor learning outcomes in the control group were evaluated based on aspects such as searching for relevant information from textbooks or the internet, performing activities according to predetermined steps, and collecting products from group discussions. According to [27], psychomotor process skills involve physical movements of body parts in carrying out a task.

The table analysis showed that the experimental group achieved higher psychomotor learning outcomes than the control class. This finding indicates that students in the experimental group demonstrated stronger psychomotor skills when learning under the PjBL model. These findings are consistent with those of [28], who reported that PjBL fosters contextual learning in which students actively solve problems, make decisions, conduct research, present results, and prepare documents.

A learning model that uses projects or activities as a medium allows students to explore, evaluate, interpret, synthesize, and create information to produce various learning outcomes [29]. This view is also supported by Thomas [30], who emphasized that PjBL is a learning model that focuses on project work. With project tasks, students feel more challenged and creative in solving problems and making decisions. PjBL also provides students with opportunities to collaborate and present more effectively.

5. Students' Creative Thinking Ability

The average results of both the control and experimental groups indicated relatively low levels. One factor contributing to the low scores was difficulty understanding the students' language. Additionally, during the posttest in the experimental group, students had just participated in the *Latihan Dasar Kepemimpinan Siswa* (LDKS, Student Leadership Training), leaving them in a less optimal condition. Lesson scheduling was also acknowledged as affecting learning outcomes. [31] supported this view, stating that complex language can become a barrier to students' comprehension of learning materials. Factors influencing students' difficulty in understanding texts include vocabulary, word meaning, grammatical structures, and sentence differences.

Another influencing factor was the physical and mental fatigue of students after engaging in outdoor activities, as highlighted by [32]. Although outdoor learning can provide benefits such as improved self-confidence, self-awareness, life skills, and environmental appreciation, fatigue may negatively affect subsequent learning outcomes. Therefore, factors such as objectives, strategies, resources, weather, and transportation must be considered to ensure the effectiveness and comfort of outdoor learning activities.

From the pre-test and posttest results of the experimental group, there was a significant improvement from an average of 21.61 to 51.61. The improvement in creative thinking ability, measured by N-gain, in the experimental group was 0.38, which falls within the moderate range ($0.30 < \text{N-gain} < 0.70$). Similarly, the control group also showed moderate improvement with an N-gain of 0.35. This improvement can be attributed to the application of the PjBL model in the experimental group, where students actively engaged in student-centered, project-based learning. These findings align with several studies, including [33], [34], [35], and [36], which reported that implementing the PjBL model had a positive impact on students' creative thinking ability after treatment.

CONCLUSION

Based on the results and discussion of students' learning outcomes and creative thinking ability in Class XI of SMA Negeri 8 Banjarmasin using the PjBL model, it can be concluded that the cognitive product learning outcomes of students showed no significant effect of the PjBL model on the circulatory system topic. This is supported by the Asymp. Sig. (2-tailed) value of 0.335, which is greater than 0.05, indicating that H0 was accepted and H1 was rejected; therefore, no difference in posttest knowledge learning outcomes was found between the experimental and control classes. In contrast, the creative thinking ability of students demonstrated a significant effect of the PjBL model on the circulatory system topic, as shown by the Asymp. Sig. (2-tailed) value of 0.000, which is less than 0.05. This result led to the rejection of H0 and acceptance of H1, confirming that there was a difference in posttest creative thinking ability between the experimental and control classes. Based on these findings, it is recommended that greater attention be given to the preparation and development of learning instruments to enhance the quality of future research outcomes. Furthermore, additional studies are encouraged to apply the PjBL model to other biology concepts to explore its broader impact on student learning.

REFERENCES

[1] A. I. Andiyanti, F. Fatimah, dan L. Maharani, "Implementasi Model Pembelajaran Berbasis Proyek Pada Materi Klasifikasi Makhluk Hidup Untuk Meningkatkan Hasil Belajar Siswa Kelas VII SMP AL-Azhar," *SAINTIFIK*, vol. 10, no. 1, hlm. 14-20, 2025.
[2] F. Ningsih, S. Danuji, dan H. R. Putri, "Penerapan Media Pembelajaran Video Animasi Pada Materi Pewarisan Sifat Terhadap Hasil Belajar Siswa Kelas IX di SMP Negeri 4 Glenmore," *SAINTIFIK*, vol. 10, no. 1, hlm. 44-49, 2025.
[3] Fiqriani, R. A., Halang, B., & Mahrudin. (2023). Pengembangan bahan ajar berbentuk e-booklet keanekaragaman famili Cyprinidae sebagai bahan pengayaan konsep Animalia di SMA. *JUPEIS: Jurnal Pendidikan dan Ilmu Sosial*, 2(1), 14–28.
[4] Adawiyah, R., Zaini, M., & Ajizah, A. (2022). Hasil belajar dan keterampilan berpikir kritis peserta didik menggunakan LKPD-elektronik konsep virus. *Practice of the Science of Teaching Journal: Jurnal Praktisi Pendidikan*, 1(2), 78–87.
[5] Muliadia, D. Liestianty, A. Widiantoro, dan S. Reskika, "Penguatan Bahan Ajar pada Topik Adsorpsi dan Analisis Logam secara Voltammetri dengan pendekatan STEM," *SAINTIFIK*, vol. 10, no. 1, hlm. 74-83, 2025.
[6] Mulyadi, E. (2015). Penerapan model project based learning untuk meningkatkan kinerja dan prestasi belajar fisika siswa SMK. *Jurnal Pendidikan Teknologi dan Kejuruan*, 22(4), 385–395.
[7] Melinda, V., & Zainil, M. (2020). Penerapan model project based learning untuk meningkatkan kemampuan komunikasi matematis siswa sekolah dasar (studi literatur). *Jurnal Pendidikan Tambusai*, 4(2), 1526–1539.
[8] Hanifah, N., Yuliani, A., & Maya, R. (2018). Analisis kemampuan berpikir kreatif matematis siswa MTs pada materi lingkaran. *Aksioma*, 7(1), 80–86.
[9] Hayati, S. (2023). Implementasi model creative problem solving (CPS) berbantuan media interaktif Android terhadap kemampuan berpikir kreatif, self-efficacy, dan hasil belajar pengetahuan peserta didik pada materi laju reaksi kelas XI MIA SMAN 1 Alalak (*Skripsi*). Universitas Lambung Mangkurat.
[10] Wahyuni, A., & Hidayati, D. W. (2020). Pengaruh kemampuan berpikir kreatif berbasis ICT terhadap kemampuan spasial mahasiswa. *Jurnal Informa Politeknik Indonusa Surakarta*, 6(1), 6–9.
[11] Setiawan, H., Biyatmoko, D., & Putra, A. P. (2021). Profile of student ability in creative problem solving in biotechnology concepts. *BIO-INOVED*, 3(3), 143–149.
[12] Prilyta, R. A., Susanti, R., & Santoso, L. M. (2016). Pengaruh penerapan model problem based learning berbantuan Edmodo pada materi sistem peredaran darah terhadap hasil belajar peserta didik kelas XI SMA Negeri 8 Palembang. *Jurnal Pembelajaran Biologi*, 3(2), 169–182.
[13] Paramida, H. P. (2022). Pengaruh penggunaan e-LKPD berbasis model project based learning (PjBL) terhadap hasil belajar peserta didik pada materi sistem peredaran darah manusia kelas XI SMA (*Skripsi*). Universitas Sriwijaya.
[14] Safitri, A., Putra, A. P., & Ajizah, A. (2022). Hasil belajar dan keterampilan generik sains pada penggunaan culture literacy digital wetland LKPD konsep vertebrata siswa kelas X SMA. *Journal of Banua Science Education*, 2(2), 73–84.
[15] Annisa, S. (2023). Penerapan model pembelajaran problem based learning materi kelainan sistem gerak pada manusia terhadap hasil belajar siswa kelas XI MA (*Skripsi*). Universitas Lambung Mangkurat.
[16] Kunandar. (2015). *Penilaian autentik: Penilaian hasil belajar peserta didik berdasarkan Kurikulum 2013*. Jakarta: Rajawali.
[17] Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
[18] Irmawati, R. A., & Ratnasari, S. (2021). Analisis kemampuan pemecahan masalah siswa dalam menyelesaikan soal higher order thinking skills (HOTS). *Journal of Educational Integration and Development*, 1(4).
[19] Surya, A. P., Relmasira, S. C., & Hardini, A. T. A. (2018). Penerapan model pembelajaran project based learning (PjBL) untuk meningkatkan hasil belajar dan kreativitas siswa kelas III SD Negeri Sidorejo Lor 01 Salatiga. *Jurnal Pesona Dasar*, 6(1), 41–54.
[20] Ramadhanti, N., Sukmanasa, E., & Imaniah, R. S. (2023). Penerapan model project-based learning untuk meningkatkan hasil belajar satuan waktu siswa kelas III sekolah dasar. *E-Jurnal Inovasi Pembelajaran Sekolah Dasar (E-JIPSD)*, 11(2).
[21] Fathurrohman, M. (2016). *Model pembelajaran inovatif: Alternatif desain pembelajaran yang menyenangkan*. Yogyakarta: Ar-Ruzz Media Group.
[22] Ardianti, S. D., Pratiwi, I. A., & Kanzunnudin, M. (2017). Implementasi project based learning (PjBL) berpendekatan science edutainment terhadap kreativitas peserta didik. *Refleksi Edukatika: Jurnal Ilmiah Kependidikan*, 7(2), 145–150.
[23] Sifa, M. A., & Atmojo, R. W. I. (2018). Peningkatan keterampilan fluency melalui penerapan model pembelajaran project based learning (PjBL) pada pembelajaran IPA di sekolah dasar. *Jurnal Pendidikan Dasar*, 6(1), 43–49.
[24] Banjari, A. Z. R. (2019). Pengaruh penerapan model pembelajaran problem based learning (PBL) dan tipe numbered head together (NHT) pada pembelajaran konsep sistem peredaran darah manusia terhadap hasil

belajar siswa kelas XI MIA SMAN 6 Banjarmasin tahun ajaran 2018/2019 (*Skripsi*). Universitas Lambung Mangkurat.
[25] Prabowo, C. T. (2015). Pengaruh metode pembelajaran project based learning terhadap prestasi belajar siswa mata pelajaran las lanjut kelas XI jurusan teknik pemesinan SMK Muhammadiyah Prambanan (*Skripsi*). Universitas Negeri Yogyakarta.
[26] Dewi, S., Sumarmi, & Amirudin, A. (2016). Penerapan model pembelajaran problem based learning untuk meningkatkan keaktifan dan keterampilan sosial siswa kelas V SDN Tangkil 01 Wlingi. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 1(3), 281–288.
[27] Berutu, M. H. A., & Tambunan, M. I. H. (2018). Pengaruh minat dan kebiasaan belajar terhadap hasil belajar biologi siswa SMA/MA se-kota Stabat. *Jurnal Biolokus: Jurnal Penelitian Pendidikan Biologi dan Biologi*, 1(2), 109–116.
[28] Sadia, W. (2013). Pengaruh model project based learning terhadap pemahaman konsep dan belajar. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha*, 3, 7.
[29] Magdalena, I., Islami, N. F., Rasid, E. A., & Diasty, N. T. (2020). Tiga ranah taksonomi Bloom dalam pendidikan. *Edisi*, 2(1), 132–139.
[30] Margono, D., Arip, A. G., & Hindriana, A. F. (2018). Implementasi penggunaan model project based learning (PjBL) dalam pembuatan pestisida organik untuk meningkatkan kreativitas dan hasil belajar siswa. *Edubiologica: Jurnal Penelitian Ilmu dan Pendidikan Biologi*, 6(2), 81–89.
[31] Mulyana, E., Juariah, J., Suherman, A., Widyanti, T., & Supriatna, A. (2022). Implementasi model project based learning dalam meningkatkan kemampuan berpikir kreatif. *Sosial Khatulistiwa: Jurnal Pendidikan IPS*, 2(1).
[32] Febriani, Y. (2018). *Hubungan konsep diri dan cara belajar dengan hasil belajar biologi berdasarkan tingkat kemampuan akademik siswa kelas XI jurusan IPA di SMA Negeri se-Kecamatan Marpoyan Damai tahun pelajaran 2016/2017* (Tesis). Universitas Islam Riau.
[33] Febriyanti, A., Susanta, A., & Muktadir, A. (2021). Pengaruh model pembelajaran project based learning (PjBL) terhadap kemampuan berpikir kreatif dalam pembelajaran tematik muatan pelajaran IPA peserta didik kelas V SD Negeri. *Jurnal Pembelajaran dan Pengajaran Pendidikan Dasar*, 3(2), 176–183.
[34] Helmiati. (2012). *Model pembelajaran*. Yogyakarta: Aswaja Pressindo.
[35] Kusumaningtyas, N., Sikumbang, D., & Hasnunidah, N. (2020). Pengaruh model project based learning (PjBL) terhadap kemampuan berpikir kreatif peserta didik. *Jurnal Bioterdidik*, 8(2), 11–19.
[36] Erisa, H., Hadiyanti, A. H. D., & Saptoro, A. (2020). Model project based learning untuk meningkatkan kemampuan berpikir kreatif dan hasil belajar siswa. *JPD: Jurnal Pendidikan Dasar*.