



Implementation of Project-Based Learning (PjBL) to enhance students' collaborative skills and creativity in biology learning: A literature review

Anisa Salsabila Humaira *, Gina Mardiana, Nur Ramadhaniaty, Putri Cahaya, Rini

Department of Biology Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Banjarmasin, South Kalimantan, Indonesia, 70123

*Corresponding Author Email: 2210119220034@mhs.ulm.ac.id

Abstract. Biology learning in secondary schools is still dominated by memorization-based methods, which limit students' collaborative and creative skills. This approach provides little room for the development of cooperative skills and students' creativity, even though both skills are crucial in facing 21st-century challenges that demand critical, collaborative, and creative thinking. This study aims to examine the effectiveness of Project-Based Learning (PjBL) in improving collaborative skills and creativity in biology students. The method used was a Systematic Literature Review (SLR) with data sources from Google Scholar 2020–2024. Of the 6,313 initial articles, ten articles were selected based on inclusion and exclusion criteria. Data were analyzed descriptively using content analysis techniques. In the past five years, publications on (PjBL) in biology have increased. The results show that PjBL improves collaboration and creativity in student learning. These findings confirm that PjBL is relevant in developing 21st-century skills and making biology learning more contextual. Therefore, implementing PjBL is essential to improving the quality of biology learning.

Abstrak. Pembelajaran Biologi di sekolah menengah masih didominasi metode konvensional yang berfokus pada hafalan materi. Pendekatan ini kurang memberikan ruang bagi pengembangan keterampilan kolaboratif dan kreativitas siswa, padahal kedua keterampilan tersebut sangat penting dalam menghadapi tantangan abad ke-21 yang menuntut kemampuan berpikir kritis, kolaboratif dan kreatif. Penelitian ini bertujuan menelaah efektivitas Project Based Learning (PjBL) dalam meningkatkan keterampilan kolaboratif dan kreativitas siswa biologi. Metode yang digunakan adalah Systematic Literature Review (SLR) dengan sumber data dari Google Scholar tahun 2020–2024. Dari 6.313 artikel awal, sepuluh artikel dipilih berdasarkan kriteria inklusi dan eksklusi. Data dianalisis secara deskriptif menggunakan teknik analisis konten. Dalam lima tahun terakhir, PjBL di biologi meningkat. Hasil menunjukkan bahwa PjBL terbukti meningkatkan kolaborasi, dan kreativitas belajar siswa. Temuan ini menegaskan bahwa PjBL relevan dalam mengembangkan keterampilan abad ke-21 dan menjadikan Pembelajaran Biologi lebih kontekstual. Oleh karena itu, model PjBL perlu diimplementasikan untuk meningkatkan kualitas pendidikan biologi.

Received date: 31/07/2025
Accepted date: 17/08/2025
Published date: 29/09/2025

Keyword: biology education; creativity; collaborative skills; project-based learning

Introduction

The twenty-first century learning emphasizes an active and student-centered approach by having the skills to think critically, creatively, collaboratively, and be able to communicate effectively in response to the demands of a changing world (Ayuningsih *et al.*, 2025). This approach places students at the center of attention, encourages collaboration, offers challenges, and is integrated into society. The role of the teacher has significant importance in providing meaningful learning experiences, enabling students to apply knowledge in everyday life, and being actively involved in the learning process (Rahim & Ismaya, 2023). The goal is to produce graduates who not only master knowledge, but also have the essential skills of the 21st century, namely 4C: critical thinking, communication, creativity, and collaboration. These skills are needed so that students are able to adapt, work together, and think creatively and critically in facing various global challenges (Rahmadhani, 2024).

The Merdeka Curriculum is designed to equip learners with skills needed at the national and global levels. This curriculum was developed in response to the challenges of the 21st century, which demand critical thinking, creativity, and collaboration (Setiyaningsih & Wiryanto, 2022). Through freedom in choosing learning paths, learners can develop their potential more optimally. This curriculum also encourages students to imagine, create, and innovate in the learning process (Wahyuni *et al.*, 2023). In addition, strengthening cooperation with peers is an important part of creating learning experiences that are meaningful and relevant (Permana, 2023). Therefore, educators play an important role in designing learning that supports the maximum development of creativity and collaboration.

According to Hamdani *et al.* (2019), stated that students are better at mastering questions in the form of memory and memorization without understanding a concept. Current learning tends to still be in the form of memorization (rote Learning). Things like this are what make students easily forget the material that has been learned. This shows that students in Indonesia are still thinking at a low level. In line with according to (Nugraha *et al.*, 2023) in Biology learning so far tends to only hone aspects of remembering and understanding, which is a low order of thinking (low-level thinking), there are still many students learning only memorize, only record what delivered by the teacher and tend not to be active in the learning process. Based on the PISA 2022 results, Indonesia ranks 69th in the world and 6th in ASEAN with an average science literacy score of 383 points, experiencing a 13-point decrease from the 2018 score (396 points). Although Indonesia's global ranking rose 6 positions, this score is still far below the OECD average (476 points) and is at its lowest level since 2009 (OECD, 2024). This happens because education in Indonesia focuses on memorization, limiting higher-order thinking skills such as creativity and communication (Sugandi *et al.*, 2023).

Complex Biology learning materials require learning methods that are able to facilitate critical, collaborative, and creative thinking activities. Biology materials often involve complex concepts and interconnections between various systems, thus requiring an approach that can help students understand and apply the knowledge effectively. Therefore, a learning approach is needed that can accommodate these three activities. One relevant approach is the Project-Based Learning (PjBL) model, which emphasizes the active involvement of learners in completing meaningful projects as a means to develop higher-order thinking skills (Prapsetyo *et al.*, 2025). Project-Based Learning (PjBL) provides opportunities for students to engage in real projects relevant to biology material, so that they can apply the knowledge they have learned in a broader context. Through Project-Based Learning (PjBL), students not only learn about theory but also develop critical thinking skills, collaboration, and creativity (Ramadhan & Hindun, 2023). The PjBL model has an important role in answering the challenges of 21st-century learning that encourages collaborative skills and creativity of learners by providing space for learners to work together, solve problems, and produce meaningful products. PjBL focuses on creativity, both from educators in designing meaningful projects and from learners in completing these projects. PjBL can solve complex problems and increase student involvement in the learning process (Nugraha *et al.*, 2023).

The Project-Based Learning (PjBL) learning model is an innovative approach that centers on students and provides space for them to independently build knowledge through active involvement in projects, while the teacher acts as a facilitator and motivator (Andita *et al.*, 2018). PjBL aims to develop students' critical and creative thinking skills in solving real problems, as well as broaden their insights into various problems faced (Sari & Angreni, 2018). In addition, this model also encourages students to work together in groups, hone collaborative skills, and produce solutions or products that are meaningful. With challenging and contextual project activities, PjBL facilitates the development of creativity and optimal student collaboration in the learning process (Noviati, 2021). According to Wulandari *et al.* (2019), creativity is key in solving problems logically, which is very important so that students can successfully face the complexity of today's world. In addition, research shows that the implementation of PjBL has a significant impact on increasing creativity, communication, and active involvement of students in the learning process. Not only that, this model also encourages awareness of environmental issues and facilitates collaborative problem solving (Rafik *et al.*, 2022).

Based on the above interpretation, 21st-century learning emphasizes the development of critical, creative, collaborative, and communication (4C) thinking skills through an active and student-centered approach with teachers

acting as facilitators in creating meaningful and contextual learning experiences. The Merdeka curriculum is designed to answer these demands by providing freedom of learning that encourages imagination, innovation, and cooperation between students. However, learning practices in Indonesia are still dominated by a rote approach, which has an impact on low higher-order thinking skills, as reflected in Indonesia's science literacy score, which is still below the international average. This shows the need for learning that is able to encourage active student involvement, especially in biology subjects that are complex and demand deep conceptual understanding. Project-Based Learning (PjBL) comes as a relevant model because it allows students to build knowledge through challenging real projects, encouraging them to think critically, work together, and produce creative solutions. Therefore, this research aims to examine the implementation of Project-Based Learning in improving students' collaborative skills and creativity in the Biology subject through a study of literature.

In the last five years (2020-2024), the trend of publications regarding the application of Project Based Learning (PjBL) in Biology Learning shows a significant increase which reflects the interest and attention that continues to grow from researchers on the topic of the Project Based Learning (PjBL) learning model in improving collaborative skills and student creativity in Biology Learning. Based on a review of the ten most relevant articles, it was found that the PjBL model is consistently able to improve the collaborative skills and creativity of learners through the implementation of real projects, group work, contextual problem solving, and the use of digital learning media. PjBL not only encourages active and independent learning but also improves students' learning outcomes, social responsibility, and critical thinking skills. The implications of these findings are very important for the future of biology education, because PjBL is able to bridge learning theory with practical application in real life, strengthen the relevance of subject matter to the environmental and social context of students, and equip them with 21st-century skills that are needed to face global challenges adaptively and innovatively.

The literature study contains theories, findings, and other research materials that are used as the basis for preparing the research framework. The description in the literature study is to clarify the problem-solving that has been described in the previous problem formulation (Alfarizi & Hermina, 2025). This review is important to avoid duplication of research and strengthen the background and objectives of the research (Ridwan *et al.*, 2021). The process includes reading, understanding, examining, analyzing, synthesizing, and comparing research results. The study of literature also helps researchers understand the latest developments and identify research gaps that have not been widely studied (Alif & Solihin, 2023).

Research Methods

Methods can be divided into several parts, which include:

1) Type

This research method uses the Systematic Literature Review (SLR) research type, which uses secondary data obtained from various sources of scientific papers and current literature. Data was collected starting in July through the Google Scholar page with the keywords "Project Based Learning"; "Collaborative Skills"; 'Creativity'; "Biology Education". Based on these keywords found 6,313 articles were found, and 10 of the most relevant, the determination of article selection is determined based on inclusion and exclusion criteria. Data collection techniques were carried out by collecting key information from each article based on research findings. Furthermore, the data analysis technique used is descriptive analysis.

2) Data source and time

Data sources were obtained from *Google Scholar* with searches conducted on July 29, 2025.

3) Data collection techniques

Data collection techniques in this study were carried out through article searches on Google Scholar with publication limits 2020-2024. The search using relevant keywords resulted in 6,313 articles, and then was selected into 5,046 original articles by excluding review articles. The first 100 articles were selected from English and Indonesian, sorted by relevance. Of these, 80 articles had open access to abstracts or full-text. Subsequent screening by field of study resulted in 23 articles in the field of biology education, and the final stage obtained 10 articles that fit the research theme for analysis. The data collection procedure is shown in Figure 1.

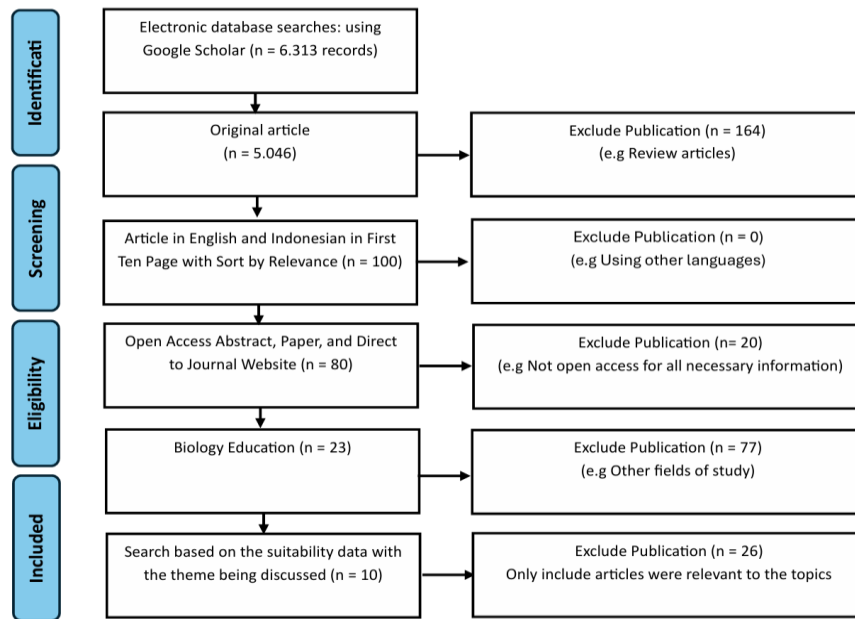


Figure 1 (Chart) limited google scholar database 2020-2024

4) Data analysis techniques

The data in this study were analyzed using content analysis techniques to systematically identify, organize, and interpret the content of the articles based on specific themes, categories, or meanings related to the focus of the study. According to Krippendorff (2019), content analysis is a research technique that produces replicable and valid inferences from textual data into the context of its use. The analysis was conducted through several steps, namely: (1) identifying the content of each selected article; (2) identifying the main themes that emerged in the articles; (3) grouping the findings into several categories, such as media development methods, the use of AR in learning, its impact on student understanding, and its relevance to local values; and (4) compiling a summary based on these themes to answer the research objectives.

Results and Discussion

Based on the number of relevant documents, there has been a significant increase from year to year, as shown in the following graph, which records the total number of documents from 2020 to 2024.

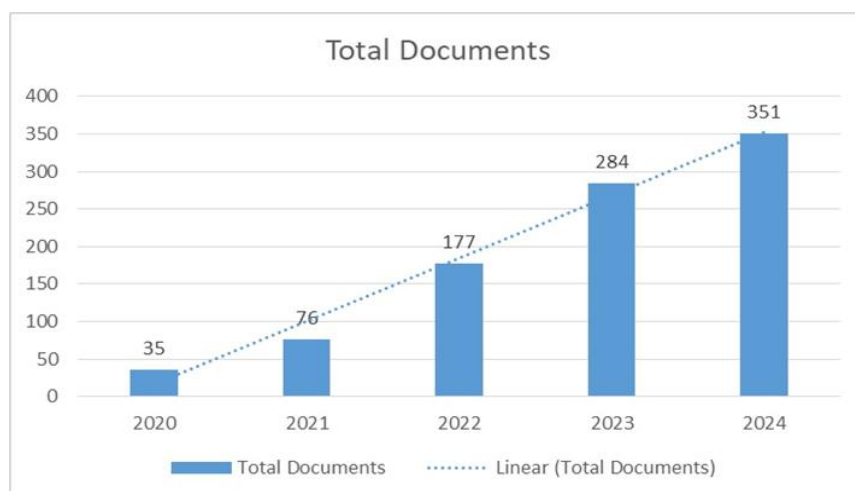


Figure 2 Graph showing the distribution of the number of documents from 2020 to 2024

Based on the graph in Figure 2, the number of documents from 2020 to 2024 there is a consistent increasing trend in the number of publications that discuss the application of Project-Based Learning (PjBL), collaborative skills, and student creativity in Biology Learning. In 2020, the number of documents recorded was 503, and it continued to increase to 780 documents in 2021. This increase continued significantly in 2022 with a total of 1,070 documents, then increased to 1,630 documents in 2023, and reached 2,330 documents in 2024. The linear trend line displayed on the graph shows a trend of steady growth over time. This increase shows that the topic of PjBL and 21st-century skills development is getting more and more attention from researchers. This reflects a wider awareness of the importance of active, collaborative, and creative learning approaches, especially in Biology Learning, which demands direct and contextual student involvement. Thus, it can be concluded that PjBL is one of the learning models that is increasingly relevant to be studied and applied in order to support the development of student competencies in the modern era. This is in line with the findings of Yunita *et al.* (2022), who stated that the PjBL model encourages students to work collaboratively in completing meaningful projects. In addition, research by Ramadhan & Hindun (2023) also showed that the application of PjBL can increase student creativity through product creation activities that are relevant to the learning context. After selection, there are 10 most relevant articles discussing this topic. The ten articles can be seen in Table 1.

Tabel 1 Ten Most Relevant Articles

Code	Researcher (Year)	Problem	Method	Findings
1	Afdania, et al. (2024).	Learning models that are not in accordance with student development make biology boring.	Qualitative descriptive with a questionnaire.	PJBL is effective in improving 21st-century skills and is of interest to students & teachers.
2.	Jannah, et al. (2023).	Teachers need to transform into facilitators of 21st-century learning by utilizing collaborative learning and technology, so that the implementation of the new curriculum is effective.	Qualitative analysis based on observation, interviews, and documentation to explore the characteristics of the messages and generate a comprehensive understanding of the research subjects.	PjBL creates active, collaborative, fun, and relevant learning with 21st-century skill demands through the synergy of teacher creativity, technology utilization, and student-centered curriculum.
3.	Riskayanti, Y. (2021).	Teachers still use the lecture method a lot, so that 21st century skills, especially 4C (Critical thinking, Communication, Collaboration, Creativity), have not developed in students.	Descriptive, through Project-Based Learning, with 66 students in class XII.	Project-Based Learning (PJBL) increases student activeness and develops 4C skills (critical thinking, communication, collaboration, and creativity). Students become more creative and critical when making educational comics and are able to work together and communicate effectively in groups.
4.	Rochim, et al. (2024).	The difficulty of designing relevant and interactive Biology Learning.	Qualitative through teacher interviews.	PJBL facilitates the development of critical thinking skills, communication, collaboration, and creativity relevant to the Merdeka Curriculum.
5.	Tendrita, M., & Hidayati, U. (2023).	21st-century skills, especially critical and creative thinking, have not developed optimally due to minimal questions, difficulty linking theory with real cases, and ideas are still conceptual, due to learning that does not support higher-level thinking.	Pretest-Posttest with critical and creative essay tests, descriptive analysis, and the Wilcoxon Test through the application of PjBL.	The results showed an increase in critical thinking from 41.67 to 54.14 and creative thinking from 42.10 to 52.00, with sig. <0.05, confirming Project-Based Learning is effective in improving 21st-century skills.

Code	Researcher (Year)	Problem	Method	Findings
6	Riak, S., & Hananto. (2023)	Low collaboration, self-regulation, and creative thinking skills of students.	Classroom Action Research (PTK)	PJBL proved effective in improving students' collaboration, self-regulation, and creative thinking skills. The scores of the three skills increased significantly from the initial to the final cycle.
7	Oktaviani, et al. (2024).	Traditional learning does not encourage creativity and collaboration.	Pretest-posttest experiment.	Implementation of PPA significantly increased students' creativity scores.
8	Mona, et al. (2023).	Low collaboration and responsibility of students during group work.	Two-cycle PTK.	PJBL improved collaboration skills from 52% to 85%.
9.	Suaidiah, et al. (2024).	Lack of student collaboration skills has an impact on low Biology learning outcomes.	Classroom Action Research (PTK) with Lesson Study approach (2 cycles).	The Project-Based Learning (PjBL) model improved collaboration skills (from 57% to 73%) and student learning outcomes, with the number of completed students increasing from 14 to 22 people.
10	Parwati, et al. (2023).	Lack of creativity and student engagement in Biology Learning.	Quasi-experiment (T test).	PJBL increases creativity and learning outcomes better than the control class.

Based on the results of the review of the 10 articles reviewed, it can be concluded that the application of Project-Based Learning (PjBL) plays an important role in improving students' creativity and collaborative skills in Biology learning. This increase is reflected in students' activities in working together to complete projects and produce creative products that are relevant to the learning material, as illustrated in Figure 3.

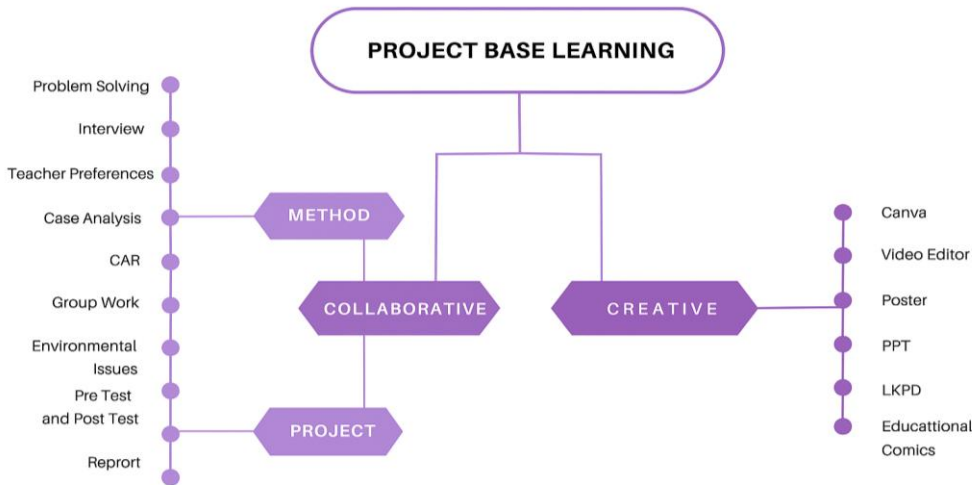


Figure 3 Scheme of Project-Based Learning (PjBL)

The research results from the ten articles found that the Project-Based Learning (PjBL) learning model was consistently able to improve learners' collaborative and creative skills through the application of various methods and types of projects in learning. In the collaborative aspect, the article findings show that methods such as problem solving, interviews, teacher preferences, real case analysis, and Classroom Action Research (PTK) are used to encourage teamwork, group discussion, and joint problem solving. In addition, learning strategies through group work and classroom experiments also proved effective in building communication, shared responsibility, and social skills among learners.

Learners are given the freedom to develop creative ideas and express project results through various media and digital tools such as Canva, video editor, educational posters, PowerPoint Presentation (PPT), preparation of LKPD, and making educational comics. These activities not only enhance learners' inventiveness but also make the learning process more meaningful and contextualized. Learners are directly involved in environmental problem-solving projects, implementation of biology projects, and evaluation of learning outcomes through pre-test and post-test, followed by the preparation of scientific reports. The findings from these articles confirm that the combination of methods, collaborative work, and real problem-based project development can create an active, contextualized learning process that leads to the achievement of 21st-century skills.

Creative thinking ability is a way of thinking that can generate ideas, something new or different from what has existed before, in solving problems (Malik *et al.*, 2019). Creative thinking is a mental activity to develop or find original, aesthetic, constructive ideas related to concept views and emphasizes aspects of intuitive and rational thinking (Dupri *et al.*, 2021). Collaboration skills are skills that are able to link critical thinking skills, motivation, and relate material to their lives in solving problems together to achieve common goals (Puspitasari *et al.*, 2019).

One of the learning models that can facilitate collaboration and creativity in learning is Project-Based Learning (PjBL). According to Nurfitriyanti (2016), Project-Based Learning (PjBL) is a learning model that emphasizes understanding of concepts through direct involvement of learners in solving important problems or tasks. In the planning and implementation stages of the project in the PjBL model, learners are encouraged to work collaboratively in designing solutions, dividing tasks, and discussing ideas together. This stage also provides space for them to learn independently and express their creativity through the products they produce. Through this process, learners not only build their knowledge but also produce real products as a result of meaningful and contextualized learning. This is in line with the results of research by Mona *et al.* (2023), which explains that the application of the project-based learning (PjBL) model can improve learners' collaboration skills through activities such as group discussions, division of tasks in teams, and cooperation in designing and completing projects. Learning project. And strengthened by Putri & Zulyusri's research (2022), which shows that the PjBL model can improve students' creativity skills, especially at the stages of product design and preparation, where students are encouraged to pour original ideas and innovative solutions to the problems raised in the project.

Project-Based Learning (PjBL) is proven to support the development of 4C skills, namely critical thinking, communication, creativity, and collaboration, which are the main competencies of the 21st century. The Project-Based Learning (PjBL) model has a significant positive impact on biology education, especially in improving students' collaborative skills and creativity. PjBL encourages students to work together in groups, which is the core of collaborative skill development, because it involves the process of sharing ideas, sharing tasks, and solving problems together (Yunita *et al.*, 2022). In addition, the involvement of students in designing and producing products at each stage of the project encourages the emergence of new ideas and innovative solutions, thus facilitating optimal creativity development. PjBL also provides space for students to be more independent and responsible for their learning process, which also strengthens these two skills in the context of Biology Learning (Lutfi *et al.*, 2018).

This situation allows students to express biological concepts visually and narratively, thus deepening their understanding of the subject matter and increasing their ability to innovate in the field of science and technology. In its implementation, Project-Based Learning (PjBL) provides ample space for students to develop creativity through the process of designing projects and creating products that are relevant to the Biology topics studied (Putri & Zulyusri, 2022). In addition, collaborative activities such as group work, discussions, and joint decision-making that occur during project implementation also strengthen students' social and collaborative skills (Yunita *et al.*, 2022). Through a project-based approach, students can see directly the application of biological science in everyday life, such as environmental or public health issues, so that they not only gain theoretical knowledge, but also practical skills that are contextual and meaningful (Ramadhani & Astuti, 2021). Thus, PjBL not only enriches Biology Learning but also equips students with relevant 21st-century skills in the context of the scientific and social world.

Conclusion

The Project-Based Learning (PjBL) learning model consistently improves students' collaborative skills and creativity. Through the application of various methods and types of projects, students are encouraged to work together to solve problems, which strengthens their communication skills and social responsibility. PjBL provides flexibility for students to develop creative ideas and express project results using various digital media, thus making the learning process more meaningful and contextualized. PjBL is proven to be effective in developing collaboration and creativity skills, which are key 21st-century competencies. This model not only increases learning motivation but also helps students to be independent and responsible in the learning process. By connecting biological theories with real-life problems, PjBL allows students to see the application of biological science in everyday life, so that they acquire relevant

theoretical knowledge and practical skills. Overall, PjBL enriches Biology Learning and equips students with much-needed skills in the scientific and social world, making it an effective approach in biology education.

Acknowledgement

The authors would like to thank those who have provided support in conducting this literature study. This research is supported by data and references obtained from Google Scholar as a credible scientific library. Gratitude is also expressed to the Supervisor Prof. Dr. H. Muhammad Zaini, M.Pd., Prof. Dr. H. Aminuddin Prahutama Putra, M.Pd. & Hery Fajeriadi, S.Pd., M.Pd., and Nurul Hidayati Utami, S.Pd., M.Pd. as lecturer reviewers who have provided valuable advice and support during this research process. Their guidance was very helpful in directing the research focus and improving the quality of this work. The author would like to thank friends and colleagues who have contributed to data collection, analysis and provided constructive feedback. Their support and cooperation were very meaningful in completing this research. Hopefully, this article can make a useful contribution to the world of education and become a reference for further research.

References

- Afdania, T., Purba, A. S., Ahwani, N., Ramadhana, N. P., Mukra, R., & Arwita, W. (2024). Studi literatur: Analisis penerapan model pembelajaran problem-based learning (PBL), project based learning (PjBL) dan deep learning pada guru biologi dan siswa di kelas XII SMAN 1 Labuhan Deli Tarisya. *Journal BIOnatural*, 12(1), 1–23. <https://ejournal.uncm.ac.id/index.php/bio/article/view/1492>
- Alfarizi, G. M., & Hermina, D. (2025). Posisi dan fungsi teori serta literatur review dalam penelitian kualitatif. *As-Sulthan Journal of Education*, 1(3), 541–549. <https://ojssulthan.com/asie/article/view/59/41>
- Alif, M., & Solihin, O. (2023). Kajian tinjauan literatur dalam penelitian sosial. *Journal Signal*, 11(2), 277–297. <https://repository.unikom.ac.id/70831/>
- Andita, P. S., Stefanus, C. R., & Agustina, T. A. H. (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. <https://jurnal.usk.ac.id/PEAR/article/view/10703>
- Ayuningsih, R. F., Andrianto, D., & Kurniawan, W. (2025). Integrasi model pembelajaran blended learning dan flipped classroom: Strategi efektif dalam pembelajaran abad ke-21. *STRATEGY: Jurnal Inovasi Strategi dan Model Pembelajaran*, 5(1), 10–21. <https://doi.org/10.51878/strategi.v5i1.4942>
- Dupri, Nazirun, N., & Candra, O. (2021). Creative thinking learning of physical education: Can it be enhanced using the discovery learning model? *Journal Sport Area*, 6(1), 37–47. [https://doi.org/10.25299/sportarea.2021.vol6\(1\).5690](https://doi.org/10.25299/sportarea.2021.vol6(1).5690)
- Hamdani, M., Prayitno, B. A., & Karyanto, P. (2019). Meningkatkan kemampuan berpikir kritis melalui metode eksperimen. In *Proceedings Biology Education Conference: Biology, Science, Environmental, and Learning*, 16 (Vol. 1, pp. 139–145). <https://jurnal.uns.ac.id/prosbi/article/view/38412/25445>
- Jannah, S. R., Firmansyah, R., & Nurfitri, A. (2023). Penerapan model Project Based Learning dalam menginisiasi kegiatan kolaboratif peserta didik pada pembelajaran biologi. *Jurnal Biologi*, 1(3), 1–10. <https://doi.org/10.47134/biology.v1i3.1972>
- Lutfi, Ismail, & Azis, A. A. (2018). Pengaruh Project-Based Learning terintegrasi STEM terhadap literasi sains, kreativitas dan hasil belajar peserta didik. In *Prosiding Seminar Nasional Biologi dan Pembelajarannya*, (pp. 189–194). <https://eprints.unm.ac.id/31086/1/67.pdf>
- Malik, A., Nuraeni, Y., Samsudin, A., & Sutarno, S. (2019). Creative thinking skills of students on harmonic vibration using model Student Facilitator and Explaining (SFAE). *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, 8(1), 77–88. <https://doi.org/10.24042/jipfalbiruni.v8i1.3056>
- Mona, N., Rachmawati, R. C., Mulyaningrum, E. R., & Rifangi, S. (2023). Implementasi pembelajaran praktikum biologi scientific approach terhadap literasi sains peserta didik MAN 2 Kota Semarang. *Jurnal Pendidikan Tambusai*, 7(2), 11158–11166. <https://doi.org/10.26877/jpgp.v1i2.230>
- Muhammad Rafik, Febrianti, V. P., Nurhasanah, A., & Muhajir, S. N. (2022). Telaah literatur: Pengaruh model pembelajaran Project Based Learning (PjBL) terhadap kreativitas siswa guna mendukung pembelajaran abad 21. *Jurnal Pembelajaran Inovatif*, 5(1), 80–85. <https://doi.org/10.21009/JPI.051.10>
- Noviati, M. D. A. (2021). Application of the Project-Based Learning Model (PjBL). *SHES: Conference Series*, 4(6), 644–647. <https://doi.org/10.20961/shes.v4i6.68514>
- Nugraha, I. R. R., Supriadi, U., & Firmansyah, M. I. (2023). Efektivitas strategi pembelajaran Project Based Learning dalam

- meningkatkan kreativitas siswa. *Jurnal Penelitian dan Pendidikan IPS*, 17(1), 39–47. <https://doi.org/10.21067/jppi.v17i1.8608>
- Nurfutriyanti, M. (2016). Model pembelajaran Project Based Learning terhadap kemampuan pemecahan masalah matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 6(2), 149–160. <http://dx.doi.org/10.30998/formatif.v6i2.950>
- OECD. (2024). *PISA 2022 Technical Report*. OECD Publishing. <https://doi.org/10.1787/01820d6d>
- Oktaviani, S., Safitri, S., Sriwijaya, U., & Sriwijaya, U. (2024). Effectiveness of Project-Based Learning on improving creative thinking skills. *Edukasi*, 4(3), 37–50. <https://doi.org/10.57032/edukasi.v4i3.215>
- Parwati, L., Darussyamsu, R., Rahmi, Y. L., & Fajrina, S. (2023). Pengaruh model pembelajaran Project Based Learning terhadap kreativitas siswa pada mata pelajaran biologi. *Innovative: Journal of Social Science Research*, 3(4), 1381–1391. <http://j-innovative.org/index.php/Innovative/article/view/3642>
- Permana, G. (2023). Implementasi konsep kurikulum merdeka dan perangkat pembelajaran terbuka dalam meningkatkan kreativitas dan kemandirian peserta didik. In *prosiding Conference of Elementary School*, (pp. 292–301). <https://journal.um-surabaya.ac.id/Pro/article/view/19746>
- Prapsetyo, A. M. D. L., Putri, T. N., & Prapsetyo, A. (2025). Efektivitas model Project Based Learning untuk meningkatkan keterampilan berpikir kritis peserta didik. *Jurnal Dwija Kusuma*, 13(1), 1–10. <https://ojs.akmil.ac.id>
- Puspitasari, N. I., Rinanto, Y., & Widoretno, S. (2019). Peningkatan keterampilan kerjasama peserta didik melalui penerapan model Group Investigation. *Bio-Pedagogi*, 8(1), 1–5. <https://doi.org/10.20961/bio-pedagogi.v8i1.35544>
- Putri, Y. A., & Zulyusri, Z. (2022). Meta-analisis pengaruh model Project Based Learning terhadap kemampuan berpikir kreatif siswa pada pembelajaran biologi. *Bioeduca: Journal of Biology Education*, 4(2), 1–11. <https://doi.org/10.21580/bioeduca.v4i2.11891>
- Rahim, A., & Ismaya, B. (2023). Pendidikan karakter dalam kurikulum merdeka belajar: Tantangan dan peluang. *Journal Sains and Education*, 1(3), 88–96. <https://doi.org/10.59561/jse.v1i3.234>
- Rahmadhani, P. (2024). Studi literatur: Pengaruh model pembelajaran Project Based Learning (PjBL) terhadap keterampilan kolaborasi peserta didik. *Jurnal Pendidikan Tambusai*, 8(1), 5153–5162. <https://doi.org/10.31004/jptam.v8i1.13097>
- Ramadhan, E. H., & Hindun, H. (2023). Penerapan model pembelajaran berbasis proyek untuk membantu siswa berpikir kreatif. *Protasis: Jurnal Bahasa, Sastra, Budaya, dan Pengajarannya*, 2(2), 43–54. <https://doi.org/10.55606/protasis.v2i2.98>
- Riak, S., & Hananto, H. (2023). Penerapan model pembelajaran project-based learning dalam meningkatkan keterampilan kolaborasi, kemampuan regulasi diri, dan keterampilan berpikir kreatif pada pembelajaran biologi topik pembelahan sel pada siswa SMA kelas XII IPA. *Academy of Education Journal*, 14(2), 890–905. <https://jurnal.ucy.ac.id/index.php/fkip/article/view/1942>
- Ridwan, M., Suhar, A. M., Ulum, B., & Muhammad, F. (2021). Pentingnya penerapan literature review pada penelitian ilmiah. *Journal Masohi*, 2(1), 42–51. <https://doi.org/10.36339/jmas.v2i1.427>
- 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>
- Rochim, A. A., Baharung, S., & Isnaini, I. (2024). Perencanaan pembelajaran biologi berbasis project based learning pada kurikulum merdeka di SMAN 1 Bungku Tengah. *Jurnal Pendidikan Tambusai*, 8(Mei), 18154–18161. <https://doi.org/10.31004/jptam.v8i2.15015>
- Sari, R. T., & Angreni, S. (2018). Penerapan model pembelajaran project based learning (PjBL) upaya peningkatan kreativitas mahasiswa. *Jurnal Varidika*, 30(1), 79–83. <https://journals.ums.ac.id/varidika/article/view/6548>
- Setiyaningsih, S., & Wiryanto, W. (2022). Peran guru sebagai aplikator profil pelajar Pancasila dalam kurikulum merdeka belajar. *Jurnal Ilmiah Mandala Education*, 8(4), 3041–3052. <https://ejournal.mandalanursa.org>
- Suaidiah, S., Jamaluddin, J., & Hardiana, H. (2024). Penerapan model pembelajaran project based learning untuk meningkatkan keterampilan kolaborasi dan hasil belajar biologi di SMAN 7 Mataram tahun ajaran 2022/2023. *Jurnal Ilmiah Profesi Pendidikan*, 9(1), 278–284. <https://doi.org/10.29303/jipp.v9i1.1883>
- Sugandi, H., & Sa'diatul Fuadiyah, H. A. (2023). Studi literatur mengenai pengaruh model pembelajaran PjBL terhadap kemampuan berpikir kreatif peserta didik. *Journal of Science Education*, 3(2), 169–182. <https://doi.org/10.52562/biocephpy.v3i2.532>
- Tendrita, M., & Hidayati, U. (2023). Efektivitas project based learning sebagai implementasi kurikulum merdeka terhadap keterampilan abad 21 mahasiswa pendidikan biologi. *Kulidawa*, 4(2), 92–99. <https://doi.org/10.31332/kd.v4i2.7916>
- Wahyuni, T., Darsinah, D., & Wafroturrahmah, W. (2023). Inovasi pembelajaran dalam kurikulum merdeka dimensi kreatif. *Jurnal Tarbiyah dan Ilmu Keguruan Borneo*, 4(1), 79–86. <https://doi.org/10.21093/itikborneo.v4i1.6652>

- Wulandari, A. S., Suardana, I. N., & Devi, N. P. L. (2019). Pengaruh model pembelajaran berbasis proyek terhadap kreativitas siswa SMP pada pembelajaran IPA. *Jurnal Pendidikan dan Pembelajaran Sains Indonesia (JPPSI)*, 2(1), 47–58. <https://ejournal.undiksha.ac.id/index.php/JPPSI/article/view/17222>
- Yunita, H., Komalasari, B., & Mahfuz, M. (2022). *Efektivitas model project based learning pada mata kuliah metodologi pengajaran PAI di Program Studi PAI IAIN Curup* [Doctoral dissertation, IAIN Curup]. <http://e-theses.iaincurup.ac.id/id/eprint/1048>