

Research Trends in PjBL (Project-Based Learning) at Indonesian Journal of Biology Education

Mega Elvianasti^{1*}, Festiyed², Yerimadesi³, Eka Kartikawati⁴, Zulherman⁵

^{1,4}Universitas Muhammadiyah Prof. Dr. Hamka, Indonesia

^{2,3} Universitas Negeri Padang, Indonesia

⁵ Universitas Utara Malaysia Sintok, Malaysia

Corresponding Author ✉ megaelvianasti@uhamka.ac.id*

ABSTRACT

Project-based learning (PjBL) was one of the learning strategies that can develop students' scientific skills in the 21st century. This study used a qualitative approach by analyzing several articles published in biology education journals in Indonesia from 2015–2022, focusing on studying the implementation of project-based learning on biological materials. The current study reveals that there has been a decline in the number of publications over the past four years. Among these studies, the dominant research design is quantitative. In addition, high school students and environmental content were the most targeted subjects and content, respectively. ANOVA and tests are the most commonly used data analysis techniques and instruments. Meanwhile, the most widely measured skills as learning outcomes are critical and creative thinking. Based on what this study found, a number of suggestions have been made to do more research on PjBL and to test other 21st century skills.

Keywords: *Project Based Learning, Biology Education, Research Trends*

ARTICLE INFO

Article history:

Received

July 08, 2022

Revised

September 19,
2022

Accepted

October 01, 2022

How to cite

Elvianasti, M., et al., (2022). Research Trends in PjBL (Project-Based Learning) at Indonesian Journal of Biology Education. *Jurnal Iqra' : Kajian Ilmu Pendidikan*, 7(2). 105-119.

<https://doi.org/10.25217/ji.v7i2.2646>

Journal Homepage

<http://journal.iainnumetrolampung.ac.id/index.php/ji/>

This is an open access article under the CC BY SA license

<https://creativecommons.org/licenses/by-sa/4.0/>

INTRODUCTION

In Indonesia, in recent years, science learning in schools has been directed at holistic learning. This is in line with the independent learning curriculum, which continues the direction of K13 development with a holistic orientation, competency-based not content, and contextualization and personalization in accordance with the cultural context, school mission, and local environment as well as the needs of students. The independent learning curriculum has main characteristics, namely: project-based learning to develop students' soft skills. Project-based learning is a learning model that connects knowledge and action; it allows students to learn by applying their knowledge related to real life (Sidawi, 2005 ; Baser et al., 2017). In line with Cresswell-Yeager (2021) with real-world applications in projects, students can connect many principles; learning becomes active; and students can apply communication concepts and reflect on their observations.

Science learning relies on initial experience in studying concrete thoughts and then making these thoughts more complex and applicable. The approach to education

must provide a favorable environment for students to gain more experience in understanding the scientific process (Bilgin et al., 2015), similar to project-based curriculum materials that can assist students in achieving learning outcomes (Harris et al., 2015). According to Kizkapan & Bektas (2017) and (Gülbahar dan Tinmaz, 2006; Zadok, 2020) teaching methods have an essential role in science education. Therefore, teachers can contribute by applying constructivist learning so that learning is more meaningful. Project-based learning (PjBL) is an example of a student-centred model where students learn to build their own learning experiences independently (Paristiowati et al., 2022). When students participate in student-centered activities (active learning), they will acquire "real world" or "non-technical" transverse competencies (Duch, Groh, dan Allen 2001; Rodriguez, Zhou, dan Carrió 2017; Russell et al., 2018). Project-based learning can be applied to biology learning starting from low level to high level. Thus, these findings provide new information about research trends regarding project-based biology learning in Indonesia over the last seven years that can contribute to research development and improve the quality of learning in accordance with the independent learning curriculum.

PjBL is commonly used in scientific classes to help students have a better understanding of science issues (Fogleman et al., 2011; Schwarz et al., 2009; Hsu et al., 2015) and developing skills relevant to the 21st century (Morales et al., 2013). In addition, it can improve the quality of learning. The findings of Siswono et al., (2018) show that with PjBL, students feel enthusiastic and actively discuss with other students, as well as improve communication skills (Owens & Hite, 2020), creativity, teamwork, and critical thinking (Russell et al., 2018) and metacognitive (Lukitasari et al., 2021). By focusing on driving questions relevant to scientific practice, allowing students to interact and seek solutions to continuing questions, and producing tangible objects as project deliverables, PjBL can boost student engagement (Krajcik & Shin, 2015; Juuti et al., 2021).

There are many studies that examine research trends in Indonesia, especially those related to learning biology. As done by M. Haviz (2019) which examines research trends in biology journals but does not specialize in certain topics. Then the trend of research on critical thinking skills (Susetyarini & Fauzi, 2020). Furthermore, Rahardjanto (2022) focused on the trend of R&D research in biology learning. The results show that in research R&D is dominated to develop products to support biology learning. In addition, other research trends reveal that there is still a low number of research publications that examine biology learning, especially biochemical material in Indonesia (Wahyono et al., 2020). However, the trend of research on learning biology has increased significantly in the last 63 years (Abdullah, 2022). Although there have been many research results about research trends in biology learning, however, no one has studied the trends in project-based learning biology learning in Indonesia.

Using a qualitative approach by analyzing several articles in Indonesian biology education journals from 2015 to 2022, this study aims to collect information on various studies that discuss the implementation of project-based learning on biology materials in Indonesia. In detail, this research is intended to answer the following questions: (1) What is the trend in the number of research papers on PjBL in Indonesia? (2) What was the most dominant research subject chosen by the researcher? (3) How is the diversity of research methods used to investigate PjBL in Indonesia? (4) What instruments are used by researchers to measure the success of PjBL? (5) What data analysis techniques are used by researchers in PjBL? (6) Biological material that is

frequently used as a material in the implementation of PjBL? (7) Which science skills are often measured by researchers? In several aspects, this research is different from previous research, which focused on implementing PjBL. First, this study focuses on all Science and Technology Index-accredited articles published between 2015 and 2022. (SINTA). Second, this research will look into a number of articles that have PjBL as their primary topic. Third, content analysis is based on a number of parameters.

METHOD

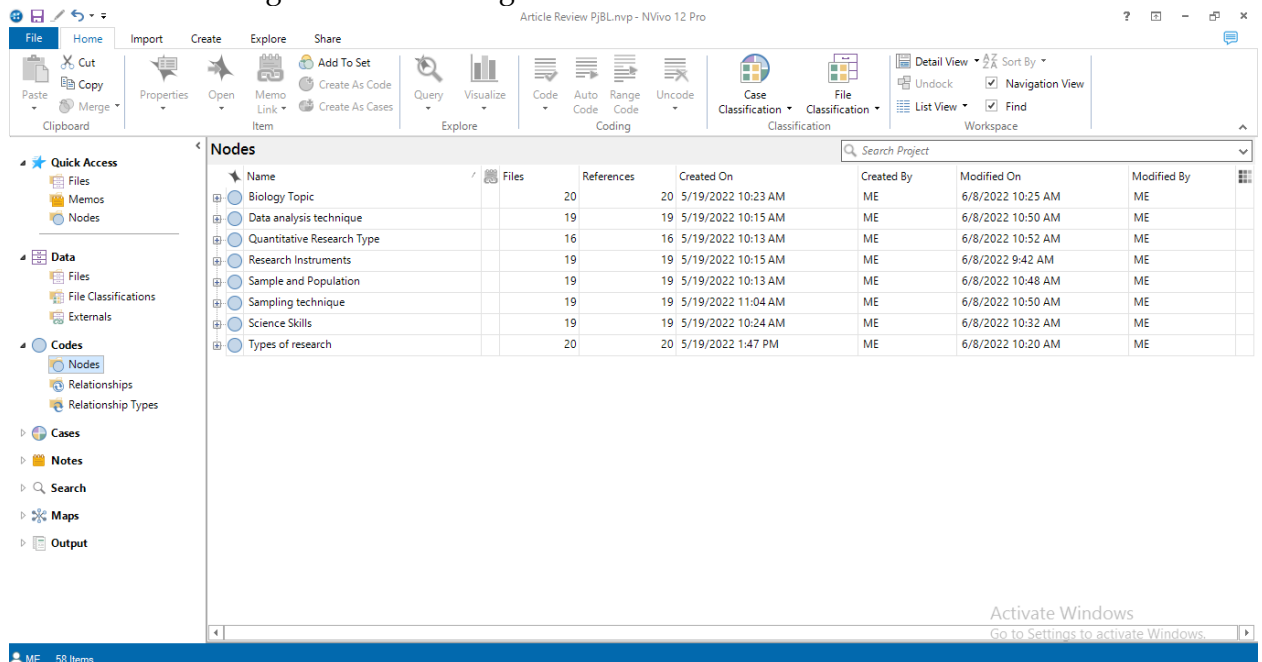
This research adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) research procedure and is based on a qualitative method that examines the findings of various studies published in Indonesian scientific publications.

The data obtained was sourced from biology education journals registered with SINTA (Science and Technology Index). SINTA is a platform for indexing journals in Indonesia, starting from rank 6 (bottom) to rank 1 (top). As of May 2022, there are 19 biology education journals that SINTA has indexed. Furthermore, all research articles related to project-based learning were collected from these journals. The articles analyzed are those published in the period 2015–2022. The results of PjBL research were the 20 articles that were found after the article collection process was done.

The study's tool was a content analysis guideline (Figure 1), which included 1) the number of publications per year, 2) the number of biology education journals indexed by SINTA, 3) the type of research, 4) the type of research that is quantitative, 5) research samples, 6) sampling techniques, 7) types of instruments, 8) data analysis techniques, 9) biology topics, and 10) types of science skills.

Data sourced from journals was analyzed using coding techniques with the help of NVIVO 12 so that the data that had been collected could be visualized in the form of diagrams.

Figure 1. The Coding Process of 20 Selected Articles

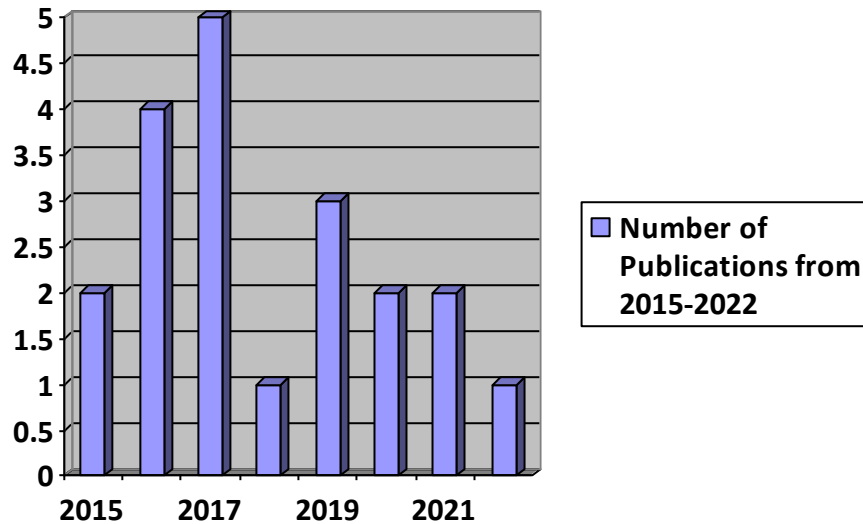


RESULT AND DISCUSSION

Count of Publications

The number of articles published in a given period indicates how often researchers on biological content research PjBL. In Figure 2, it can be seen that the trend of PjBL research increased starting from 2015–2017.

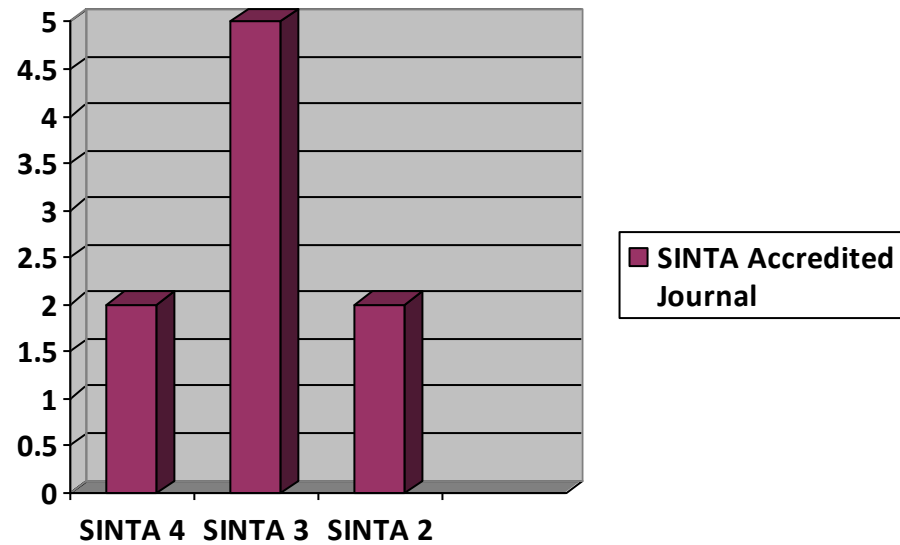
Figure 2. Shows the Number of Publications Per Year from the SINTA Accredited Biology Education Journal Over an Eight-Year Period.



In 2019–2022, there was a decrease in the number of publications; this shows that there is still little research on project-based learning conducted by researchers, especially on biological content. Because the biology content is so relevant to real life, teachers can use it to develop project-based learning. PjBL can connect knowledge and action, allowing students to learn by applying what they've learned to real-life situations (Sidawi, 2005 ; Baser et al., 2017).

The independent learning curriculum that has been launched by the Ministry of Research, Technology, and Higher Education can bring habituation to project-based science learning. So it is hoped that the studies that review the implementation of PjBL will increase, and the quality of education in Indonesia will also improve. There are a lot of ways to improve the quality of education, especially when it comes to helping to improve education in developing countries (Madani, 2019). One of the factors that affect the quality of education comes from the quality of research results carried out by researchers.

Figure 3. Number of Journals Accredited by SINTA

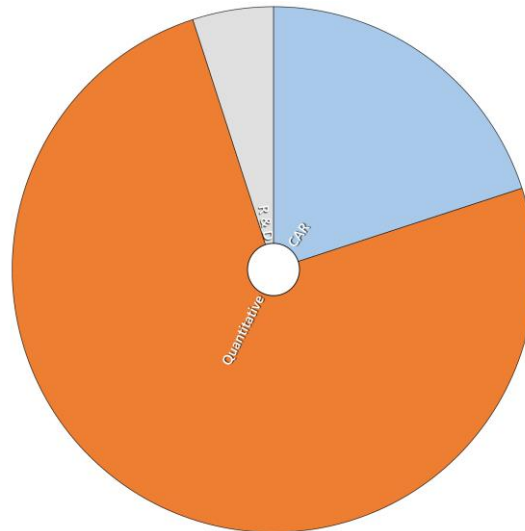


Based on a search through the SINTA platform, two journals accredited by SINTA 2 were found, namely: BIOSFER: Journal of Biology Education and JPBI (Jurnal Pendidikan Biologi Indonesia). Accredited by SINTA 3 were as many as five journals, namely: Bioedusiana, JPBI, Journal of Biology Education, Bioedusains (Jurnal Pendidikan Biologi), and the Journal of Biology Education. Meanwhile, the journals indexed by SINTA 4 are Bioedukasi and Journal of Biology Education (UNIMED). Journal indexation shows the quality and ranking of the journal.

Types of research

The right type of research can assist researchers in determining the direction and objectives of their research. Based on Figure 4, quantitative research is the most dominant type of research used by researchers in investigating the effectiveness of project-based learning on biological content. The purpose of quantitative research is to study a specific group of people to generate knowledge and create an understanding of the social world (Ahmad et al., 2019) this follows the objectives of educational research. Folajogun (2020) findings show that quantitative methods have dominated research in education and science for ten years.

Figure 4. Trends in Types of Project-Base Research on Biological Content



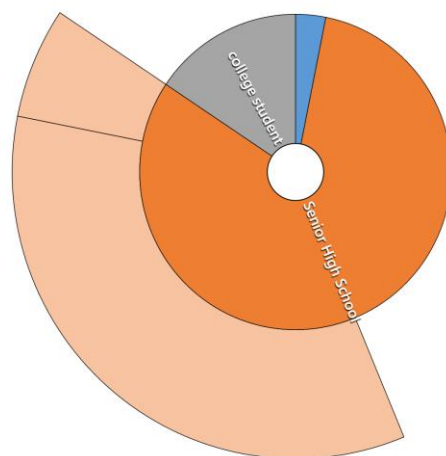
The study of this type of research provides us with the knowledge and skills needed to solve problems and meet the challenges of today's current pace of development (S. Singh, 2019). Following the university's mandate, research so that its findings can solve community problems, enrich teaching content, and contribute to sustainable growth and development (Folajogun, 2020). Education research in Indonesia also leads to classroom action research. In this type of research, researchers often do 2-3 cycles to observe and solve problems in class. Classroom action research is a technique for determining what works best in the classroom to help students learn better. Although we have a lot of knowledge about good teaching in general (McKeachie, 1999; Chickering dan Gamson, 1987; Weimer, 1996 ; Mettetal, 2002) each teaching situation is unique in terms of content, level, student skills and learning styles, teacher skills and teaching styles, and a variety of other factors. To get the most out of any circumstance, the teacher must figure out what works best.

This type of R&D research related to project-based learning on biological content is still little researched in Indonesia. This opens opportunities for researchers to develop project-based learning, especially in developing learning models by integrating various existing approaches. For example, combining the local culture can lead students to think contextually because the situation is actual and close to their daily lives. This is in line Miller et al., (2021) The teacher's task is to focus on "real world" scenarios to link student learning in a meaningful context. Culture-based education (ethnoscience) has recently become a hot topic of discussion among academics to continue the nation's ideals and aims to arouse students' love for their own culture. According to Sudarmin (2014) ethnoscience-based science learning can shape students' character; besides, the learning model integrated with the ethnoscience approach can provide students with comprehensive and holistic skills from various learning domains (Khoiri & Sunarno, 2018). Project-based learning that includes culture helps students learn more about science and understand it better in places like the United States and Taiwan (Hsu et al., 2016).

Research Subject

The research subjects in various project-based learning research are students. Based on Figure 5, the most selected research subjects are students in high school (SMA) in classes X and XI, followed by students in college and junior high school (SMP). Although the most chosen research subjects are high school students, project-based learning is recommended for college students (Almulla, 2020). In line with Goktas (2012) in educational research in Turkey, the research subjects most often chosen were students at universities and teachers.

Figure 5. Research Subjects in Project-Based Biology Learning Research



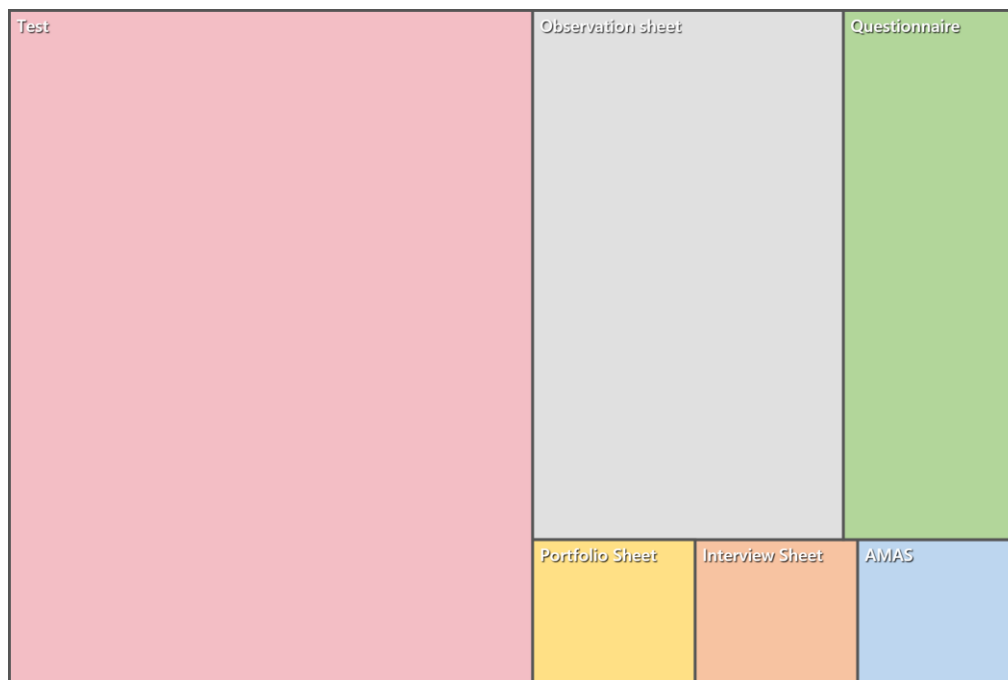
The picture above shows that project-based learning is more suitable for high-grade students because PjBL takes a long time and involves teamwork, project management, deep understanding, application of knowledge, and problem-solving (Nilson, 2016 ; Cresswell-Yeager, 2021). According to Piaget's cognitive theory, J. (1983) ; Lefa (2014) students who are in high school are in the formal operational stage (12 years and over) and can use their concrete operations to form more complex processes, and students already have abstract thinking patterns. Students are placed in situations where they have to solve problems at this age. In addition, the Gestalt theory also explains that students can understand a problem that can be concluded. Problems can come from the stimuli and responses given to students. Universities are using PjBL more and more as a way to teach and learn through social interaction (Lee & Lim, 2012; Von Kotze & Cooper, 2000; Lin et al., 2021).

Types of Research Instruments

Researchers in data collection need instruments. The most dominant instrument used in project-based learning is the test shown in Figure 6. This instrument is widely used to measure students' conceptual understanding, critical thinking skills, creative thinking skills and metacognitive skills. The tests given can be in the form of essay questions and descriptions. The test is designed to measure a sample's quality, ability, skill, or knowledge against a given standard, which can usually be considered acceptable or not. In educational practice, a test determines a student's ability to complete a particular task or tasks, indicating mastery of a skill or content knowledge. Tests can take the form of multiple-choice or weekly spelling (Adom et al., 2020).

The test used to measure students' conceptual understanding, critical thinking, creativity, and metacognition refers to the cognitive domains of remembering, understanding, applying, analyzing, evaluating, and creating. While the test for critical thinking skills refers to the cognitive part at the level of analyzing, evaluating, and creating (Cochran et al., 2007), the tests used to measure critical thinking skills are widely used in Indonesia in the form of essays and multiple choice. Several critical thinking tests, such as BaSIC Skills for Critical Thinking; Cornell Critical Thinking Test, Level X; and Ross Test of Higher Cognitive Processes (Follman et al., 1996). According to (Susetyarini & Fauzi, 2020) Indonesia's most common test for critical thinking is the Indonesia Cornell Critical Thinking Test. While creativity in PjBL is an important goal in education (You, 2021), creativity refers to bright ideas proposed by students to solve a problem. Although the research results do not explain the type of test used, researchers can use several tests commonly used by researchers in education.

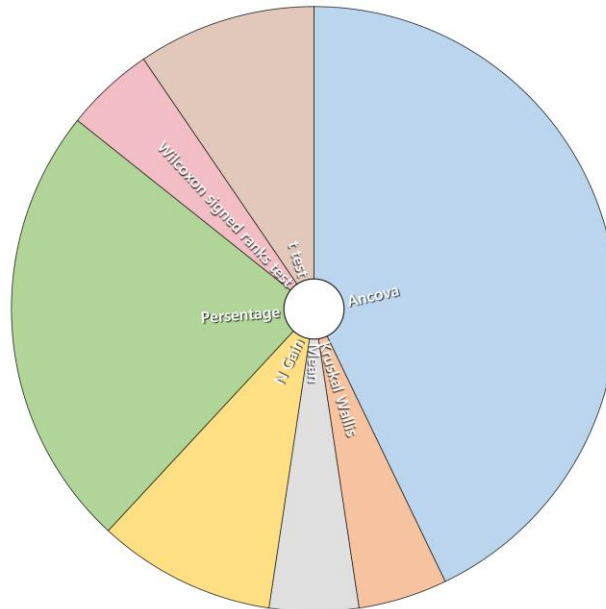
Figure 6. Distribution of Instrument Types in PjBL Research in Indonesia
Data analysis techniques



Data analysis can refer to specific procedures and methods that include how to work with information (data) to support the work, goals, and plans of a program (Richmond, 2006), referring to Figure 7, the tendency of researchers to test the hypothesis by using ANCOVA then percentage and t-test. This aligns with the type of research that dominates (Figure 4), namely quantitative research. Some research results do not explain clearly how the data analysis techniques are used. Analysis of covariance (ANCOVA) is a practical, powerful, and versatile statistical technique. ANCOVA is a statistical procedure used to analyze differences in response variables between groups while accounting for variability; it is most commonly used in many disciplines such as health, ecology, environment, psychology, and education (Cangür et al., 2018). Before performing the data analysis technique with ANCOVA, the

researcher first conducted a prerequisite test with normality and homogeneity tests using SPSS.

Figure 7. The Most Popular Data Analysis Techniques in PjBL Research

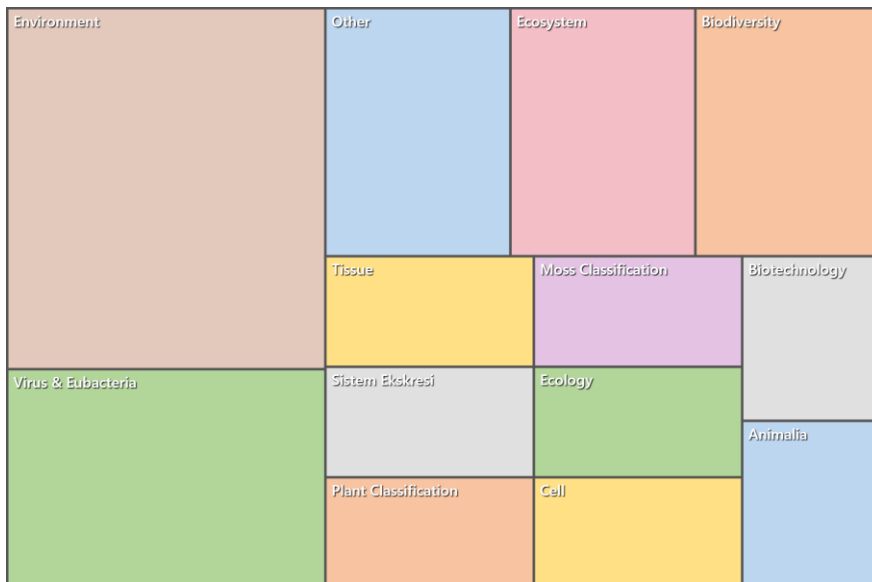


The percentage used by the researcher measures the relative frequency; the percentage indicates the frequency of the value given relative to the total number of cases and is multiplied by one hundred (Richmond, 2006). The instrument used by the researcher correlates with the data analysis technique used so that the research results can be tested for accuracy and validity. As in Figure 6, the percentage of the tests used is often calculated to find out the maximum and minimum scores so that researchers can make a range of scores and criteria.

Selected Biological Materials at PjBL

Biology material is contextual material at the high school to university level and is suitable for the PjBL learning model. In addition, some contents are conceptual and abstract, so they need help, such as media, to teach them. In Figure 8, the most frequently selected biological content in PjBL are environmental content with five publications, viruses and eubacteria with three publications; and ecosystem and biodiversity content with two publications.

Figure 8. Dominant Biology Topics Taught in PjBL



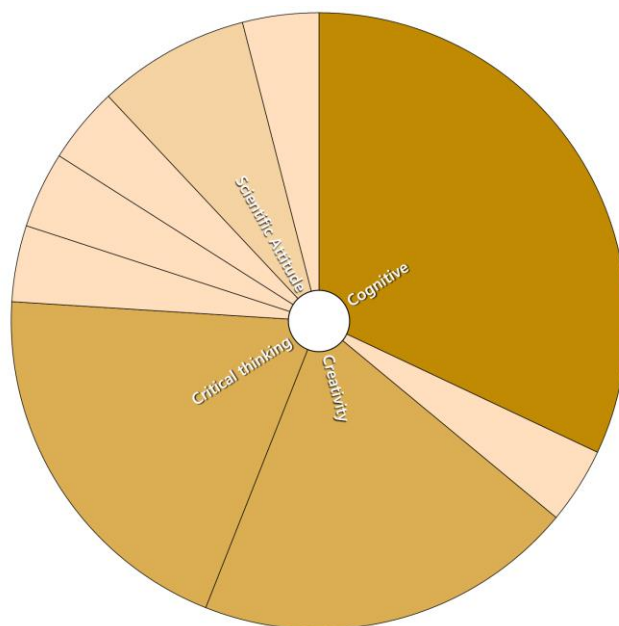
Based on the study results, the selected biological materials did not explain why the researchers chose these materials. The material chosen follows the characteristics of PjBL. This can be a concern for other researchers who, in selecting a material that will be used as a pilot in research, reasons can be followed that are accompanied by existing theories. According to (Susetyarini & Fauzi, 2020) researchers tend not to detail the research background related to the factual conditions of the study.

Content about the environment is close to the daily lives of students. Environmental problems are also increasing along with the increasing number of human activities. Integrating environmental content into learning is expected to increase students' environmental awareness, not damage the environment, and develop students' understanding of environmental conservation and improvement to improve the quality of life of the community (Pane & Patriana, 2016). The curriculum in Indonesia separates environmental and ecosystem content at the high school level. However, the true ecosystem is part of the environment because, for the survival of plants, animals, and microbes, they require energy from the environment and interact with abiotic and biotic components (Y. K. Singh, 2006). Like the material for viruses and eubacteria, the researchers also did not explain the concrete reasons for choosing the material. Virus and bacteria content is included in complex content because it is abstract and cannot be seen with the naked eye, so to teach it, the teacher needs the help of tools or media. Students have difficulty analyzing the role of viruses in life and understanding the process of replicating viruses, while in bacterial content, students have difficulty identifying bacteria (Firmanshah et al., 2020). Assuming that this content is complex, the researcher uses the PjBL model to teach it to students.

PjBL Studies Assess Science Skills

The learning process is said to be successful if it can achieve the learning objectives and expected learning outcomes. In PjBL research, the desired learning outcomes tend to be 21st-century skills (Figure 9), namely: critical thinking skills and creative thinking. In addition, the desired learning outcomes are cognitive knowledge and scientific attitudes.

Figure 9. Types of Science Skills Expected in PjBL Research



To achieve 21st-century skills, experience is needed to prepare students who are innovative, creative, and contribute to knowledge (Andrade, 2016), experience can be obtained from the activeness of teachers in creating interactive and creative learning environments. Furthermore Abualrob (2019) says that schools must try to provide kids with the ability to think quickly, be tough and resourceful learners, solve problems creatively, and be engaged members of their communities.

The results showed differences from previous research, namely: research trends in project-based biology learning increased in 2015-2017 and decreased until 2022. This was due to several obstacles in its implementation such as students being less accustomed to completing projects, indiscipline, limited time, and limited equipment so teachers must have confidence and commitment in implementing project-based learning (Cintang, 2019). In addition, Le (2021) stated that teamwork is a difficult thing experienced by students in project work.

The implication and impact of the results of this study are that other researchers can refer to and use it as a reference source in developing project-based learning. Then from the research results, it can be seen that project-based learning can be implemented in the future and students can develop their 21st-century skills. Limitations in this study related to the data or the scale of the journal used are still minimal so the results are less than optimal and the limitations of researchers in visualizing research results in the form of images or graphs. Following the demands of an independent learning curriculum where learning must be project-oriented. For this reason, other researchers

need to develop project-based biology learning. In addition, project-based learning can also be integrated with the STEM approach to Science, Technology, Engineering, Mathematics, STEAM (Science, Technology, Engineering, Arts and Mathematics), TPACK (Technological Pedagogical Content Knowledge and ethnoscience).

CONCLUSION

This study reviewed articles highlighting project-based learning published in Indonesian biology education journals from 2015 to 2022. The trend found is a decrease in the number of publications over the last four years. This can be an opportunity for future researchers that project-based learning on biology content still needs to be developed in line with curriculum changes in Indonesia that lead to PjBL. Most quantitative research is chosen by researchers in line with the need to test the effectiveness of PjBL in biology classes. In addition, high school students and college students were mainly selected as research subjects, while environmental materials, viruses and eubacteria, and ecosystems were the most selected materials. At the same time, the type of instrument widely used in measuring skills and student learning outcomes is the test. While the most common data analysis technique found is ANCOVA, along with the type of research that is most widely used. The most common types of skills that are measured, on the other hand, are critical and creative thinking, which are 21st century skills.

Regarding the findings of this study, several recommendations have been made for further research. First, it is necessary to increase the frequency of research and development (R&D) to create innovations in learning. Second, research on PjBL is highly recommended in Indonesia's independent learning curriculum (new paradigm), so the need for development in this research is very much needed. Third, there is no qualitative research on PjBL, which gives qualitative researchers great hope to contribute. Third, researchers should provide adequate information, especially on selecting biological content in PjBL and the instruments used. Lastly, researchers are told to choose the best research method to solve the problems that have been brought up.

ACKNOWLEDGEMENT

Thanks to all parties who have provided beneficial feedback and contributions.

AUTHOR CONTRIBUTION STATEMENT

All authors have contributed and participated in conducting research, and approved the final version of the manuscript

REFERENCES

- Abdullah, K. H. (2022). *Publication Trends in Biology Education : A Bibliometric Review of 63 Years*. 19(2), 465–480.
- Abualrob, M. M. A. (2019). Determinants of Building 21st Century Skills in Palestinian Elementary Schools. *Higher Education Studies*, 9(2), 108. <https://doi.org/10.5539/hes.v9n2p108>
- Adom, D., Mensah, J. A., & Dake, D. A. (2020). Test, measurement, and evaluation: Understanding and use of the concepts in education. *International Journal of Evaluation and Research in Education*, 9(1), 109–119. <https://doi.org/10.11591/ijere.v9i1.20457>
- Ahmad, S., Wasim, S., Irfan, S., Gogoi, S., Srivastava, A., & Farheen, Z. (2019).

- Qualitative v/s. Quantitative Research- A Summarized Review. *Journal of Evidence Based Medicine and Healthcare*, 6(43), 2828–2832. <https://doi.org/10.18410/jebmh/2019/587>
- Almulla, M. A. (2020). The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. *SAGE Open*, 10(3). <https://doi.org/10.1177/2158244020938702>
- Andrade, M. S. (2016). Curricular Elements for Learner Success – 21st Century Skills. *Journal of Education and Training Studies*, 4(8), 143–149. <https://doi.org/10.11114/jets.v4i8.1743>
- Baser, D., Ozden, M. Y., & Karaarslan, H. (2017). Collaborative project-based learning: an integrative science and technological education project. *Research in Science and Technological Education*, 35(2), 131–148. <https://doi.org/10.1080/02635143.2016.1274723>
- Bilgin, I., Karakuyu, Y., & Ay, Y. (2015). The effects of project based learning on undergraduate students' achievement and self-efficacy beliefs towards science teaching. *Eurasia Journal of Mathematics, Science and Technology Education*, 11(3), 469–477. <https://doi.org/10.12973/eurasia.2014.1015a>
- Cangür, Ş., Sungur, M. A., & Ankarali, H. (2018). The methods used in nonparametric covariance analysis | Parametrik olmayan kovaryans analizinde kullanılan metotlar. *Duzce Medical Journal*, 20(1), 1–6. <https://doi.org/10.18678/dtfd.424774>
- Cintang, N. (2019). *The Obstacles and Strategy of Project Based Learning Implementation in Elementary School. February 2018*. <https://doi.org/10.11591/edulearn.v12i1.7045>
- Cochran, D., Conklin, J., & Modin, S. (2007). A new Bloom. *Learning & Leading with Technology*, 5191(February), 22–25.
- Cresswell-Yeager, T. (2021). Forming, storming, norming, and performing: Using a semester-long problem-based learning project to apply small-group communication principles. *Communication Teacher*, 35(2), 155–165. <https://doi.org/10.1080/17404622.2020.1842476>
- Firmanshah, M. I., Jamaluddin, J., & Hadiprayitno, G. (2020). Learning difficulties in comprehending virus and bacteria material for senior high schools. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 6(1), 165–172. <https://doi.org/10.22219/jpbi.v6i1.10981>
- Folajogun, F. V. (2020). Researching educational issues: An analysis of methods used in conducting doctoral research. *Jiste*, 24(1), 9–22.
- Follman, J., Lavelly, C., & Berger, N. (1996). Inventory of Instruments of Critical Thinking. *Informal Logic*, 18(2), 261–267. <https://doi.org/10.22329/il.v18i2.2383>
- Goktas, Y. (2012). *Trends in Educational Research in Turkey : A Content*. 12(1), 455–460.
- Harris, C. J., Penuel, W. R., D'Angelo, C. M., DeBarger, A. H., Gallagher, L. P., Kennedy, C. A., Cheng, B. H., & Krajcik, J. S. (2015). Impact of project-based curriculum materials on student learning in science: Results of a randomized controlled trial. *Journal of Research in Science Teaching*, 52(10), 1362–1385. <https://doi.org/10.1002/tea.21263>
- Hsu, P. S., Van Dyke, M., Chen, Y., & Smith, T. J. (2015). The effect of a graph-oriented computer-assisted project-based learning environment on argumentation skills. *Journal of Computer Assisted Learning*, 31(1), 32–58. <https://doi.org/10.1111/jcal.12080>
- Hsu, P. S., Van Dyke, M., Chen, Y., & Smith, T. J. (2016). A cross-cultural study of the effect of a graph-oriented computer-assisted project-based learning environment on middle school students' science knowledge and argumentation skills. *Journal of*

- Computer Assisted Learning, 32(1), 51–76. <https://doi.org/10.1111/jcal.12118>
- Juuti, K., Lavonen, J., Salonen, V., Salmela-Aro, K., Schneider, B., & Krajcik, J. (2021). A Teacher–Researcher Partnership for Professional Learning: Co-Designing Project-Based Learning Units to Increase Student Engagement in Science Classes. *Journal of Science Teacher Education*, 32(6), 625–641. <https://doi.org/10.1080/1046560X.2021.1872207>
- Khoiri, A., & Sunarno, W. (2018). Pendekatan Etnosains Dalam Tinjauan Fisafat. *SPEKTRA: Jurnal Kajian Pendidikan Sains*, 4(2), 145. <https://doi.org/10.32699/spektra.v4i2.55>
- Kizkapan, O., & Bektas, O. (2017). The effect of project based learning on seventh grade students' academic achievement. *International Journal of Instruction*, 10(1), 37–54. <https://doi.org/10.12973/iji.2017.1013a>
- Le, T. T. K. (2021). *Project-based Learning in 21st Century: A Review of Dimensions for Implementation in University-level Teaching and Learning*. *Project-based learning in the 21 st century: a review of dimensions for implementation in university-level*. October 2018.
- Lefa, B. (2014). The Piaget theory of cognitive development: An educational implications. *Research Gate*, 1(9), 1–9. [Google Scholar](#)
- Lin, J. W., Tsai, C. W., Hsu, C. C., & Chang, L. C. (2021). Peer assessment with group awareness tools and effects on project-based learning. *Interactive Learning Environments*, 29(4), 583–599. <https://doi.org/10.1080/10494820.2019.1593198>
- Lukitasari, M., Hasan, R., Sukri, A., & Handhika, J. (2021). Developing student's metacognitive ability in science through project-based learning with e-portfolio. *International Journal of Evaluation and Research in Education*, 10(3), 948–955. <https://doi.org/10.11591/IJERE.V10I3.21370>
- M. Haviz, M. R. (2019). Rend in biology education research from 2012 to 2017: a content analysis of papers in selected journals from indonesi. *EDUSAINS*, 11(2), 221–232.
- Madani, R. A. (2019). Analysis of Educational Quality, a Goal of Education for All Policy. *Higher Education Studies*, 9(1), 100. <https://doi.org/10.5539/hes.v9n1p100>
- Mettetal, G. (2002). The What, Why and How of Classroom Action Research. *Journal of the Scholarship of Teaching and Learning*, 2(1), 6–13.
- Miller, E. C., Severance, S., & Krajcik, J. (2021). Motivating Teaching, Sustaining Change in Practice: Design Principles for Teacher Learning in Project-Based Learning Contexts. *Journal of Science Teacher Education*, 32(7), 757–779. <https://doi.org/10.1080/1046560X.2020.1864099>
- Morales, T. M., Bang, E. J., & Andre, T. (2013). A One-year Case Study: Understanding the Rich Potential of Project-based Learning in a Virtual Reality Class for High School Students. *Journal of Science Education and Technology*, 22(5), 791–806. <https://doi.org/10.1007/s10956-012-9431-7>
- Owens, A. D., & Hite, R. L. (2020). Enhancing student communication competencies in STEM using virtual global collaboration project based learning. *Research in Science and Technological Education*, 00(00), 1–27. <https://doi.org/10.1080/02635143.2020.1778663>
- Pane, M. M., & Patriana, R. (2016). The Significance of Environmental Contents in Character Education for Quality of Life. *Procedia - Social and Behavioral Sciences*, 222, 244–252. <https://doi.org/10.1016/j.sbspro.2016.05.153>
- Paristiowati, M., Rahmawati, Y., Fitriani, E., Satrio, J. A., & Hasibuan, N. A. P. (2022). Developing Preservice Chemistry Teachers' Engagement with Sustainability Education through an Online, Project-Based Learning Summer Course Program.

- Sustainability* (Switzerland), 14(3). <https://doi.org/10.3390/su14031783>
- Rahardjanto, A. (2022). Publication Trend of R & D in the Journal of Biological Education in Indonesia (Sinta 2 : 2017-2021): A Systematic Literature Review. 10(1), 21–35.
- Richmond, B. (2006). Introduction to Data Analysis Handbook. *Academy for Educational Development*, 1–27. [Google Scholar](#)
- Russell, J. A., Helms, C. R., Everhart, R. C., & Miller, D. J. (2018). Applying project based learning in an undergraduate design and construction program at appalachian state university. *Journal of Green Building*, 13(4), 147–165. <https://doi.org/10.3992/1943-4618.13.4.147>
- Singh, S. (2019). Purpose and Process of Research. *Methodological Issues in Management Research: Advances, Challenges, and the Way Ahead*, August, 27–36. <https://doi.org/10.1108/978-1-78973-973-220191003>
- Singh, Y. K. (2006). *Environmental Science*. New Age International Publishers.
- Siswono, T. Y. E., Hartono, S., & Kohar, A. W. (2018). Effectiveness of project based learning in statistics for lower secondary schools. *Egitim Arastirmalari - Eurasian Journal of Educational Research*, 2018(75), 197–212. <https://doi.org/10.14689/ejer.2018.75.11>
- Sudarmin. (2014). Pendidikan karakter, etnosains dan kearifan lokal. *Fakultas Matematika Dan Ilmu Pengetahun Alam, UNNES*, 1–139. [Google Scholar](#)
- Susetyarini, E., & Fauzi, A. (2020). Trend of critical thinking skill researches in biology education journals across Indonesia: From research design to data analysis. *International Journal of Instruction*, 13(1), 535–550. <https://doi.org/10.29333/iji.2020.13135a>
- Wahyono, P., Eka, F., & Susetyarini, E. (2020). JPBI (Jurnal Pendidikan Biologi Indonesia) The diversity of methodologies applied in Indonesian journal articles focused on biochemistry learning. 6(1), 1–8.
- You, J. W. (2021). Enhancing creativity in team project-based learning amongst science college students: The moderating role of psychological safety. *Innovations in Education and Teaching International*, 58(2), 135–145. <https://doi.org/10.1080/14703297.2020.1711796>
- Zadok, Y. (2020). Project-based learning in robotics meets junior high school. *Journal of Engineering, Design and Technology*, 18(5), 941–958. <https://doi.org/10.1108/JEDT-01-2019-0023> <https://doi.org/10.1108/JEDT-01-2019-0023>

Copyright Holder :

© Elvianasti, M., et al., (2022).

First Publication Right :

© Jurnal Iqra' : Kajian Ilmu Pendidikan

This article is under:

