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META ANALISIS MODEL *BLENDED LEARNING* MENGGUNAKAN *PROBLEM-BASED LEARNING* PADA PEMBELAJARAN BIOLOGI DI SMA

META-ANALYSIS OF THE BLENDED LEARNING MODEL IMPLEMENTING PROBLEM-BASED LEARNING IN BIOLOGY INSTRUCTION IN SENIOR HIGH SCHOOLS

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Abstract. This study aims to analyze the application of the Blended learning model based on Problem-based Learning (PBL) in Biology learning at the high school level through the meta-analysis method. The research stages used are (1) identifying the type of research and the variables used, (2) recording the average value and standard deviation of the experimental and control groups, and (3) calculating the effect size using the unstandardized mean difference (UMD). Data were obtained from three studies relevant to this topic. The results of the analysis show that the PBL model based on blended learning significantly affects student learning outcomes, especially in improving critical thinking skills, scientific literacy, and problem-solving abilities. This approach involves PBL stages such as problem orientation, independent and group investigations, and reflection, effectively encouraging students to be more active, collaborative, and independent in learning. Overall, this study confirms that combining PBL with blended learning can support more innovative and effective biology learning at the high school level. The results of this study can be used as a reference by teachers to implement PBL learning using blended learning techniques.
Keywords: ***Biology learning, Blended learning, Meta-analysis, Problem-based learning***

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INTRODUCTION

Information and communication technology development has brought significant changes in the world of education, including in teaching methods in schools. One of the innovations that has emerged is the blended learning model, which integrates face-to-face learning with online learning (Tong et al., 2022). This model provides flexibility in the teaching and learning process and allows students to learn more interactively and collaboratively. Research shows blended learning can improve student motivation and learning outcomes, especially in complex subjects such as Biology (Purba et al., 2022).

Biology, as one of the science subjects at the Senior High School (SMA) level, has unique characteristics, where students are expected not only to understand basic concepts but also to be able to apply this knowledge in the context of everyday life (Lestari & Rakhmawati, 2024; Shafira & Suratsih, 2023). Biology learning often involves a deep understanding of biological processes, interactions between living things, and the application of these concepts in real situations (Sudrajat et al., 2024). Therefore, an innovative and effective approach is needed to improve students' understanding (Ammar et al., 2024). In this context, blended learning offers an interesting solution by utilizing technology to support active and collaborative learning (Fauziah et al., 2022).

One of the learning models that can be integrated into blended learning is problem-based

learning (PBL). PBL is a learning method that focuses on solving real problems where students are faced with situations that require analysis, discussion, and collaboration to find solutions (Cahyani & Pertiwi, 2024; Munthe et al., 2023; Shafira & Suratsih, 2023). This approach improves students' critical thinking skills and encourages them to be actively involved in the learning process (Zulfa, 2022). Integrating PBL into blended learning is expected to create a deeper and more meaningful learning experience, where students learn theory and apply it in relevant contexts (Rehman et al., 2024).

Several studies have shown that the implementation of blended learning-based PBL can improve students' learning motivation and scientific literacy skills. For example, research by Triyanti (2022) showed that students who learned with this approach showed significant improvements in critical thinking skills and understanding of Biology concepts. In addition, this model also provides opportunities for students to collaborate and interact with peers, which are important aspects of science learning (Asyhari, 2021).

So far, no research has analyzed the effects of PBL in a blended learning setting on the effectiveness of students' biology learning, especially in biology learning. With this background, this article aims to conduct a meta-analysis of the blended learning model that uses a problem-based learning approach in biology learning in high school. Through the collection and analysis of data from various relevant studies, it is hoped that a more comprehensive understanding can be obtained regarding the effectiveness of this model in improving student learning outcomes in biology. This research is expected to contribute to developing more innovative and effective learning methods in schools.

METHOD

This study used a meta-analysis method to assess the application of the blended learning model based on problem-based learning (PBL) in biology learning at the high school level. Meta-analysis is a method used to conclude the results of two or more studies to combine, evaluate, and summarize previous research. Through the meta-analysis approach, various research questions can be analyzed based on data obtained from previously published studies. The final result of this analysis is called the effect size. Effect size is a measure that shows the extent of the effect or difference between related variables. In this study, the effect size calculation uses the unstandardized mean difference (UMD), the average difference, without changing the scale (Herman & Saleh, 2023).

The research stages began with a journal search using keywords such as "blended learning," "problem-based blended learning," and "biology learning." To ensure that the articles used are relevant and of high quality, the researcher has set several selection criteria, namely: (1) articles must come from accredited journals and be published within the last five years (2020-2024), (2) research must focus on high school level, (3) the research design used is an experiment with a pretest-posttest control group model, (4) the dependent variable in the research must be student learning outcomes, (5) articles must present data in the form of average scores from the experimental group and control group, (6) the standard deviation of the control group must be listed in the article, and (7) articles must specifically mention the class level, biology material taught, and the platform used in the implementation of blended learning. Determining these criteria aims to facilitate collecting and analyzing data in meta-analysis research.

The steps in the data tabulation process include: (1) identifying the type of research and the variables used, then entering the data into the appropriate variable column, (2) recording the average value and standard deviation of the experimental and control groups for each study analyzed, and (3) calculating the effect size using the unstandardized mean difference (UMD) because the measurement scale used to assess student learning outcomes is uniform (Cohen et al., 2018).

RESULTS AND DISCUSSION

Results

The results of identification show that three articles meet the criteria. The selected articles are shown in Table 1.

Table 1. Sources used

No	Article Title	Journal	Link
1.	The Effect of Problem-Based Learning Model Based on Blended Learning on Critical Thinking Skills of Grade XI Students at SMAN 2 Mataram (Habibah et al., 2022)	Jurnal Ilmiah Profesi Pendidikan	https://jipp.unram.ac.id/index.php/jipp/article/view/603/368
2.	The Effect of Problem-Based Learning Based on Blended Learning on Critical Thinking Skills of Students at SMA Negeri 4 Rejang Lebong (Triyanti, 2022)	Linggau Journal Science Education	https://www.jurnal.lp3mkil.or.id/index.php/ljse/article/view/237/173
3.	The Effect of Problem-Based Learning Based on Blended Learning and Outcome Based Education on Biological Science Literacy Skills of Students at SMAN 7 Mataram (Zulfa et al., 2022)	Jurnal Ilmiah Profesi Pendidikan	https://jipp.unram.ac.id/index.php/jipp/article/view/559/348

The three articles were then analyzed for their impact on students. The results of the analysis are shown in Table 2.

Table 2. Impacts that emerge with the Problem-based learning model based on blended learning on biology subjects in high school

No	Article Title	Result	Criteria
1.	The Effect of Problem-Based Learning Model Based on Blended Learning on Critical Thinking Skills of Grade XI Students at SMAN 2 Mataram (Habibah et al., 2022)	$\frac{64,89 - 59,20}{26,59} = 0,214$	Efek Sedang
2.	The Effect of Problem-Based Learning Based on Blended Learning on Critical Thinking Skills of Students at SMA Negeri 4 Rejang Lebong (Triyanti, 2022)	$\frac{59 - 57}{25,46} = 0,079$	Efek Lemah
3.	The Effect of Problem-Based Learning Based on Blended Learning and Outcome Based Education on Biological Science Literacy Skills of Students at SMAN 7 Mataram (Zulfa et al., 2022)	$\frac{51,21-51,47}{6,22} = 0,042$	Efek lemah

Discussion

The data in Table 3 shows that the analysis results can be obtained from the effect size formula. Effect size is a practical significant measure in research that describes how much correlation, difference, or influence a variable has on other variables. This measure complements information from the analysis results obtained through a significant test. The effect size formula can be calculated by finding the difference between the percentage of post-test and pre-test results of student learning and then dividing it by the maximum percentage. In the first article

analysis, the experimental group's results were 64.89, and the control group's results were 59.20, which produced an effect size of 0.214 with a moderate effect category. In the second article analysis, the experimental group's results were 59, and the control group's were 57, resulting in an effect size of 0.079 with a weak category.

In the results of article 3 listed in the table, the average pre-test score of students' scientific literacy skills in the experimental group was 42.24, with the lowest score of 30 and the highest score of 65. Meanwhile, the control group had a pre-test average of 47.07, with a minimum score of 35 and a maximum score of 70. The normality test of the pre-test data showed a p-value of 0.115 for the experimental group and 0.107 for the control group, which means that the data was normally distributed (p-value> 0.05). In the post-test results, the average scientific literacy skills of the experimental group increased to 60.17, with the lowest score of 50 and the highest score of 80. In contrast, the control group had a post-test average of 55.86, with a minimum score of 30 and a maximum score of 70.

The post-test data's normality test also showed that both groups' data were normally distributed, with a p-value of 0.093 for the experimental group and 0.110 for the control group. Complete data related to the results of the pre-test and post-test of scientific literacy skills in both groups are presented in table form. Based on the Tests of Between-Subjects Effect results, the significance value of scientific literacy skills was 0.000, which is less than 0.05 (p <0.05). This result shows the influence of implementing problem-based learning based on blended learning and outcome-based education on the scientific literacy skills of grade X students at SMAN 7 Mataram in the 2021/2022 Academic Year.

The first article, entitled The influence of the problem-based learning model based on blended learning on the critical thinking skills of class XI students at SMAN 2 Mataram, states that the problem-based learning (PBL) model based on blended learning has a significant influence on improving students' critical thinking skills compared to conventional methods (Diniyyah et al., 2022). The significant difference in post-test scores between the control and experimental groups shows that the stages in PBL start from problem orientation to analysis and evaluation, which systematically stimulate students' critical thinking skills (Boye & Agyei, 2023). This model trains students to understand problems and encourages them to be independent, collaborative, and reflective in finding solutions. This statement confirms that PBL-based learning can effectively develop high-level thinking skills in a modern educational environment, especially when supported by technology in blended learning.

Furthermore, the article entitled "The influence of problem-based learning based on blended learning on students' critical thinking skills at SMA Negeri 4 Rejang Lebong" states that PBL based on blended learning affects the improvement of students' critical thinking skills. These results are supported by the research results of Hasan and Syatriandi (2018), who stated that PBL can increase students' activeness in solving problems by exploring information from various sources.

The results of the third article research show that applying the problem-based learning (PBL) model positively impacts students' scientific literacy skills, especially when combined with the blended learning approach and outcome-based education. This analysis provides insight into the characteristics of PBL, which encourage students to be active, critical, and trained in problem-solving, directly supporting scientific literacy development. In addition, the increase in results in the experimental group compared to the control group shows the effectiveness of this model in creating more meaningful learning. This result underscores the importance of choosing a learning model that focuses on knowledge transfer and the formation of high-level thinking skills and students' scientific literacy (Anggrella & Sudrajat, 2024).

This study has several important implications in the field of education. The findings of this study can help biology teachers at the high school level to understand the effectiveness of blended learning models based on problem-based learning (PBL) in improving student learning

outcomes. By combining face-to-face and online learning, this approach provides flexibility and encourages students to be more active, think critically, and solve problems independently. In addition, the results of this meta-analysis can be a reference for educational policymakers in designing learning strategies relevant to technological developments and the needs of 21st-century learning. Furthermore, this study contributes to other researchers as a reference for the development of related studies, both in expanding the scope of the subject and exploring implementation at different levels of education. Thus, this study plays a role in encouraging more effective and adaptive learning innovations in the digital era .

CONCLUSION

This study aims to determine the effectiveness of using PBL in blended learning mode in students' biology learning. The results of the identification found three articles that met the established criteria. The analysis of the three articles shows that the PBL model with a blended learning approach can increase student activity, make students more critical, and train students to solve problems by digging for more information through various sources. Teachers can use the results of this study as a consideration for implementing technology-based learning that maintains the development of students' thinking skills.

REFERENCES

Ammar, M., Al-Thani, N. J., & Ahmad, Z. (2024). Role of pedagogical approaches in fostering innovation among K-12 students in STEM education. Social Sciences & Humanities Open, 9, 100839. https://doi.org/https://doi.org/10.1016/j.ssaho.2024.100839

Anggrella, D. P., & Sudrajat, A. K. (2024). Development of an Integrated Project-Based Learning Module Based on Black Soybean Ethnoscience to Improve Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, 10(6), 3038–3045. https://doi.org/10.29303/jppipa.v10i6.5855

Asyhari, A. (2021). Pengaruh *blended learning* berbasis elektronik modul pada materi ekosistem terhadap motivasi belajar siswa di MA NU Mazro'atul Huda Karanganyar Demak. *Jurnal Pro-Life*, *8*(3), 239−249. https://doi.org/10.33541/pro-life.v8i3.3475

Boye, E. S., & Agyei, D. D. (2023). Effectiveness of problem-based learning strategy in improving teaching and learning of mathematics for pre-service teachers in Ghana. *Social Sciences and Humanities Open*, 7(1), 100453. https://doi.org/10.1016/j.ssaho.2023.100453

Cahyani, D. N., & Pertiwi, K. R. (2024). DEVELOPMENT OF E-LKPD BASED ON PBL IN REPRODUCTIVE HORMONE MATERIAL TO INCREASE REPRODUCTIVE HEALTH LITERACY. *Jurnal Edukasi Biologi*, 10(2), 191–203. http://dx.doi.org/10.21831/edubio.v10i2.21810

Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education* (8th ed.). London: Routledge. https://doi.org/10.4324/9781315456539

Diniyyah, M., Susilo, H., Balqis, B., & Sudrajat, A. K. (2022). Improving critical thinking and problem- solving skills through POGIL combined with digital mind map. *Jurnal Pendidikan Biologi Indonesia*, 8(3), 275–286. https://doi.org/10.22219/jpbi.v8i3.18992

Fauziah, N., Mustofa, R. F., & Ali, M. (2022). Pengaruh *blended learning* menggunakan quipper school terhadap hasil belajar biologi. *Symbiotic: Journal of Biological Education*, *3*(2), 90−101. https://doi.org/10.32939/symbiotic.v3i2.79

Habibah, F. N., Setiadi, D., Bahri, S., & Jamaluddin, J. (2022). Pengaruh model *problem-based learning* berbasis *blended learning* terhadap keterampilan berpikir kritis peserta didik kelas XI di SMAN 2 Mataram. *Jurnal Ilmiah Profesi Pendidikan*, *7*(2), 686−692. https://doi.org/10.29303/jipp.v7i2b.603

Hasan, R., & Syatriandi, B. (2018). *Pengaruh model pembelajaran berbasis masalah (pbm)*

terhadap kemampuan berpikir kritis dan hasil belajar biologi siswa di SMA NEGERI 06 Kota Bengkulu. In Prosiding Seminar Nasional SIMBIOSIS. https://prosiding.unipma .ac.id/index.php/simbiosis/article/view/651/0

Herman, M., & Saleh, A. R. (2023). *Blended learning* dan hasil belajar biologi siswa sma: sebuah meta-analisis. *Biology and Education Journal*, *3*(1), 37−49. https://doi.org/10.25299/baej.2023.13071

Lestari, I., & Rakhmawati, A. (2024). PENGEMBANGAN LKPD BERBASIS PROJECT BASED LEARNING UNTUK MENINGKATKAN KETERAMPILAN KOLABORASI SISWA MATERI BIOTEKNOLOGI. *Jurnal Edukasi Biologi*, 10(2), 177–190. http://dx.doi.org/10.21831/edubio.v10i2.19644

Munthe, R. N. S., Agustin, A. S., Putri, Z. A., Kundariati, M., Anggur, M. R. I., Fadilla, N. B., Nurhawa, W. O., Susilo, H., Ibrohim, I., & Sudrajat, A. K. (2023). Implementation of problem-based learning model through lesson study for improving prospective biology teachers' communication and collaboration skills. *AIP Conference Proceedings*, 2569(1), 20037. https://doi.org/10.1063/5.0112404

Purba, D. D., Manalu, K., & Sya'rawi, M. A. (2022). Pengaruh model pembelajaran *blended learning* terhadap hasil belajar biologi siswa SMA Kelas X IPA MAN 3 Medan Pada Mata Virus Di Masa Pandemi Covid-19. *Best Journal (Biology Education, Sains and Technology)*, *5*(1), 225-230. https://doi.org/10.30743/best.v5i1.4828

Rehman, N., Huang, X., Mahmood, A., AlGerafi, M. A. M., & Javed, S. (2024). Project-based learning as a catalyst for 21st-Century skills and student engagement in the math classroom. Heliyon, 10(23), e39988. https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e39988

Shafira, I. H., & Suratsih, S. (2023). PENGGUNAAN E-LKPD BERBASIS MASALAH TERHADAP PENINGKATAN KETERAMPILAN BERPIKIR KRITIS PESERTA DIDIK PADA MATERI SISTEM EKSKRESI KELAS XI DI SMA NEGERI 1 PANGKALPINANG. *Jurnal Edukasi Biologi*, 9(1), 1–14. https://doi.org/10.21831/edubio.v9i1.18515

Sudrajat, A. K., Anggrella, D. P., & Nugroho, A. I. (2024). What dominates most? The opinion of preservice biology teachers about factors associated with motivation to conduct innovative learning. *BIO-INOVED: Jurnal Biologi-Inovasi Pendidikan*, 6(3), 361–369. https://dx.doi.org/10.20527/bino.v6i3.19379

Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. *Heliyon*, 8(12), e12657. https://doi.org/10.1016/j.heliyon.2022.e12657

Triyanti, M. (2022). Pengaruh *problem-based learning* berbasis *blended learning* terhadap kemampuan berpikir kritis siswa di SMA Negeri 4 Rejang Lebong. *Linggau Journal Science Education*, *2*(1), 67−76. https://jurnal.lp3mkil.or.id/index.php/ljse/article/view/237

Wahyuni, A., Romansyah, R., & Hardi, E. (2022). Pengaruh implementasi model *problem-based learning* berbasis *blended learning* terhadap kemampuan memecahkan masalah. *J-KIP (Jurnal Keguruan dan Ilmu Pendidikan)*, *3*(3), 576−583. http://dx.doi.org/10.25157/j-kip.v3i3.8595

Zulfa, E. (2022). Pengaruh Pembelajaran *Problem-based learning* berbasis *blended learning* dan *outcome-based education* terhadap kemampuan literasi sains biologi siswa di SMAN 7 Mataram. *Jurnal Ilmiah Profesi Pendidikan*, *7*(2), 559−564. https://doi.org/10.29303/jipp.v7i2b.559