



Effect of Problem-Based Learning Assisted by Wordwall on Science Learning in Elementary Schools

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Abstract

Science learning in elementary schools plays a crucial role in fostering students' critical thinking skills. This study investigates the effect of implementing the Problem-Based Learning (PBL) model assisted by Wordwall in science education at an elementary school. A quasi-experimental design with a one-group pretest–posttest approach was employed, involving 14 students ($N = 14$). Research instruments included a validated and reliable multiple-choice achievement test, observation sheets of learning activities, and student response questionnaires. Data were analyzed using normality tests, N-gain, and paired t-tests with SPSS 21. The findings revealed a significant improvement in student learning outcomes, with mastery increasing from 35.71% (5 students) to 92.85% (13 students). The paired t-test produced a t-value of 9.165 with a significance level of $p = 0.00006 (< 0.05)$, indicating a highly significant difference before and after the intervention. These results suggest that the Problem-Based Learning model assisted by Wordwall is effective in enhancing science learning achievement and holds potential for application across other subjects and learning contexts.

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INTRODUCTION

Science education, particularly the natural sciences, plays a crucial role in shaping logical, critical, and innovative thinking in students. The teaching of Natural Sciences aims not only to transfer factual knowledge but also to develop scientific process skills, problem-solving abilities, and a scientific attitude (Hosnan, 2020). However, in reality, Natural Sciences instruction in schools is often still dominated by conventional, teacher-centered methods, in which students tend to be passive and less engaged in the discovery process (Fajari & Chumdari, 2021). As a result, conceptual understanding is not as deep as it could be, interest in learning declines, and higher-order thinking skills do not develop optimally (Putriani & Gunawan, 2023; Sukma et al., 2022; Tyas & R., 2017).

This challenge has become increasingly complex due to the rapid development of information technology (IT) in the era of the Fourth Industrial Revolution and Society 5.0 (Geddes et al., 2018; Muetya et al., 2022). The integration of information technology into learning has become essential for

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creating a learning environment that is more interactive, adaptive, and relevant to the needs of the 21st century. The use of information technology has the potential to provide diverse learning resources, facilitate complex experimental simulations, and support collaboration between students and teachers (Safira et al., 2020). Therefore, an innovative learning approach is needed that can integrate the characteristics of active, constructive, and problem-based science learning with the support of information technology.

One learning model considered effective in addressing these issues is Problem-Based Learning (PBL). Problem-Based Learning (PBL) is a learning approach that challenges students to learn by solving real-world problems (authentic problems) (Alfares, 2025). In Problem-Based Learning (PBL), students actively identify problems, gather information, formulate hypotheses, analyze data, and present solutions, thereby fostering critical thinking skills, problem-solving skills, and independent learning (Hasram et al., 2021; Savery, 2015). A number of studies have shown that Problem-Based Learning (PBL) is effective in improving learning outcomes, motivation, and higher-order thinking skills in science education (Huda & Abduh, 2021; Kartono, 2021; Ramadhan et al., 2021; Tursynkulova et al., 2023).

Nevertheless, the implementation of Problem-Based Learning (PBL) sometimes faces obstacles, such as limited resources, time constraints, or difficulties in identifying relevant and challenging problems (Akcaý & Benek, 2019; Desty et al., 2023). This is where the role of information technology becomes particularly significant. The use of information technology, such as WordWall, in Problem-Based Learning (PBL) can enrich the context of problems, provide quick access to information, facilitate data visualization, and support communication and collaboration (Loyens, 2014). Science education using the Problem-Based Learning (PBL) model supported by WordWall has the potential to create learning experiences that are more authentic, in-depth, and relevant to the real world, while also preparing students to face global challenges (As'ari et al., 2022; Madhakomala et al., 2025; Pratiwi & Setyaningtyas, 2020; Putriani & Gunawan, 2023; Yusuf & Ali, 2025).

Based on a Scopus search using the keywords “Problem-Based Learning” and “Wordwall,” 39 research articles were found that utilize information technology; however, not a single article was found on the application of Wordwall in science education. It appears that the application of Wordwall has been studied very rarely by researchers. The search results from the Scopus website were then visualized using VOSViewer, yielding the following image.

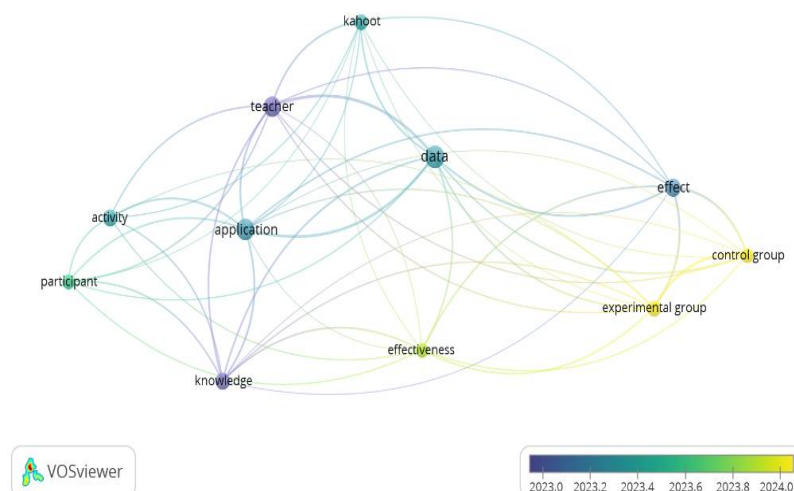


Fig 1. Scopus Wordwall Data Visualization on VOSviewer

As shown in figure 1 above, Wordwall has rarely been studied by researchers. This is evident from the limited number of keywords that can represent research related to Wordwall. Research on Wordwall began in 2023, indicated by the purple color, and the most recent study on Wordwall was conducted in 2024, indicated by the yellow color. Based on the introductory discussion above, the author is interested in further investigating the impact of implementing Problem-Based Learning (PBL) aided by Wordwall in elementary school science education.

METHODS

This study employed a quantitative research method using a one-group pretest-posttest design (Akem et al., 2025; Anidar et al., 2026; Dasrizal et al., 2025; Dzahabiyah et al., 2021; Efendi et al., 2026; Engkizar et al., 2023, 2026; Firda & Sunarti, 2022; Lestari et al., 2021; Nurdyanto et al., 2024; Pratiwi & Setyaningtyas, 2020; Ridwan & Wastiah, 2024; Syafril et al., 2021). The study was conducted at Elementary School 17 Cupak in Gunung Talang Subdistrict, Solok Regency, West Sumatra Province. The study was carried out from June 2, 2025, to June 9, 2025. This study involved teachers as observers and research informants. The study population consisted of 15 fifth-grade students at Elementary School 17 Cupak in Gunung Talang Subdistrict, Solok Regency. The sampling technique used was a census, in which the entire population all 15 students was included in the sample.

The study was conducted over two sessions. During the first session, the researcher administered a pretest to assess the students' initial proficiency, and at the end of the session, a posttest was administered to measure the students' learning outcomes after being taught using the Problem-Based Learning (PBL) model aided by WordWall. The pretest and posttest items used had undergone validation and reliability testing. The questions used in the pretest and posttest were of the same type and format, namely multiple-choice and blind image questions regarding the respiratory organs. Students were asked to identify the type of organ shown in the image.

The research instruments used were learning outcome tests, observation sheets, and student response questionnaires regarding the learning process. The teacher used learning activity observation sheets to assess how the researcher conducted the lesson and to evaluate student activities during the learning process. Additionally, the researcher distributed response questionnaires to students to assess their satisfaction and their willingness to participate in the learning process. The student response questionnaire consisted of "Yes" and "No" columns and was not in the form of a Likert scale. The learning outcome data obtained were then tested for normality, analyzed using the N-Gain test, and subjected to a paired t-test using SPSS 21 with a significance level of 0.05. The criteria for classifying N-Gain scores are presented in the following table.

Table 1. Gain Score Breakdown

N-Gain Value	Category
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

The categories for assessing the effectiveness of N-Gain, expressed as percentages, are shown in the table below.

Table 2. N-Gain Criteria

Percentage	Criteria
<40	Not Effective
40 – 55	Less Effective

56 – 75	Fairly Effective
>76	Effective

RESULT AND DISCUSSION

The results of the questionnaire on learning activities in Natural Sciences instruction using the Problem-Based Learning (PBL) model supported by Wordwall, as completed by the teacher, indicate that the researcher conducted the lessons in accordance with the Problem-Based Learning (PBL) syntax. Natural Sciences instruction using the Problem-Based Learning (PBL) model supported by Wordwall successfully increased students' motivation to learn. This was reflected in the students' enthusiastic engagement throughout the learning process. All students participated in solving the problems presented by the researcher. Additionally, students took part in quizzes administered by the researcher via Wordwall with enthusiasm and strove to achieve the highest possible scores. Teachers assessed that the researcher successfully managed the classroom well and was able to guide students effectively through the problem-solving process. This was demonstrated by the absence of any obstacles faced by the students throughout the process. The teacher also assessed that teaching natural sciences using the Problem-Based Learning (PBL) model with Wordwall was more effective than using other learning models alone, because the time required was relatively short and aligned with the time allocated by the school for natural science lessons, namely 2 x 35 minutes.

The results of the student questionnaire analysis regarding the implementation of WordWall-assisted Problem-Based Learning (PBL) in science education show that 100% of students answered "Yes" to the statement "I like learning with the WordWall-assisted Problem-Based Learning (PBL) model." 93% of students answered "Yes" to the statement that learning Natural Sciences using the Problem-Based Learning (PBL) model supported by WordWall makes it easier for them to understand the material. 100% of students reported feeling more motivated to learn Natural Sciences using the Problem-Based Learning (PBL) model supported by WordWall. 86.7% of students responded that it was easier to remember Natural Sciences material when taught using the Problem-Based Learning (PBL) model supported by WordWall, and 100% of students responded that they were more interested in learning after being taught with the Problem-Based Learning (PBL) model supported by WordWall. The results of the above study indicate that students are motivated to learn Natural Sciences using the Problem-Based Learning (PBL) model supported by WordWall. These findings align with the views of [Ferlina & Fratiwi, \(2024\)](#), who found that learning with WordWall can capture students' interest, make learning more enjoyable, strengthen memory retention, and enhance students' creativity.

The results of the author's study are also consistent with the research by [Yanti et al., \(2023\)](#), who found that students are more enthusiastic about learning using WordWall compared to other media because WordWall offers a game-based learning process. Furthermore, [Putriani & Gunawan, \(2023\)](#) explain that problem-based learning combined with WordWall can increase students' interest in learning while fostering their curiosity about the subject matter.

This study was conducted over two sessions during a Natural Sciences lesson on the human respiratory system. The study involved 15 fifth-grade students at Elementary School 17 Cupak in Solok Regency. Pretest scores were obtained before the implementation of Wordwall-assisted PBL in the Natural Sciences lesson, while posttest scores were obtained at the end of the lesson during the second session. For more details, Table 3 below shows the students' pretest and posttest scores.

Table 3. Pretest and Posttest Scores of Fifth-Grade Students at Elementary School 17 Cupak

No	Student Name	Pretest Score	Criteria	Posttest Score	Criteria
1	Abdul Lathif	70	Achieved	90	Achieved
2	Alvino Ziggi Derin	40	Not Achieved	80	Achieved
3	Anggun Dilovis	60	Not Achieved	80	Achieved
4	Aqiza Marsyaf	70	Achieved	90	Achieved
5	Felisia Violet Befan	60	Not Achieved	90	Achieved
6	Habib Haddillah Husein	80	Achieved	100	Achieved
7	Hanifa Monarizqi	50	Not Achieved	80	Achieved
8					Not
	Hazwani Insiyiroh	30	Not Achieved	60	Achieved
9	Hugo Ammar Maulid	70	Achieved	100	Achieved
10	Muhamad Ilham	50	Not Achieved	80	Achieved
11	Muhammad Fadhil	40	Not Achieved	80	Achieved
12	Rafka Nadim Ukail	70	Achieved	90	Achieved
13	Rahmadani	60	Not Achieved	90	Achieved
14	Vannia Putia Alsaqina	50	Not Achieved	80	Achieved
15	Zahira Rahmatul Rani	40	Not Achieved	70	Achieved
Total		840		1260	
Average		56		84	

Based on the data presented in table 3, it can be seen that the average pretest score was 56 and increased to 84 on the posttest, representing an increase of 28 points. In terms of the total pretest score, it rose from 840 to 1,260 on the posttest an increase of 420 points. The highest pretest score was 80, while the lowest was 30. The highest posttest score was 100, and the lowest was 60. This indicates that there was an improvement in learning outcomes between the pretest and posttest.

Table 3 also indicates that there was an increase in the number of students who achieved mastery between the pretest and posttest. Student mastery on the pretest defined according to the Learning Objective Mastery Criteria (KKTP) as a score of 70 was achieved by only 5 students, or 33.33%, while the remaining 10 students did not achieve mastery, representing 66.66%. In contrast, on the posttest, the number of students who met the proficiency criteria increased to 14 students, or 93.33%, and only 1 student did not meet the criteria, representing 6.66%. This indicates an increase in learning achievement among 9 students, or 60%, following the implementation of the Problem-Based Learning (PBL) model with the assistance of Wordwall in science instruction. Further details are shown in figure 2 below.

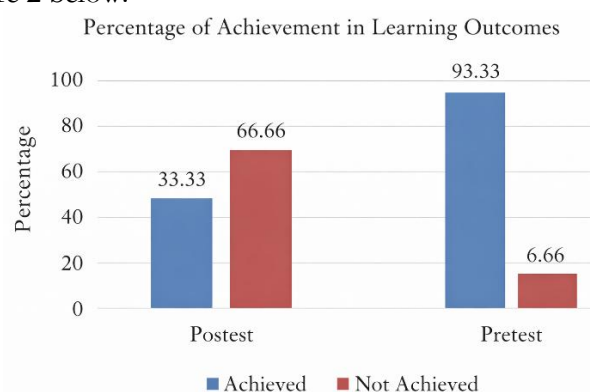
**Fig 2. Comparison of Students' Mastery of Natural Sciences**

Figure 2 shows that learning achievement, which was initially only 33.33% on the pretest, increased to 93.33% on the posttest representing a 60% increase in students' learning achievement after they studied using the Problem-Based Learning (PBL) model supported by WordWall. Consistent with this, research by Sukma and Handayani (2022) found that the use of WordWall in science instruction can increase learning success by 82%.

Statistical Tests

Statistical tests on the data were conducted using SPSS 21 software. Statistical tests on the data can be performed after the normality test. Normality tests in this study were conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Normality tests were performed to determine whether the data were normally distributed or not. If the data were normally distributed, statistical tests could be performed. However, if the data were not normally distributed, they were analyzed using nonparametric tests. The results of the normality tests for the research data are presented in figure 3 below.

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
nilai PRETEST	.166	15	.200 [*]	.942	15	.409
nilai Postes	.219	15	.051	.905	15	.112

^{*}. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Fig 3. Results of the Normality Test for Research Data

Figure 3 shows that the Kolmogorov-Smirnov normality test for the pretest data yielded a value of 0.200, while the posttest data yielded a value of 0.051; both values exceed the significance level of 0.05. This indicates that the pretest and posttest data analyzed using the Kolmogorov-Smirnov test are normally distributed. Additionally, figure 3 shows that the Shapiro-Wilk normality test for the pretest data yielded a value of 0.409, and the posttest data yielded a value of 0.112, which also exceed the significance threshold of 0.05. This further confirms that the pretest and posttest data evaluated using the Shapiro-Wilk test are normally distributed. Based on the normality tests conducted on the research data, the assumptions for parametric testing are met, allowing the analysis to proceed with a paired t-test.

A t-test was conducted to examine the difference between students' pretest and posttest mean scores in order to determine whether the use of the PBL model, supported by WordWall, had an effect on student learning outcomes. The results of the paired t-test in this study are presented in Table 5 below.

Paired Samples Test									
		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	nilai PRETEST - nilai Postes	-28.000	6.761	1.746	-31.744	-24.256	-16.039	14	.000

Fig 4. Results of the Paired t-Test on the Use of Wordwall-Assisted PBL

Figure 4 shows that the results of the t-test indicate a significant difference between students' pretest and posttest scores. The average difference between the pretest and posttest is 28.00 points, with a 95% confidence interval ranging from 24.256 to 31.744. The paired t-test result was 16.039 with 14 degrees of freedom (df) (calculated $t = 1.7613$) and a significance level of 0.05. This means that the calculated t-value is greater than the critical t-value that is, 16.039 is greater than 1.7613 indicating a highly significant improvement in learning outcomes following the implementation of the problem-based learning model supported by Wordwall. Therefore, it can be concluded that the problem-based

learning model supported by Wordwall has a significant effect on improving students' learning outcomes.

The improvement in student learning outcomes between the pretest and posttest was analyzed using the N-Gain test to assess the effectiveness of the Wordwall-assisted Problem-Based Learning (PBL) model. The results of the N-Gain analysis showed an average of 0.67, placing the N-Gain in the moderate-to-high category. These findings indicate that the implementation of the Wordwall-assisted Problem-Based Learning (PBL) model can effectively improve students' conceptual understanding, with a 67 percent increase observed. Based on these results, it can be concluded that the Wordwall-assisted Problem-Based Learning (PBL) model is quite successful in helping students understand the material and improve their learning outcomes, although further improvements are still needed for student learning outcomes to reach the high category. A summary of the N-Gain test results is presented in Table 4.

Table 4. N-Gain Categories for Student Learning Outcomes

Category	Number of Students	Percentage
High	4	26.67%
Medium	11	73.33
Low	0	0
Total	15	100%

Table 4 shows that of the 15 students, 4 (26.67%) fell into the high N-Gain category, while 11 students, or 73.33%, fell into the moderate category. No students fell into the low category (0%). This indicates that the teaching methods implemented were effective in improving student learning outcomes. These N-gain results also indicate that the majority of students showed moderate improvement, and more than a quarter of the students achieved high improvement. These findings confirm that the WordWall-assisted problem-based learning model used was able to have a positive impact on students' understanding and learning outcomes, although its effectiveness still varied among students. This is in line with [Uluçınar, \(2023\)](#), who argued that a problem-based learning model combined with technology-based media makes it easier for students to understand the material compared to using the problem-based learning model alone.

CONCLUSION

Based on the results of the research analysis, it can be concluded that the implementation of the Problem-Based Learning (PBL) model, supported by Wordwall, has been proven to significantly improve students' learning outcomes in natural science. The learning achievement rate increased significantly from 33.33% to 93.33%. This finding is also supported by the results of a paired t-test, which showed a significant difference between pretest and posttest scores. The average N-gain score for students was 0.67, which falls into the moderate-to-high category, and the majority of students demonstrated a significant improvement in understanding. These findings support the conclusion that the combination of Problem-Based Learning (PBL) and Wordwall can improve learning achievement, conceptual understanding, and enhance students' retention. In addition to improving learning outcomes, the Problem-Based Learning (PBL) model supported by Wordwall also has a positive impact on students' motivation and enthusiasm during the learning process. The game-based Wordwall platform creates a fun, interactive, and efficient learning environment, thereby mitigating the drawback of Problem-Based Learning (PBL), which tends to be time-consuming.

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