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The Effect of Wordwall-Assisted Problem-Based Learning (PBL) on the Science Learning Outcomes of Fifth-Grade Students at SD Negeri 19 Beringin, Padang City

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Abstract

Low science learning outcomes remain a concern in elementary classrooms characterized by teacher-centered instruction and limited use of interactive learning media. This study examined the effect of Wordwall-assisted problem-based learning (PBL) on fifth-grade students' science learning outcomes at SD Negeri 19 Beringin, Padang City. A quantitative quasi-experimental approach was employed using a nonequivalent posttest-only control group design. All 55 fifth-grade students participated through saturated sampling: 28 students in Class V.A formed the experimental group, and 27 students in Class V.B formed the control group. Data were collected using a multiple-choice science achievement test that had undergone validity, reliability, item discrimination, and difficulty testing. Analysis comprised normality and homogeneity tests followed by an independent-samples t-test. The experimental group achieved a higher mean posttest score (85.86) than the control group (79.26), and the difference was statistically significant ($t = 3.576$). These findings indicate that Wordwall-assisted PBL was associated with higher science learning outcomes within the studied setting. Integrating PBL with Wordwall may therefore provide an interactive instructional alternative for supporting science learning in elementary classrooms.

Keywords: Problem-Based Learning; Wordwall; Science Learning Outcomes; Elementary Education; Quasi-Experimental Design

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INTRODUCTION

Education is an essential foundation for developing human resources and preparing individuals to face changes in society and everyday life. Through education, students are expected not only to acquire knowledge but also to develop thinking skills, problem-solving abilities, attitudes, and competencies that can be applied in various situations. The achievement of these educational objectives is closely related to the quality of the learning process. Learning is not merely an activity in which teachers transfer information to students, but also a process that provides opportunities for students to actively construct knowledge through meaningful learning experiences Muthmainnah, (2023). Therefore, the learning process needs to be designed to encourage students to participate actively, interact with learning materials, and connect the concepts they learn with situations encountered in everyday life, which is highly emphasized in building 21st-century skills Atika Ulya Akmal et al., (2023).

One of the subjects that has an important role in developing students' understanding of their surrounding environment is Natural Science (Ilmu Pengetahuan Alam/IPA). Science learning in elementary schools is closely related to natural phenomena and the processes through which students understand those phenomena through observation, investigation, experimentation, reasoning, and drawing conclusions. Harefa & Sarumaha, (2020) explain that science is a systematic and universal body of knowledge that discusses natural phenomena through scientific processes. Similarly, Dewi et al., (2021) state that science learning is intended to develop students' curiosity toward natural phenomena, train them to think and work scientifically through investigation and observation, and encourage them to understand and apply scientific concepts in everyday life. Thus, science learning should not be limited to memorizing concepts, but should provide opportunities for students to investigate phenomena, solve problems, discuss findings, and apply scientific knowledge in meaningful contexts.

The characteristics of science learning require teachers to select appropriate learning models and instructional media. Learning models provide a systematic framework for organizing learning activities so that students can achieve the intended learning objectives. In elementary science education, the use of student-centered learning models is important because students need direct experiences and opportunities to construct their understanding. Yulianti & Gunawan, (2019) explain that Problem-Based Learning (PBL) can influence

students' conceptual understanding and critical thinking because learning begins with problems that encourage students to investigate and find solutions. Consequently, the implementation of an appropriate learning model can become an important factor in creating an active learning environment and improving students' learning outcomes.

However, the ideal conditions of science learning are not always reflected in classroom practices. Learning activities may still be dominated by teacher explanations, while students have limited opportunities to actively participate in problem-solving, discussion, investigation, and presentation activities. Such conditions can make students more dependent on information provided by the teacher and less accustomed to constructing knowledge independently. The limited use of interactive learning media can also make learning activities less varied and reduce opportunities for students to engage directly with learning materials. When learning is dominated by conventional activities, students may experience difficulties in understanding concepts and applying them to different situations, which can ultimately affect their learning outcomes.

These conditions were also identified at SD Negeri 19 Beringin, Kota Padang. Based on the preliminary data contained in the research, the science learning outcomes of the students before entering grade V were still relatively low. The data on the daily assessment of science learning for grade IV students in the 2025/2026 academic year showed that the percentage of students who achieved the Learning Objective Achievement Criteria (Kriteria Ketercapaian Tujuan Pembelajaran/KKTP) was still limited. The KKTP for science was set at 80. In class IV.A, only 7 out of 28 students, or 25%, achieved the criterion, while 21 students, or 75%, had not achieved it. In class IV.B, only 6 out of 27 students, or 22%, achieved the criterion, while 21 students, or 78%, had not achieved it. The average scores were also 67.54 for class IV.A and 72.37 for class IV.B, both of which were below the established KKTP. This phenomenon is consistent with challenges found in Indonesian elementary education, where the use of conventional teaching methods may make it difficult for students to understand science concepts and reduce their engagement in the learning process Wahyuni et al., (2025).

The condition indicates that students' science learning outcomes required attention and improvement. In addition to the low achievement of the learning criteria, the learning process identified in the research was still influenced by teacher-centered practices. Students were not optimally involved in problem-solving activities, while the use of interactive

learning media was also not optimal. These conditions suggest that the learning process needs to be developed toward a more active, collaborative, problem-oriented, and engaging learning environment. Therefore, an instructional model that can place students as active participants and encourage them to investigate and solve problems is needed.

One alternative that can be applied to address these problems is the Problem-Based Learning (PBL) model. PBL is a learning model that begins with presenting problems that are relevant to students' lives. Students are then encouraged to identify the problem, organize themselves for learning, conduct individual or group investigations, develop and present their work, and analyze and evaluate the problem-solving process. Through these activities, students are positioned as active participants in constructing knowledge rather than merely receiving information from the teacher. According to Syamsidah & Suryani, (2018), PBL positions students as subjects who actively participate in the learning process. The problem-oriented nature of PBL also provides opportunities for students to develop critical thinking, collaboration, communication, and problem-solving skills.

The effectiveness of PBL in science learning has been supported by previous research. A meta-analysis conducted by Tamariska febri kristiana, (2021) involving studies on PBL and elementary science learning found that the application of PBL had a substantial influence on improving students' science learning outcomes, with an average effect size of 2.70, categorized as high. Another meta-analysis by Djonomiarjo, (2020)also reported that the PBL model had a significant impact on improving science learning outcomes at the elementary school level. These findings indicate that PBL is relevant to science learning because its problem-oriented activities provide students with opportunities to actively construct knowledge and apply scientific concepts to problems.

Although PBL provides a student-centered learning structure, its implementation can be strengthened through the use of appropriate instructional media. Interactive media can help present learning materials in a more engaging form and provide students with opportunities to interact directly with questions, activities, and learning tasks. One digital learning medium that can be integrated into PBL is Wordwall. Wordwall is a web-based interactive learning platform that provides various game-based activities, such as quizzes, matching activities, and other interactive exercises. The use of game-based activities can provide a more varied learning experience and can be utilized both during the learning process and as an evaluation activity. The integration of Wordwall into game-based learning

has also been shown to encourage active participation and increase student engagement in elementary science learning Damayanti et al., (2025)

The integration of Wordwall into PBL is relevant because the two components can complement one another. PBL provides the learning structure through problem identification, investigation, discussion, presentation, and evaluation, while Wordwall can be used as an interactive medium to strengthen students' understanding and provide learning reinforcement. In the present study, Wordwall was used through interactive activities such as Match Up, Open the Box, and Quiz. These activities were integrated into the learning process to support students' participation and understanding of the material on light and its properties. The research module also shows that Wordwall was used as a medium for games and reinforcement of students' understanding of science concepts.

Previous empirical studies have demonstrated the potential of Wordwall to improve elementary students' learning outcomes. Agusti & Aslam, (2022), for example, examined the effectiveness of the Wordwall application on elementary science learning outcomes using a true experimental design involving 64 students. Their findings showed a significant effect of Wordwall on students' science learning outcomes, with a calculated t-value of 3.203, which was higher than the critical t-value of 2.039. Savira and Gunawan (2022) also investigated the use of Wordwall in elementary science learning and reported that the application could improve students' science learning outcomes. Furthermore, Ariyani et al., (2025) found that Wordwall had a significant effect on students' learning outcomes in IPAS at SD N 1 Piji through a quasi-experimental study involving fifth-grade students.

The positive findings from these studies suggest that Wordwall can serve as an effective interactive medium in elementary science learning. A recent literature analysis also reported that interactive Wordwall media can create a more engaging learning atmosphere, increase students' enthusiasm, and encourage more active participation in elementary science learning. However, the effectiveness of an interactive medium cannot be separated from the learning model in which it is implemented. Wordwall primarily functions as a learning medium, whereas PBL provides a pedagogical framework for organizing students' learning experiences. Therefore, combining PBL with Wordwall may provide a more comprehensive learning experience by integrating problem-solving activities with interactive digital learning activities.

Several previous studies have examined PBL and Wordwall in elementary education. Studies on PBL have generally demonstrated its positive contribution to science learning outcomes, while studies on Wordwall have demonstrated its potential as an interactive medium for improving students' learning outcomes. However, based on the relevant studies reviewed in this research, PBL and Wordwall have more frequently been examined as separate interventions. The research conducted by Agusti & Aslam, (2022), Savira & Gunawan, (2022), and Ariyani et al., (2025), for example, focused on the use or effectiveness of Wordwall, while other studies have examined PBL as a learning model. The present study differs by integrating the Problem-Based Learning model with Wordwall in elementary science learning. The combination is expected to provide students with opportunities to engage in problem-solving activities while also participating in interactive digital activities that reinforce their understanding of the material.

The selection of the topic "Light and Its Properties" is also relevant to the characteristics of PBL-based science learning. The topic includes concepts that can be connected to phenomena encountered by students in everyday life, such as the propagation of light, reflection, refraction, the ability of light to pass through transparent objects, dispersion, and the formation of shadows. These phenomena can be presented as contextual problems that encourage students to observe, investigate, discuss, and formulate explanations based on their observations. The learning activities in the research included observation, experiments, group discussions, presentations, and the use of digital media, thereby providing opportunities for students to connect scientific concepts with real-life phenomena.

The combination of PBL and Wordwall is therefore expected to address two important aspects of the learning process. First, PBL can provide students with meaningful opportunities to investigate problems, work collaboratively, construct knowledge, and develop solutions. Second, Wordwall can provide interactive activities that reinforce students' understanding and make learning evaluation more engaging. When these components are integrated appropriately, students are expected to become more actively involved in the learning process and to obtain a deeper understanding of the science concepts being studied.

Based on the problems identified at SD Negeri 19 Beringin and the findings of previous studies, there is a need to empirically examine the effect of integrating the Problem-

Based Learning model with Wordwall on elementary science learning outcomes. This research is particularly important because it focuses on fifth-grade students and the topic of light and its properties, while previous studies have generally examined PBL or Wordwall separately or have focused on different grade levels and learning contexts. The present study therefore seeks to provide empirical evidence concerning the implementation of a Wordwall-assisted PBL model in science learning at the elementary school level.

Based on the above considerations, this study aims to determine the effect of the Wordwall-assisted Problem-Based Learning (PBL) model on the science learning outcomes of fifth-grade students at SD Negeri 19 Beringin, Padang City. The study is expected to contribute empirical evidence regarding the integration of a problem-based learning model and interactive digital media in elementary science education. In practical terms, the findings are expected to provide an alternative for teachers in designing more active, interactive, and student-centered science learning activities.

METHODS

This study employed a quantitative approach using a quasi-experimental method with a nonequivalent posttest-only control group design. The study involved two groups, namely an experimental group and a control group. The experimental group was taught using the Problem-Based Learning (PBL) model assisted by Wordwall, while the control group received conventional learning. The population consisted of all fifth-grade students at SD Negeri 19 Beringin, Padang City, in the 2026/2027 academic year. A saturated sampling technique was used, involving all 55 students in the population as the research sample. Class V.A consisted of 28 students and was assigned as the experimental group, while Class V.B consisted of 27 students and was assigned as the control group through a simple random drawing.

The research instrument was a multiple-choice test designed to measure students' science learning outcomes on the topic of Light and Its Properties. Before being used as the posttest, 40 test items were subjected to validation and trial testing. The instrument was analyzed based on empirical validity, reliability, item discrimination, and difficulty level. Based on the results of these analyses, 25 items were selected and used as the final posttest.

Data collection was conducted after the learning intervention had been completed in both groups.

The data were analyzed using descriptive and inferential statistics with SPSS version 27. Descriptive analysis was used to determine the mean, minimum score, maximum score, and standard deviation of the posttest results. Before testing the research hypothesis, prerequisite analyses were conducted through the Shapiro-Wilk normality test and Levene's test for homogeneity. Since the data were normally distributed and homogeneous, an independent-samples t-test was used to determine whether there was a significant difference in science learning outcomes between the experimental and control groups. The hypothesis testing was conducted at a significance level of 0.05.

RESULTS

Based on the research conducted in both classes, data regarding the students' science learning outcomes were obtained. This learning outcome data was obtained from the post-test after being given treatment using the Wordwall-assisted Problem Based Learning (PBL) model in the experimental class and the conventional model in the control class. From the post-test, the average score (Mean), highest score (Maximum), lowest score (Minimum), and standard deviation (Std. Deviation) were obtained, as shown in the following table:

Table 1. Descriptive Statistics of Science Learning Outcomes

Class	N	Minimum	Maximum	Mean	Std. Deviation
Class Experiment	28	72	100	85.86	6.485
Class Control	27	64	96	79.26	7.193

Based on the data presented in Table 1, a noticeable difference was observed in the mean scores of the experimental group at 85.86, in contrast to the control group's average of 79.26. As a result, the average score of the experimental group surpasses that of the control group. Furthermore, the standard deviation in the experimental class (6.485) is lower than in the control class (7.193), indicating that the learning outcomes in the experimental class are more evenly distributed. The outcomes of the prerequisite data examinations are as follows:

1. Normality Test

The results of the normality test using the Shapiro-Wilk method at a significance level of α=0.05 are shown in the table below:

Table 2. Outcomes of the Normality Assessment for Science Learning Results

Class	Statistic	df	Sig.
Class Experiment	.957	28	.302
Class Control	.973	27	.686

According to Table 2, the Sig. value > α=0.05 was found for both the experimental class (0.302) and the control class (0.686). This indicates that the data for both groups follows a normal distribution.

2. Homogeneity Test

The outcomes of the homogeneity test using Levene's Test at a significance level of α=0.05 are presented in the table below:

Table 3. Outcomes of the Homogeneity Test for Science Learning Results

Value	Levene Statistic	df_1	df_2	Sig.
Based on Mean	.245	1	53	.623
Based on Median	.172	1	53	.680
Based on Median and with adjusted df	.172	1	52.074	.680
Based on trimmed mean	.254	1	53	.617

As shown in Table 3 above, the Sig. value (0.623) is greater than α (0.05), indicating that the variances of the two samples are indeed homogeneous.

3. Hypothesis Test

Once it was established that both sample classes exhibited a normal distribution and had uniform variances, a hypothesis test was performed using the Independent Samples t-test. The outcomes are presented below:

Table 4. Independent Samples T-Test Results

Value	f	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	.245	.623	3.576	53	<,001	6.598	1.845	2.897	10.299
Equal variances not assumed			3.569	51.980	<,001	6.598	1.849	2.888	10.308

The outcome of the hypothesis test calculation on both sample classes revealed that tcount = 3.576 and ttable = 1.674. Hence, since tcount > ttable (3.576 > 1.674) and the significance value is less than 0.05, we reject H0 and accept H1. Thus, it can be inferred that there is a significant effect of applying the Problem Based Learning (PBL) model assisted by Wordwall media on the science learning outcomes of fifth-grade students at SD Negeri 19 Beringin.

DISCUSSION

The main findings of this study demonstrate that the implementation of the Wordwall-assisted Problem-Based Learning (PBL) model significantly influenced the science learning outcomes of fifth-grade students concerning the topic of Light and Its Properties. Quantitatively, this is evidenced by the mean score of the experimental class reaching 85.86, which is significantly higher than the control class (79.26) that applied conventional learning. The hypothesis testing further corroborates this evidence, revealing a t_{count} (3.576) that is greater than the t_{table} (1.674). These findings indicate that presenting contextual problems at the beginning of the lesson effectively triggers students' curiosity, while the integration of interactive gamification through Wordwall (such as Match Up and Quiz) plays a massive role in maintaining focus and motivation during problem-solving sessions Jaurah, (2020). In contrast to teacher-centered conventional learning, the integration of PBL and Wordwall facilitates students to actively construct their own understanding of science concepts Pipit Hima Puspita & Deni Setiawan, (2025). In contrast to teacher-centered conventional learning, the integration of PBL and Wordwall facilitates students to actively construct their own understanding of science concepts Suhandary et al., (2024). This active construction is critical, as problem-based tasks compel students to transition from passive listeners to active problem solvers Prabowo et al., (2024).

The results of this study are highly consistent with recent empirical literature in elementary science education. Agustin et al., (2025) emphasized that integrating problem-solving syntax with Wordwall's digital interactive activities not only accommodates diverse learning styles but also significantly boosts students' cognitive outcomes in elementary science. This aligns with the nature of science education, which demands direct exploration rather than mere memorization. Furthermore, Mandjur et al., (2024) documented that the problem-based approach forces students into an active inquiry process, significantly elevating their science literacy compared to traditional methods. Additionally, the effectiveness of Wordwall as an evaluation and reinforcement medium in this study is supported by the findings of Hasanah, (2024) who proved that application-based media like Wordwall concretize abstract scientific concepts for fourth and fifth graders. This study successfully bridges a gap in the literature by proving that a pedagogical framework (PBL) combined with a digital interactive tool (Wordwall) provides a much more comprehensive learning experience. This results in learning outcomes that are not only higher but also more evenly

distributed, as shown by the lower standard deviation in the experimental class (6.485) compared to the control class (7.193).

Consequently, this research provides meaningful theoretical and practical contributions. Theoretically, these findings enrich the literature on primary science education by proving the synergistic effectiveness of problem-based pedagogy and interactive technology. Practically, these results present a direct implication for educators, specifically teachers at SD Negeri 19 Beringin and other elementary schools, to design more varied and student-centered science learning strategies. Utilizing Wordwall as an academic ice-breaking and evaluation tool serves as a practical solution to the lack of interactive media in classrooms, which frequently leads to student boredom and disengagement Ningsi & Hartono, (2025). Moreover, it emphasizes the importance of teachers mastering Technological Pedagogical Content Knowledge (TPACK) to seamlessly integrate digital tools into pedagogic models Aulia Nurdin et al., (2023).

Despite the positive and significant impact shown, this study has several limitations. First, the sample size is relatively small (55 students) and confined to a single school, which may limit the broad generalizability of the findings. Second, this study solely focused on cognitive learning outcomes concerning one specific topic, namely Light and Its Properties. Therefore, future research is recommended to expand the population and sample size, encompassing a wider geographic or demographic area. Moreover, upcoming studies could explore the application of Wordwall-assisted PBL on different science topics and continuously measure other variables such as High-Order Thinking Skills (HOTS) or intrinsic learning motivation.

CONCLUSION

This study concludes that the implementation of the Wordwall-assisted Problem-Based Learning (PBL) model has a positive and significant effect on the science learning outcomes of fifth-grade students at SD Negeri 19 Beringin, specifically on the topic of Light and Its Properties. The findings confirm that integrating problem-solving activities with interactive digital media creates a more engaging and effective learning environment, as evidenced by the significantly higher post-test scores in the experimental group compared to the control group.

Furthermore, this research contributes to the development of elementary science education by providing empirical evidence on the synergy between problem-based pedagogy and digital gamification. Practically, it offers educators a viable, student-centered instructional strategy to replace conventional teacher-centered methods, actively addressing the lack of interactive media utilization in elementary classrooms.

Based on the findings and limitations of this study, several recommendations are proposed for future research. Future studies are encouraged to expand the research sample across multiple schools to ensure broader generalizability. Additionally, applying this integrated learning model to other science topics or investigating its impact on other critical educational variables such as Higher Order Thinking Skills (HOTS) and intrinsic learning motivation would provide a more comprehensive understanding of its overall effectiveness.

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