The Effect of Wordwall-Assisted Problem-Based Learning Model on Improving Mathematical Literacy and Self-Regulated Learning

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ABSTRACT

This study aims to determine whether students' mathematical literacy skills improve more with Wordwall-assisted problem-based learning than with conventional learning. This study uses a quantitative approach with a quasi-experimental design of the pretest-posttest control group type. The research subjects consisted of 32 students in class VII D as the experimental class and 32 students in class VII B as the control class at SMP Negeri 16 Kota Serang. The instruments used were an essay test to measure mathematical literacy and a Likert scale questionnaire to measure self-regulated learning. The results of the analysis showed that the average N-Gain of the experimental class was 66.51 and that of the control class was 38.81. The t-test showed a sig. value (2-tailed) of $0.000 < 0.05$, indicating a significant difference between the two groups. The average self-regulated learning questionnaire score in the experimental class reached 80%. This study concluded that the use of the Wordwall-assisted PBL model was more effective in improving students' mathematical literacy and self-regulated learning than conventional learning.

KATA KUNCI: *Wordwall-Assisted Problem-Based Learning to Improve Mathematical Literacy and Self-Regulated Learning*

INTRODUCTION

Education is an important means of optimally developing the potential of students. Law No. 56 of 2022 states that the goal of national education is to shape individuals who are faithful, pious, noble, knowledgeable, independent, and responsible. In this context, mathematics plays a strategic role in equipping students with logical, critical, systematic, and reasoning skills. One of the main competencies in mathematics learning is mathematical literacy, which includes understanding concepts, reasoning, communication, connections, and mathematical problem solving (Nur ridskiyah et.al, 2021). Mathematical literacy skills are also a focus in international assessments such as the Programme for International Student Assessment (PISA). According to the 2022 PISA report, the average mathematical literacy score of Indonesian students was only 366, far below the OECD average of 472. In addition, only 18% of Indonesian students were able to reach the minimum proficiency level (level 2), compared to the OECD average of 69% (Mira Josy Mustadi et al, 2024). This low score is due to various factors, including difficulty understanding the context of the questions, lack of representation of appropriate solutions, and a learning process that is not yet optimal in developing students' thinking skills (Shinta & Agoestanto, 2025).

One internal factor that contributes to low mathematical literacy among students is self-regulated learning (SRL). Students with good SRL tend to be more active, independent, and focused in the learning process, and are able to manage their motivation and learning strategies effectively (Kusuma et al., 2021). Independent learning contributes greatly to improving mathematical literacy (Fricticarani et al., 2024; Kusuma et al., 2021). Therefore, improving mathematical literacy skills needs to be supported not only through appropriate learning approaches, but also by strengthening students' self-regulation aspects in learning. One learning model that suits the learning needs of the 21st century is Problem-Based Learning (PBL). This model emphasizes the active involvement of students in solving real problems related to everyday life, thereby developing critical thinking, collaboration, creativity, and communication skills. PBL is implemented through five main steps, namely: (1) orienting students to the problem, (2) organizing students to learn, (3) guiding the investigation, (4) developing and presenting the results, and (5) analyzing and evaluating the problem-solving process (Nurfadhillah et al., 2022). Previous studies have shown that the implementation of PBL is effective in improving students' mathematical literacy and learning independence (Sari & Syukur, 2023). Learning becomes more meaningful because students are directly involved in exploring, understanding, and applying knowledge (Delsi Novelni & Elfia Sukma, 2021).

As technology advances, the use of digital media such as Wordwall can strengthen the effectiveness of PBL implementation. Wordwall is a game-based interactive learning platform that provides activities such as quizzes, puzzles, and concept exercises. This application is designed to increase student engagement, motivation, and understanding through a gamification approach (Nadia et al., 2022). Wordwall also provides immediate feedback, allowing students to evaluate their learning outcomes and improve their understanding independently (Ruhsoh Triyani, 2023). Thus, the integration of Wordwall in PBL learning is believed to support the formation of self-regulated learning while improving students' mathematical literacy.

Mathematical literacy in this study was measured through four indicators, namely: (1) formulating problems in real contexts into mathematical forms, (2) using mathematical concepts and procedures in problem solving, (3) interpreting solutions and results according to context, and (4) critically evaluating solutions and the process of solving them (Utami et al., 2020). Meanwhile, students' self-regulated learning was

measured using eight indicators, namely: (1) initiative in learning, (2) diagnosing learning needs, (3) setting learning goals, (4) viewing difficulties as challenges, (5) seeking and utilizing relevant learning resources, (6) selecting and applying learning strategies, (7) evaluating the learning process and outcomes, and (8) building a positive self-concept (Sa'idah & Habibi, 2025).

Based on initial observations in class VII of SMP Negeri 16 Kota Serang, it was found that students' mathematical literacy and self-regulated learning abilities were still relatively low. Students have difficulty modeling problems, are not thorough in solving problems, and tend to depend on teachers in understanding the material. Therefore, innovative learning strategies are needed to improve these two important aspects. One alternative solution offered is through the application of the Wordwall-assisted Problem-Based Learning (PBL) model. This study aims to examine the effect of the Wordwall-assisted PBL model on students' mathematical literacy and self-regulated learning.

METHOD

This study used a quantitative approach with a quasi-experimental design, which aimed to determine the improvement of the Wordwall-assisted Problem-Based Learning (PBL) model on students' mathematical literacy and self-regulated learning (SRL) abilities. The experimental design used was a pretest-posttest control group design, in which there were two groups, namely the experimental class that received treatment in the form of PBL learning assisted by Wordwall and the control class that used conventional learning. The population in this study was all seventh-grade students at SMP Negeri 16 Kota Serang in the 2024/2025 academic year. The sample was selected using simple random sampling, with two classes selected as samples. Grade VII D, consisting of 32 students, was designated as the experimental class, while grade VII B, also consisting of 32 students, became the control class. The data collection techniques in this study consisted of a written test, in the form of essay questions given before and after the treatment to measure students' mathematical literacy skills. A questionnaire was used to measure students' self-regulated learning. The questionnaire was distributed before and after the treatment to both groups. Documentation was used to supplement the data to record learning activities during the research process.

The data analysis techniques used in this study were analysis of mathematical literacy comprehension abilities in the form of descriptive analysis, N-Gain test, N-Gain normality test using Shapiro Wilk, N-Gain homogeneity test using Levene statistic, and N-Gain two-means equality test.

RESULT AND DISCUSSION

This study was conducted to examine whether students' mathematical literacy skills improved more with problem-based learning using the Wordwall application than with conventional learning.

Results of Descriptive Analysis and N-Gain

Based on the research that has been conducted, data on students' mathematical literacy test results were obtained through pretest and posttest and tested using N-Gain in two groups, namely the experimental class and the control class. This data was obtained through a descriptive test instrument that measured students' mathematical literacy skills in data presentation material and was conducted

in classes VII B and VII D, each consisting of 32 students. The data on the results of the research on students' mathematical literacy skills were obtained using the N Gain score calculation, which was calculated based on the difference between the pretest and posttest scores relative to the maximum ideal score (100).

Table 1. N-Gain descriptive analysis results

	Experiment			Control		
	pretest	*postest*	N-Gain	*pretest*	*postest*	N-Gain
Minimum	40	70	0,30	35	50	0,11
Maximum	75	95	0,88	60	80	0,67
Mean	57,19	85,16	0,6534	49,84	69,69	0,4233
Std. Deviation	10,313	7,126	-	6,658	6,832	-

The results of descriptive analysis and N-Gain calculations show that the increase in students' mathematical literacy skills in classes that received learning using the Wordwall application-assisted Problem-Based Learning model was higher than that of students who followed conventional learning. This is indicated by the higher average posttest scores and N-Gain in the experimental class, as well as the distribution of scores, which shows a significant increase after the treatment was given.

Prerequisite Test Results Analysis

a. N-Gain Normality Test

The normality test is used to determine whether data is normally distributed or not. In this test, the normality test is performed using the Shapiro-Wilk test through SPSS 26 software. The Shapiro-Wilk test was chosen because it is suitable for a sample size of less than 50 students.

Table 2. Results of N-Gain Normality Test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df.	Sig.	Statistic	df	Sig.
Experimental class	0,084	32	0,200*	0,960	32	0,270
Control class	0,148	32	0,073	0,936	32	0,059

Based on the output results obtained, the significance value (Sig) for the N-Gain data in the experimental class is 0.270 and for the control class is 0.59. Both the Kolmogorov-Smirnov and Shapiro-Wilk tests show figures greater than 0.05. Therefore, it can be concluded that the N-Gain data in both classes are normally distributed. Since the normality requirement has been met, the next step is to test for homogeneity.

b. N-Gain Homogeneity Test

The next step is the homogeneity test, which aims to determine whether the variance (diversity) of data from two or more sources is homogeneous (the same) or heterogeneous (not the same). The homogeneity test in this study is the Levene test using SPSS version 26 software. Data is said to be homogeneous if it meets the criteria of sig.> 0.05. The results of the homogeneity test are as follows:

Table 3. Results of the N-Gain Homogeneity Test

Levene statistic	df1	df2	Sig.
2,196	1	62	,143

The results of the variance homogeneity test using Levene's Test show that the Levene statistic value is 2.196 with degrees of freedom df1 = 1 and df2 = 62, and a significance value of 0.143. Since the significance value is greater than the significance level of 0.05 (0.143 > 0.05), it can be concluded that the data has uniform or homogeneous variance. This means that the assumption of homogeneity is fulfilled so that testing can be continued using parametric statistical techniques such as the Independent Sample T-Test.

Hypothesis Testing

c. Test for Equality of Two N-Gain Means

The test for the similarity of two means aims to determine whether there is a difference in literacy improvement between two unpaired data groups. Based on the results of the previous analysis, which showed that the data were normally distributed and had homogeneous variance, this test was conducted using the Independent Sample T-Test method with the assumption of variance equality.

Table 4. Independent Sample T-test Results

Class	Sig. *Based On Mean*	Description
Experiments and controls	0,000	H0 Ditolak

Based on the results of the independent sample T-test equal variance assumed, it is known that the significance value (Sig. 2-tailed) is 0.000 < 0.05. This indicates that H_0 is rejected and H_1 is accepted. Thus, it can be concluded that there is a significant difference in the posttest results of mathematical literacy between the experimental class and the control class. This means that the application of the Wordwal-assisted problem-based learning (PBL) model improves students' mathematical literacy skills when compared to the use of conventional learning models..

Likert Scale Test (Questionnaire)

After obtaining the results of the mathematical literacy test, it was necessary to conduct a questionnaire survey on students' self-regulated learning. The questionnaire survey used a Likert scale with the help of Excel software, with the following results:

Table 5. Likert Scale Test Results

	Postest Average	Criteria
Control	74%	Strong
Experiment	80%	Very Strong

Based on the results of the questionnaire after treatment, there was a different increase in each class. The control class experienced an increase to 74% and was categorized as "strong," while the experimental class showed a more significant increase with an average score of 80%, which was categorized as "very strong." It can therefore be concluded that self-regulated learning provided through problem-based learning assisted by the Wordwal application is better than conventional learning.

DISCUSSION

This study was conducted at SMP Negeri 16 Kota Serang using a quasi-experimental approach, involving two classes as samples, namely the experimental class and the control class, each consisting of 32 students. The experimental class received treatment using the Wordwall application-assisted Problem Based Learning (PBL) model, while the control class followed conventional learning. The results showed that the application of the Wordwall-assisted PBL model had a significant effect on improving students' mathematical literacy and self-regulated learning (SRL) abilities. In terms of mathematical literacy, students in the experimental class showed better results than students in the control class. They obtained higher average scores, and their answers also demonstrated their ability to understand concepts, present data, and solve problems in a systematic and logical manner. This was supported by the syntactic structure in PBL, which emphasized active student involvement through stages such as organizing learning, conducting investigations, and presenting results. These findings are in line with the opinion of Wena, (2020) which states that PBL encourages the development of critical thinking and problem-solving skills through authentic real-world problems.

The use of Wordwall as an interactive learning medium also enhances the effectiveness of learning. This medium provides educational game-based quizzes that not only attract students' attention but also provide immediate feedback that helps students evaluate and improve their understanding. Wordwall is considered flexible because it provides a variety of question templates that can be tailored to learning objectives (Imanulhaq & Pratowo, 2022). These advantages make Wordwall a tool that can improve students' conceptual understanding and active engagement in the mathematics learning process.

In addition, the SRL questionnaire results show that students in the experimental class experienced improvements in aspects such as goal setting, learning initiative, reflection on the learning process, and self-management. This shows that learning with the PBL model and Wordwall support contributes to shaping students' learning independence. Student involvement in developing strategies, finding solutions independently, and evaluating their learning achievements reflects that they are increasingly trained to manage the learning process independently. This is supported by previous findings which suggest that an active and open classroom atmosphere can increase students' internal motivation, self-confidence, and self-control (Hamidah et al., 2022; Hamidah & Kusuma, 2021; Kusuma et al., 2021, 2022). Furthermore, Wordwall helps create a conducive learning environment and facilitates

reflective and goal-oriented learning. According to Sahanata et al., (2023) Wordwall is able to create beneficial learning interactions because it allows students to receive immediate feedback and encourages them to correct their mistakes independently.

Thus, it can be concluded that the improvement in students' mathematical literacy skills provided by learning with the Wordwall application-assisted problem-based learning model is better than that of conventional learning.

CONCLUSION

1. The improvement in students' mathematical literacy skills who were taught using the problem-based learning model assisted by the Wordwall application was better than those who used conventional learning methods
2. Self-regulated learning after using the Wordwall-assisted problem-based learning model was in the very strong category with an average percentage of 80%.

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