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The Effect of PBL-Based LKPD Assisted by Wordwall on Fifth Graders' Critical Thinking Skills in Science Learning

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ABSTRACT

This study investigated the effect of Problem-Based Learning (PBL)-based student worksheets (LKPD) assisted by Wordwall media on fifth graders' critical thinking skills in science learning. The study focused on three dimensions of critical thinking: focus, reason, and inference. A quantitative approach with a quasi-experimental design was employed. The experimental group used PBL-based LKPD integrated with Wordwall media, while the control group received conventional instruction. Data were collected through tests, observations, interviews, and documentation. Instrument validation included expert judgment, Aiken's V analysis, reliability testing, item validity, item difficulty, and discrimination analysis. The results of the normality and homogeneity tests indicated that the data were non-normal and non-homogeneous; therefore, nonparametric statistics were applied. The Mann–Whitney test showed significant differences between the experimental and control groups across all critical thinking aspects with Asymp. Sig. (2-tailed) values of 0.000 < 0.05. N-Gain analysis demonstrated high effectiveness in the experimental group for focus (96.70%), reason (87.90%), and inference (79.30%), whereas the control group showed only moderate improvement. Spearman rank correlation analysis further revealed very strong correlations among the three critical thinking dimensions. The findings indicate that PBL-based LKPD assisted by Wordwall media effectively improves students' critical thinking skills and promotes more interactive and student-centered science learning.

INTRODUCTION

Education in the twenty-first century necessitates that students acquire critical thinking competencies (Halim, 2022). The paradigm of 21st-century learning identifies seven core skills required for students' future success, among which critical thinking and problem solving constitute central components (Mesra, 2023, p. 4). As articulated by Winarni (2018a, p. 13), the primary objective of science instruction at the elementary level is to develop learners who are capable of creative thought and critical reasoning.

Critical thinking is an intellectual process involving the formulation of concepts, the application, synthesis, and evaluation of information obtained through observation, experience, reflection, reasoning, or communication, which serves as a basis for forming beliefs and taking action (Lismaya, 2019, p. 8). Consistent with this view, Ariyana et al. (2018, p. 13) state that critical thinking, according to the FRISCO theory, comprises six components: focus, reason, inference, situation, clarity, and overview. Based on the characteristics of elementary school learners and the competency demands of Grade V students, who are generally in the concrete operational stage, three components of the FRISCO framework are considered most relevant: focus, reason, and inference. Rachmawati, Ghozali, et al. (2021a, p. 149) explain that the focus element pertains to students' ability to identify known and unknown information; the reason element concerns students' capacity to articulate explanations grounded in observable reality; and

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the inference element refers to the ability to select reasons that support the conclusions they construct. Drawing from these perspectives, it can be concluded that these three FRISCO components are appropriate for measuring the critical thinking abilities of elementary school students, as they align with the developmental characteristics of learners in the concrete operational stage.

According to Zakia and Lestari (2019, p. 5), the benefits of critical thinking in educational performance include the ability to assess others' arguments, evaluate information, and develop and defend arguments when completing problem-based tasks. In the learning process, teachers as facilitators of student learning require instructional materials that support instructional effectiveness. Instructional materials may take the form of printed materials such as textbooks and student worksheets (LKPD), as well as electronic materials including educational applications, e-books, and other digital resources accessible via computers or mobile devices (Hayati et al., 2025, p. 2). One type of instructional material that can promote active learning and improve students' critical thinking skills is the student worksheet (LKPD). (Trirahayu et al., 2024).

Kosasi (2021, p. 33) states that an LKPD contains core content, learning objectives, required tools or materials, and procedural steps. It may also include various practice questions such as objective items, completion tasks, short-answer questions, and other assignments related to the main content presented in accompanying instructional materials. According to Halimah et al. (2023), a learning model that can be utilized to improve students' critical thinking abilities is Problem-Based Learning (PBL), a model grounded in problem-centered instruction. Pamungkas (2020, p. 11) describes the characteristics of PBL as the use of real-life problems as the starting point of instruction, the incorporation of contextual problems from students' surroundings, the presentation of challenges that stimulate student engagement, the utilization of diverse knowledge sources, and the promotion of collaborative, communicative, and cooperative learning. However, PBL also has limitations, including time constraints and insufficient initial student engagement (Siswanti & Indrajit, 2023, p. 77). Therefore, the implementation of PBL can be optimized through the use of appropriate instructional media.

This perspective is supported by research conducted by Saputra et al. (2023), which found that instructional media can improve students' learning outcomes and foster an enjoyable learning atmosphere. Instructional media play a crucial role in improving learning quality, as they serve as tools for conveying information about learning materials and stimulating students' attention, interest, thinking, and emotions, thereby supporting the achievement of learning objectives (Kristanto, 2016, p. 6). Among the available options, technology-based instructional media such as Wordwall are particularly suitable because they help address several weaknesses inherent in the PBL model. Wordwall media can facilitate two-way interaction between teachers and students (Hamidulloh Ipda et al., 2023, p. 40).

At present, the critical thinking skills of elementary school students remain relatively low (Harahap et al., 2024). Contributing factors include students' limited ability to articulate ideas, reluctance to express opinions, restricted opportunities for exploration, and the persistence of conventional learning methods that reduce student engagement. These issues are evident at SD Negeri 134 Rejang Lebong. Based on observations and interviews conducted with the Grade V-A teacher in August 2025, it was found that students in this class demonstrated low levels of critical thinking. Of the 20 students, only six exhibited good critical thinking ability, while fourteen demonstrated low ability. This

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low performance was apparent during lessons: students tended to be passive, struggled to complete problem-based tasks requiring analytical thinking, and were unable to identify and understand the problems presented. They also had difficulty providing evidence-based reasons for decisions and formulating appropriate conclusions. Interview results further indicated that five students struggled with the focus aspect, seven with reason, and four with inference.

Although the teacher had employed various learning models during instruction, their implementation was not yet optimal in supporting students' critical thinking in the focus, reason, and inference components. Additionally, the LKPD used in class did not fully reflect the syntax of the applied learning models. While various instructional media had been utilized, the use of electronic media remained limited.

Although previous studies have demonstrated that Problem-Based Learning and Wordwall media independently improve learning outcomes and student engagement, limited research has investigated the integration of PBL-based LKPD assisted by Wordwall media to enhance elementary students' critical thinking skills, particularly in the dimensions of Focus, Reason, and Inference. This study addresses that gap by examining the effectiveness of integrating PBL-based LKPD with Wordwall media in Grade V science learning. The findings are expected to contribute both theoretically to research on critical thinking instruction and practically by providing an effective instructional strategy for elementary science teachers.

RESEARCH METHOD

This study adopted a quantitative approach utilizing a Quasi-Experimental Design. The experimental group received instruction through PBL-based student worksheets (LKPD) integrated with Wordwall media, whereas the control group was taught using conventional methods without any form of intervention. The design implemented in this study was the Matching-Only Pretest–Posttest Control Group Design, which involved the use of an experimental group and a control group to enable comparative analysis.

Although previous studies have reported the effectiveness of Problem-Based Learning and Wordwall media in improving learning outcomes and student engagement, limited studies have specifically examined the integration of PBL-based LKPD assisted by Wordwall media in improving elementary students' critical thinking skills, particularly in the aspects of focus, reason, and inference. Therefore, this study seeks to address this gap by investigating the effectiveness of integrating PBL-based LKPD with Wordwall media in Grade V science learning.

The population of the study comprised all Grade V students at SD Negeri 134 Rejang Lebong, totaling 60 students distributed across three classes. The data subjected to analysis derived from the treatments administered to the selected sample. To ensure the selection of a representative and homogeneous sample, the researcher examined students' prior science learning outcomes. Cluster Random Sampling was employed as the sampling technique. The homogeneity test indicated that the sample groups were homogeneous ($F = 0.503 < F\text{-table} = 4.41$), thereby confirming that the classes were homogeneous. The final determination of sample groups was carried out through a lottery procedure witnessed by the classroom teacher and the school principal.

The data collection techniques employed in this study consisted of tests (pretest and posttest), observation, interviews, and documentation (Winarni, 2018, p. 64). The observation process was conducted on three occasions. First, a preliminary observation

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was carried out to obtain baseline data on the learning process prior to the implementation of the treatment. Second, subsequent observations were conducted collaboratively by the researcher and the model teacher, who had previously been briefed regarding the procedures. Third, an implementation observation was administered to measure teacher and student activities during the learning process using PBL-based LKPD supported by Wordwall media, as well as to assess aspects of students' critical thinking skills.

Interviews were conducted with the Grade V homeroom teacher of SDN 134 Rejang Lebong to obtain additional qualitative information related to instructional practices and students' critical thinking abilities. The study was implemented in the Grade V science subject during the first semester of the 2025/2026 academic year, focusing on the topic of the human digestive system. The learning indicators for this topic included the following: (1) students are able to identify and understand the problems presented in each item concerning the human digestive system; (2) students are able to provide logical reasons to support conclusions about the digestive system; and (3) students are able to formulate accurate conclusions and select appropriate reasons to justify those conclusions.

In preparation for the intervention, the researcher developed PBL-based LKPD supported by Wordwall media. The development stages included designing the LKPD format, creating the template, obtaining relevant images from online sources, and constructing the LKPD through Canva. The LKPD structure followed the guidelines of BSNP (2016), consisting of a cover page, learning objectives, procedural steps, required tools and materials, a brief explanation of the content, discussion questions, and independent exercises. Data analysis was performed using Microsoft Excel and SPSS.

The instruments employed in this study consisted of a document analysis sheet, an expert validation sheet, an implementation-observation sheet, and test items comprising both pretest and posttest questions. The document analysis sheet included curriculum documents, science (Science Learning) assessment materials, and interview guidelines. This instrument assessed the alignment of learning outcomes with instructional objectives; the alignment of Learning Objectives (TP) with Learning Achievement Targets (ATP) for the aspects of focus, reason, and inference.

The interview component was administered to the classroom teacher and examined indicators related to the instructional model, the science learning process in the classroom, the learning media used during instruction, and students' critical-thinking abilities (focus, reason, and inference). The expert validation sheet was used to evaluate the feasibility of the developed instructional media in terms of content, language, and graphical design. A total of six validators assessed three different domains. Two validators, who were practitioners, evaluated the material-related aspects, including content feasibility, presentation feasibility, and material currency. Another two practitioner validators assessed linguistic aspects, including clarity, communicativeness, appropriateness for students, and adherence to linguistic conventions. The remaining two validators assessed graphical aspects, including LKPD components, presentation feasibility, and the visual appearance of the LKPD. The expert validators for material, language, and presentation were specialists in science education or elementary-school education practitioners with a minimum of ten years of professional experience.

The implementation-observation sheet was designed to evaluate the extent to which PBL-based LKPD supported by Wordwall media facilitated students' critical-thinking abilities specifically the aspects of focus, reason, and inference. The observed components

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included: orienting students to the problem, organizing students for learning, guiding individual and group investigations, developing and presenting student work, and analyzing and evaluating the problem-solving process.

Instrument standardization was conducted through logical validation, reliability testing, empirical validity testing, item difficulty analysis, and item discrimination analysis. For the logical validation phase, the validation sheet consisted of a test-item specification grid, test items, a scoring rubric, and a list of instructional modules employing the Problem-Based Learning (PBL) model. The validity instrument utilized a five-point rating scale: very poor, poor, fair, good, and very good. To determine the degree of expert agreement, Aiken's V coefficient was calculated following Wasidi (2020) using the formula:

$$V = \frac{\Sigma s}{n(c-1)}$$

s = $r - l_o$
r = score assigned by an expert
l_o = lowest validity rating
c = highest validity rating
n = number of experts

The validity of the instrument was interpreted based on the Aiken's V coefficient: V > 0.80 = very valid; 0.40 ≤ V < 0.80 = moderately valid; 0 ≤ V < 0.40 = low validity (Wasidi, 2020, p. 61). To examine inter-rater consistency—defined as the degree of agreement between two raters assessing the same research instrument—an inter-rater reliability test was conducted. Inter-rater reliability was calculated using the formula proposed by McHugh (2012, p. 279):

$$\text{Inter-rater Reliability} = \frac{\text{Number of Agreements Between Raters}}{\text{Total Number of Items}} \times 100\%$$

Interpretation criteria were as follows: 0–4% = no agreement; 5–16% = slight agreement; 17–35% = weak agreement; 36–64% = moderate agreement; 65–81% = strong agreement; and 82–100% = almost perfect agreement (McHugh, 2012). In this study, item validity was evaluated through an instrument try-out. Students' responses on the pilot test were analyzed to determine item validity, instrument reliability, item difficulty, and item discrimination. The Pearson Product–Moment correlation coefficient was applied to determine the validity of each test item (Winarni, 2018b, p. 116), using the formula:

$$r_{xy} = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{[\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]}}$$

r_{xy} = item validity coefficient
ΣXY = sum of cross-products of X and Y
ΣX = total item scores
ΣY = total test scores
N = sample size

Validity interpretation followed Winarni (2018):
0.80–1.00 = very high; 0.60–0.79 = high; 0.40–0.59 = moderate; 0.20–0.39 = low; 0.00–0.19 = invalid.

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Reliability refers to the consistency of an instrument in producing stable results and its appropriateness as a data-collection tool (Winarni, 2018b, p. 137). Instrument reliability was measured using **Cronbach's Alpha**, calculated with:

$$r_{11} = \frac{k}{k-1}[1 - \frac{\Sigma\sigma_b^2}{\sigma_t^2}]$$

r_{11} = reliability coefficient
k = number of items
$\Sigma{\sigma_b}^2$ = total item variance
${\sigma_t}^2$ = total test variance

The instrument was considered reliable if r_{11} > r-table, and unreliable if r_{11} < r-table. Item difficulty measures the proportion of test-takers who answer an item correctly (Winarni, 2018b, p. 137). The index of difficulty (P) was computed using:

$$P = \frac{B}{JS}$$

P = difficulty index
B = number of students answering correctly
JS = total number of test-takers

Interpretation criteria were:
0.00–0.30 = difficult; 0.31–0.70 = moderate; 0.71–1.00 = easy (Winarni, 2018, p. 137). Item discrimination indicates the ability of an item to distinguish high-performing students from low-performing students. The discrimination index (DP) was computed following Winarni (2018, p. 137):

$$DP = \frac{JB_A}{J_A} - \frac{JB_B}{J_B}$$

J = total test-takers
J_A = number in upper group
J_B = number in lower group
JB_A = number of upper-group students answering correctly
JB_B = number of lower-group students answering correctly

Interpretation criteria were:
0.00–0.20 = poor; 0.21–0.40 = fair; 0.41–0.70 = good; 0.71–1.00 = excellent (Winarni, 2018, p. 138).

RESULTS AND DISCUSSION

Results

In this study, the independent variable was required to meet established validity criteria based on expert evaluations. To ensure such validity, the PBL-based student worksheet (LKPD) supported by Wordwall media was subjected to expert validation, which included assessments of content quality, linguistic appropriateness, and graphical design. Following the validation process, instrument reliability was examined using an

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inter-rater reliability approach. The results of the validity and reliability analyses are presented as follows:

Table 1. *Expert Validation Analysis of the PBL-Based LKPD Result*

Aspect	Items	Range of Aiken's V	Interpretation
Content	3	0.67–1.00	Moderate to Very Valid
Language	4	0.67–1.00	Moderate to Very Valid
Graphics	3	0.67–0.83	Moderate to Very Valid

Individual item scores ranged from **0.67 to 1.00**, indicating that all aspects met the minimum validity criterion for implementation.

Table 2. *Reliability Analysis of the PBL-Based LKPD Result*

Aspect	Number of Items	Agreement (%)	Agreement Level
Content	3	100	Very Strong
Language	4	75	Strong
Graphics	3	67	Strong

Inter-rater agreement was calculated based on the percentage of agreement between two expert validators. Agreement levels were interpreted according to McHugh (2012): 82–100% = Almost Perfect (Very Strong); 65–81% = Strong; 36–64% = Moderate; 17–35% = Weak; 5–16% = Slight; and 0–4% = No Agreement.

Table 3. Expert Validation Analysis of The Critical Thinking Aspect Summary Result

Validation Aspect	Number of Items	Minimum Aiken's V	Maximum Aiken's V	Overall Interpretation
Content	6	0.67	1.00	Valid
Language	6	0.67	1.00	Valid
Construction	6	0.67	1.00	Valid

All Aiken's V values exceeded 0.60, indicating acceptable content validity

Table 4. Reliability Analysis of Critical Thinking Aspect Result

Validation Aspect	Number of Items	Agreement Range (%)	Overall Agreement Level
Content	6	67–100	Strong–Very Strong
Language	6	67	Strong
Construction	6	67	Strong

The highest agreement was obtained for the Content–Inference dimension (100%), while all remaining dimensions achieved 67%, indicating strong agreement between the two expert validators.

Table 5. Item validity Test Result

Critical Thinking Dimension	Item	Item–Total Correlation (*r*)	Correlation Strength	Decision
Focus	1	0.947	Very High	Valid
	2	0.851	Very High	Valid
Reason	3	0.923	Very High	Valid
	4	0.935	Very High	Valid
Inference	5	0.762	Adequate	Valid
	6	0.839	Very High	Valid

Item validity was determined using the Pearson product–moment correlation. All correlation coefficients were statistically significant at $p < .01$, indicating that each item met the validity criterion and was retained for subsequent analyses.

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Table 6. Reliability Test Result

Critical Thinking Dimension	Number of Items	Cronbach's α	Reliability Interpretation
Focus	2	0.709	Acceptable
Reason	2	0.850	Good
Inference	2	0.440	Low

Reliability was assessed using Cronbach's alpha. Following commonly accepted guidelines, α ≥ 0.90 = Excellent; 0.80–0.89 = Good; 0.70–0.79 = Acceptable; 0.60–0.69 = Questionable; 0.50–0.59 = Poor; and α < 0.50 = Low.

Table 7. Item Difficulty Item Test Result

Critical Thinking Dimension	Number of Items	Difficulty Index Range (*p*)	Interpretation
Focus	2	0.575	Moderate
Reason	2	0.567–0.583	Moderate
Inference	2	0.630–0.670	Moderate

The item difficulty index (*p*) was calculated by dividing the average item score by the maximum possible score. Items with *p* values between 0.31 and 0.70 were classified as having moderate difficulty.

Table 8. Discrimination Index Result

Critical Thinking Dimension	Number of Items	Corrected Item–Total Correlation	Interpretation
Focus	2	0.571	Good
Reason	2	0.727	Very Good
Inference	2	0.286	Adequate

All items demonstrated positive corrected item–total correlations, indicating that each item contributed to the measurement of the intended construct. The Reason dimension exhibited the highest discrimination, followed by Focus, while the Inference dimension showed adequate discrimination.

Table 9. Normality Test Result

Aspect	Test Type	Group	Mean	Std. Deviation	Shapiro – Wilk Sig. Value
Focus	Pretest	Experimental	33.12	9.31	0.000
		Control	32.50	9.42	0.000
	Posttest	Experimental	97.50	11.18	0.000
		Control	60.00	20.51	0.000
Reason	Pretest	Experimental	34.97	5.14	0.000
		Control	46.66	16.75	0.000
	Posttest	Experimental	92.50	12.64	0.000
		Control	70.83	14.17	0.004
Inference	Pretest	Experimental	42.00	4.10	0.000
		Control	42.00	4.10	0.000
	Posttest	Experimental	88.00	17.35	0.000
		Control	63.00	17.19	0.006

Table 10. Homogeneity Test Result

Aspect	Average	Shapiro – Wilk Sig. Value
Focus	6.232	0.001
Reason	78.697	0.000
Inference	65.387	0.000

Table 9 presents the results of the normality test, which indicate the following: (1) The Shapiro–Wilk significance values for all pretest and posttest scores in both the experimental and control classes for the Focus aspect were 0.000. Since all significance

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values were below 0.05, it can be concluded that the Focus aspect data were not normally distributed. Accordingly, subsequent analyses were conducted using nonparametric statistics. (2) The Shapiro–Wilk significance values for the Reason aspect in the experimental class were also 0.000 for both pretest and posttest scores. In the control class, the pretest yielded a value of 0.000, while the posttest produced 0.004. Because all significance values were below the threshold of 0.05, the Reason aspect data were likewise determined to be non-normally distributed, and thus analyzed using nonparametric methods. (3) The Shapiro–Wilk significance values for the Inference aspect in the experimental class were 0.000 for both pretest and posttest. In the control class, the pretest value could not be computed by SPSS due to a standard deviation of 0.00, while the posttest produced a value of 0.006. As all computable significance values remained below 0.05, the Inference aspect data were concluded to be non-normally distributed. Consequently, nonparametric statistical analyses were applied.

The results of the homogeneity test are presented in Table 10 and show the following: (1) The Focus aspect yielded a Levene statistic of 6.232 with a significance value of 0.001, indicating that the data were not homogeneous (sig < 0.05) and must therefore be analyzed using nonparametric methods. (2) The Reason aspect produced a Levene statistic of 78.697 with a significance value of 0.000, also indicating non-homogeneous data. (3) The Inference aspect produced a Levene statistic of 65.387 with a significance value of 0.000, confirming that the data were not homogeneous and must be analyzed nonparametrically.

Based on the results of the prerequisite tests, it is concluded that the data do not meet the assumptions for parametric testing; therefore, the study proceeds with nonparametric hypothesis testing. The hypotheses tested were: Ha1 = There is an effect of PBL-based LKPD assisted by Wordwall media on students' critical thinking ability in the Focus aspect in Grade V Science learning; Ha2 = There is an effect of PBL-based LKPD assisted by Wordwall media on students' critical thinking ability in the Reason aspect in Grade V Science learning; and Ha3 = There is an effect of PBL-based LKPD assisted by Wordwall media on students' critical thinking ability in the Inference aspect in Grade V Science learning.

Hypothesis testing was conducted using the Mann–Whitney test, followed by an N-Gain analysis to determine the effectiveness of the PBL-based LKPD assisted by Wordwall media in improving students' critical thinking ability in the experimental and control classes. The results of the hypothesis testing are presented in the following section.

Table 11. Mann Whitney Test Result

Aspect	Class	N	Mean Rank	Mann Whitney U	Asymp sig 2 Tailed
Focus	Experiment	20	28.00	50.00	0.000
	Control	20	13.00		
Reason	Experiment	20	28.00	50.00	0.000
	Control	20	13.00		
Inference	Experiment	20	28.00	70.00	0.000
	Control	20	13.00		

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Table 12. N-Gain Test Result

Aspect	Class	N	N-Gain Score	% N-Gain	Interpretation
Focus	Experiment	20	1.00	96.70	High
	Control	20	0.39	39.33	Moderate
Reason	Experiment	20	0.90	87.90	High
	Control	20	0.40	40.00	Moderate
Inference	Experiment	20	0.80	79.30	High
	Control	20	0.37	37.00	Moderate

Tables 11 and 12 show the following results: (1) For the Focus aspect, the Asymp. Sig. (2-tailed) value was 0.000, which is below 0.05. Therefore, Ha1 is accepted. The N-Gain score in the experimental class was 1.00, categorized as high, indicating an effective improvement, while the control class obtained an N-Gain score of 0.39, categorized as moderate and thus considered ineffective. Given the significant difference between the two groups, it can be concluded that PBL-based LKPD assisted by Wordwall media has a significant effect on students' critical thinking skills in the Focus aspect in Grade V Science learning. Hence, the use of PBL-based LKPD supported by Wordwall media is effective in enhancing students' Focus-related critical thinking skills. (2) For the Reason aspect, the Asymp. Sig. (2-tailed) value was 0.000 < 0.05, indicating acceptance of Ha2. The experimental class achieved an N-Gain score of 0.90 (high), categorized as effective, whereas the control class obtained a score of 0.40 (moderate), categorized as ineffective. Because a significant difference was found, it can be concluded that PBL-based LKPD assisted by Wordwall media significantly influences students' critical thinking ability in the Reason aspect. Thus, the implementation of PBL-based LKPD with Wordwall media is effective in improving students' Reason-related critical thinking skills in Grade V Science learning. (3) For the Inference aspect, the Asymp. Sig. (2-tailed) value was 0.000, which is below 0.05; therefore, Ha3 is accepted. The N-Gain score for the experimental class was 0.80 (high), categorized as effective, while the control class achieved a score of 0.36 (moderate), categorized as ineffective. Because the observed differences were significant, it can be concluded that PBL-based LKPD assisted by Wordwall media has a significant effect on students' critical thinking skills in the Inference aspect. Accordingly, the use of PBL-based LKPD supported by Wordwall media is effective in enhancing students' Inference-related critical thinking skills in Grade V Science learning.

The qualitative descriptive analysis further supports these findings. Based on the results obtained, students demonstrated measurable improvement in critical thinking skills across the Focus, Reason, and Inference aspects. This improvement is presented in the table below.

Table 13. Measurement of The Focus, Reason, and Inference Aspects

Aspect	Pretest Average	Posttest Average	N-Gain
Focus	33,12	97.50	1.00
Reason	34,97	92.50	0.90
Inference	42,00	88.00	0.79

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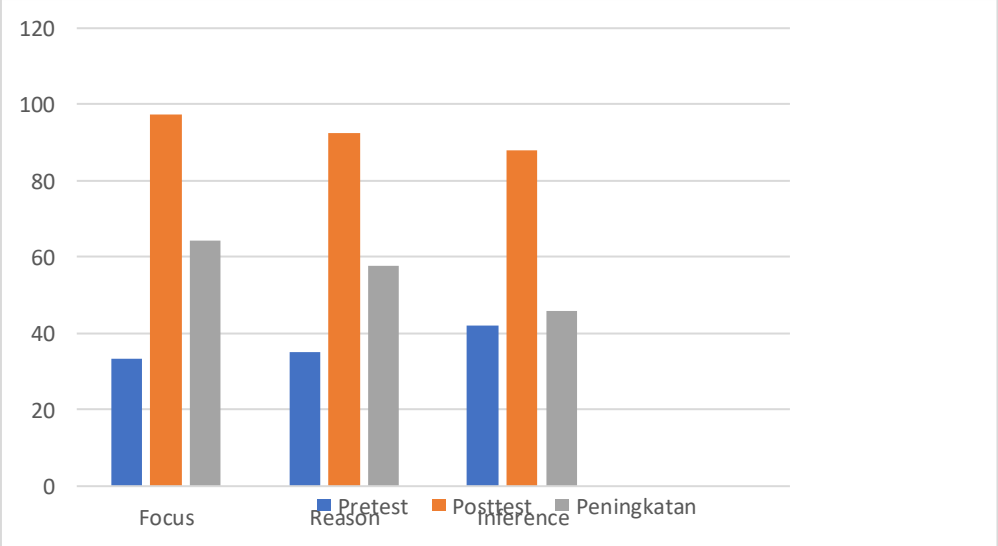

Figure 1. Measurement of The Focus, Reason, and Inference Aspects Graph

Based on the data presented above, it can be concluded that students demonstrated improvement in the Focus aspect of critical thinking. The pretest mean score of 33,12 increased to 97.50 in the posttest, with an N-Gain value of 1.00. In the Reason aspect, students obtained an average pretest score of 34,97, which increased to 92.50 in the posttest, yielding an N-Gain value of 0.90. Further improvement was observed in the Inference aspect, where the pretest mean score of 42,00 increased to 88.00 in the posttest, with an N-Gain value of 0.79.

Subsequently, a correlation analysis was conducted, beginning with a normality test using the MANOVA method, followed by a homogeneity assessment based on Levene's test for each aspect, and a hypothesis test using the Spearman rank method. The results of these analyses are presented in Table 14.

Table 14. Normality Test for Corelation Aspects

Aspect	Dd	Sig
Focus	20	0.000
Reason	20	0.000
Inference	20	0.000

Based on the results of the normality test, the significance value obtained was 0.000 < 0.05, indicating that the data are not normally distributed.

Table 15. Lavene Test

Aspect	Dd	Sig
Aspect	**Lavene Statistic**	**Sig**
Focus	1.92	0.174
Reason	18.48	0.000

Based on the data presented in the table above, the significance value for the Focus aspect was 0.174, while the Reason and Inference aspects showed significance values of 0.000. Thus, it can be concluded that only the Focus aspect has a significance value greater than 0.05 and is therefore homogeneous, whereas the Reason and Inference aspects, with significance values below 0.05, are classified as non-homogeneous.

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Table 16. Nonparametric Test Used Spearman Rank

	Result (N=20)	Focus Aspect	Reason Aspect	Inference Aspect
Focus	Correlation Coefficient	1.000	0.865	0.854
	Sig. (2-tailed)	0.000	0.000	0.854
Reason	Correlation Coefficient	0.865	1.000	0.911
	Sig. (2-tailed)	0.000	0.000	0.000
Inference	Correlation Coefficient	0.854	0.911	1.000
	Sig. (2-tailed)	0.000	0.000	0.000

Based on the data presented above, the total number of observations (N) is 20. The table also shows that the Sig. (2-tailed) values for the critical thinking aspects of Focus, Reason, and Inference are all 0.000. According to the decision criteria described earlier, these results indicate a statistically significant correlation among the Focus, Reason, and Inference dimensions of critical thinking. The output further demonstrates that the correlation coefficient for the Focus aspect is 1.000, which is interpreted as *very strong*. The Reason aspect has a correlation coefficient of 0.865, also categorized as *very strong*, while the Inference aspect yields a coefficient of 0.854, likewise classified as *very strong*. These findings indicate that the relationships among the Focus, Reason, and Inference aspects of critical thinking are consistently very strong.

Discussion

This study has several limitations. First, the research was conducted in only one elementary school with a relatively small sample size, which may limit the generalizability of the findings. Second, the study focused only on three dimensions of critical thinking: focus, reason, and inference. Future studies are recommended to investigate other dimensions of critical thinking and involve larger samples across different educational contexts.

Learning Activity Sheets (LKPD) function as instructional materials that assist students in understanding learning concepts while simultaneously supporting their development of autonomy (Muktadir, 2023). Through the use of PBL-based LKPD supported by Wordwall media on the topic of the human digestive system, students are encouraged to engage actively in the learning process, which enhances overall learning engagement. Students' positive responses to the PBL-based LKPD are evident in their interaction with the guiding questions delivered through Wordwall, which promote their *focus* in understanding the human digestive system and enable them to articulate appropriate responses.

The Focus aspect of critical thinking is characterized by students' ability to identify the problem presented in the task. Once students demonstrate proficiency in the Focus aspect, the next dimension examined is the Reason aspect, which is reflected in students' ability to make decisions based on logical reasoning and the information they have gathered. After students meet the requirements of the Reason aspect, assessment proceeds to the Inference aspect. At this stage, students are expected to draw conclusions using appropriate and relevant reasoning aligned with the questions provided.

The improvement in students' critical thinking skills may be attributed to the interactive characteristics of Wordwall media combined with the problem-solving orientation of the PBL model. Through problem-based activities, students were encouraged to identify problems, analyze information, provide logical reasons, and

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formulate conclusions independently. Furthermore, the gamified features of Wordwall increased students' engagement and motivation during the learning process. These findings are consistent with previous studies conducted by Dzikrullah and Rahmawati (2025) and Profithasari et al. (2024), which reported that Wordwall-assisted learning can improve students' critical thinking skills and learning participation.

CONCLUSION

This study demonstrates that PBL-based LKPD assisted by Wordwall media significantly improves fifth-grade students' critical thinking skills in science learning. Significant differences between the experimental and control groups were identified through the Mann–Whitney test, while the N-Gain analysis indicated higher learning effectiveness in the experimental group. The findings also revealed very strong relationships among the Focus, Reason, and Inference dimensions of critical thinking.

The findings suggest that integrating PBL-based LKPD with Wordwall provides an effective instructional approach for promoting student-centered science learning. Combining problem-based activities with interactive digital media encourages students to identify problems, justify their reasoning, and formulate logical conclusions, thereby strengthening critical thinking skills. This approach can serve as a practical alternative for elementary teachers seeking to implement technology-supported active learning.

This study was conducted in a single elementary school using a relatively small sample consisting of one experimental class and one control class. Therefore, the findings should be interpreted cautiously and should not be generalized to broader educational contexts without further empirical verification. In addition, this research examined only three dimensions of critical thinking (Focus, Reason, and Inference), while other dimensions of the FRISCO framework were beyond the scope of this study.

Future studies are recommended to involve larger and more diverse samples from different schools and regions to improve the generalizability of the findings. Further research should also investigate additional dimensions of critical thinking and compare the effectiveness of Wordwall-assisted PBL with other digital learning platforms across different science topics and educational levels.

REFERENCES

Abduh, M. (2019). *Panduan penulisan soal HOTS–Higher Order Thinking Skills*.

Agusdianita, N. (2023). Pendampingan penerapan model Problem Based Learning (PBL) untuk mengembangkan kemampuan pemecahan masalah siswa kelas III SDN 01 Kota Bengkulu. *Social, Humanities, and Educational Studies (SHES): Conference Series*, *6*(4). https://doi.org/10.20961/shes.v6i4.83120

Agusdianita, N., Winarni, E. W., Muktadir, A., & Juarsa, O. (2025). *Analisis kebutuhan pengembangan bahan ajar pemecahan masalah matematika pendidikan dasar untuk meningkatkan kemampuan pemecahan masalah pada mahasiswa pendidikan dasar*.

Agustin, D. A. (n.d.). *Mengajarkan SAINS dengan permainan*. TATA AKBAR.

Alfares. (2025). Investigating the efficacy of Wordwall platform in enhancing vocabulary learning in Saudi EFL classroom. *International Journal of Game-Based Learning, 15*(1). https://doi.org/10.4018/IJGBL.367870

Almahira, A. R. (2024). *Perkembangan berpikir matematis pada anak usia sekolah dasar*.

Andi Asari, Purba, S., Fitri, R., & Genua, V. (2023). *Media pembelajaran era digital*. CV Istana Agency.

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 5, September 2026
Page 893-911

Anggraeni, D. M., Prahani, B. K., Suprapto, N., Shofiyah, N., & Jatmiko, B. (2023). Systematic review of Problem Based Learning research in fostering critical thinking skills. *Thinking Skills and Creativity, 49*, 101334. https://doi.org/10.1016/j.tsc.2023.101334

Anwar, I., Rohmani, L. A., & Putra, A. A. I. A. (2023). Peningkatan berpikir kritis siswa SMP dalam pembelajaran SCIENCE LEARNING melalui model pembelajaran Problem Based Learning. *Jurnal Jendela Pendidikan, 3*(01). https://doi.org/10.57008/jjp.v3i01.430

Ardila, I., Nuryasin, M. J., Cahya, N., Nida, N. A., & Ashilah, H. (2023). Meningkatkan motivasi belajar siswa melalui media pembelajaran Wordwall di SMA Negeri 1 Ciruas. *Innovative Journal*. https://j-innovative.org/index.php/Innovative/article/view/6906/4976

Ariyana, Y., Pudjiastuti, A., Bestari, R., & Zamaruni. (2018). *Buku pegangan pembelajaran berorientasi pada keterampilan berpikir tingkat tinggi*. Direktorat Jenderal Guru dan Tenaga Kependidikan, Kementerian Pendidikan dan Kebudayaan.

Astutik, F. (2023). *Integrasi model Problem Based Learning pada pembelajaran berdiferensiasi di sekolah dasar untuk mewujudkan school well-being di era Merdeka Belajar*. Penerbit NEM.

Badalu, A. R., & Astutik, E. P. (2024). *Analisis kemampuan berpikir kritis siswa dengan kemampuan matematika tinggi dalam memecahkan masalah barisan dan deret*.

BSKAP. (2024). *Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi*.

BSKAP. (2025). *Kementerian Pendidikan Dasar dan Menengah*.

Damayanti. (2021). *Penggunaan media audio visual dalam meningkatkan hasil belajar akidah akhlak pada peserta didik kelas IV SDN 33 Lebong*. CV Tatakata Grafika.

Dasusmi, K. J., Destami, L., Mardiana, M., Shobah, M. D., & Muhibbatuzzaeniah, M. (2023). Studi literatur: Model Problem Based Learning (PBL) untuk meningkatkan kemampuan berpikir kritis matematis. *Griya Journal of Mathematics Education and Application, 3*(2), 325–334. https://doi.org/10.29303/griya.v3i2.319

Djaali. (2021). *Metodologi penelitian kuantitatif*. Bumi Aksara.

Dzikrullah, M. T., & Rahmawati, F. (2025). Pengaruh model pembelajaran Problem Based Learning berbantuan media Wordwall terhadap kemampuan berpikir kritis siswa program keahlian manajemen perkantoran kelas X di SMK Ketintang Surabaya. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 10*(02), 290–307. https://doi.org/10.23969/jp.v10i02.28988

Erviana, V. Y., Sulisworo, D., Robi'in, B., & Afina, E. R. N. (2022). *Problem Based Learning berbantuan virtual reality*. K-Media.

Fadilla, N., Nurlaela, L., Rijanto, T., Ariyanto, S. R., Rahmah, L., & Huda, S. (2021). Effect of problem-based learning on critical thinking skills. *Journal of Physics: Conference Series, 1810*(1), 012060. https://doi.org/10.1088/1742-6596/1810/1/012060

Fadiyah, H., Kurnianti, E. M., & Hasanah, U. (2024). Studi literatur: Peningkatan kemampuan berpikir kritis siswa sekolah dasar melalui media digital. *Didaktik: Jurnal Ilmiah PGSD STKIP Subang, 10*(2). https://doi.org/10.36989/didaktik.v10i2.2968

Faradillah, A., Hadi, W., & Soro, S. (2020). *Evaluasi proses dan hasil belajar (EPHB) matematika dengan diskusi dan simulasi (DiSi)*. Uhamka Press.

Fatima, H., Sulistyowati, P., & Sakdiyah, S. H. (2025). The effect of educational game-based learning media using Wordwall on students' social studies learning outcomes in grade V. *International Conference on Technopedagogy and Local Wisdom, 1*(1), 320–325.

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 5, September 2026
Page 893-911

Halim, A. (2022, March 1). Signifikansi dan implementasi berpikir kritis dalam proyeksi dunia pendidikan abad 21 pada tingkat sekolah dasar. *Journal of Islamic Studies and Thought*, *3*(3). https://doi.org/10.36418/jist.v3i3.385

Halimah, S., Usman, H., & Maryam, S. (2023). Peningkatkan kemampuan berpikir kritis dalam pembelajaran SCIENCE LEARNING melalui penerapan model pembelajaran Problem Based Learning (PBL) di sekolah dasar. *Jurnal Syntax Imperatif: Jurnal Ilmu Sosial dan Pendidikan, 3*(6), 403–413. https://doi.org/10.36418/syntax-imperatif.v3i6.207

Hamidulloh, I., Ahmad, M., Maratussolicah, & Fadhilah, T. D. (2023). *Media game digital SD/MI berbasis karakter P5 dan PPRA*. Mata Kata Inspirasi.

Handayani, N., Winarni, E. W., & Susanta, A. (2024). Pengaruh penerapan lembar kerja peserta didik (LKPD) berbasis Problem Based Learning (PBL) pada pembelajaran SCIENCE LEARNING dengan materi siklus air terhadap kemampuan berpikir kritis siswa kelas V SD.

Harahap, S. P. R., Andrian, F., & Annisah, S. (2024). Efektivitas media interaktif dalam meningkatkan kemampuan berpikir kritis siswa pada pembelajaran SCIENCE LEARNING. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 9*(1). https://doi.org/10.23969/jp.v9i1.12596

Hardani, Andriani, Ustiawaty, J., & Utami, E. F. (2020). *Metode penelitian kualitatif dan kuantitatif*. Pustaka Ilmu.

Haryanto, C. C., & Kusmiyati, K. (2022). Analisis penerapan model pembelajaran Problem Based Learning dalam meningkatkan kemampuan berpikir kritis siswa sekolah dasar. *TEACHING: Jurnal Inovasi Keguruan dan Ilmu Pendidikan, 2*(3). https://doi.org/10.51878/teaching.v2i3.1664

Hayati, R., Ersani, E., Darwiyanti, A., Akbar, S., Hadikusumo, R. A., Hamda, E. F., Simanungkalit, L. N., Missouri, R., Winarsih, S., Priyanti, N. Y., Syarifah, T., Suyitno, M., Wardoyo, T. H., Hatiningsih, N., Ariantara, R. G., Nurdini, Isminarti, Talindong, A., & Azizah, H. N. (2025). *Pengembangan bahan ajar*. Sada Kurnia Pustaka.

Herman, T., Andini, M., Nurhanifah, N., & Wulandari, I. (2024). *Kemampuan berpikir matematis: Berpikir relasional, berpikir fungsional dan berpikir kritis*. Indonesia Emas Group.

Hikmah, N. (2020). *Perkembangan peserta didik sekolah dasar*. Kaaffah Learning Center.

Huda, N. H., & Ikhsan, J. (2024). *Menggugat metode ceramah dalam pendidikan: Meluruskan fitnah mengusulkan paradigma baru*. CV Jejak (Jejak Publisher).

Jaya, I. M. L. M. (2020). *Metode penelitian kuantitatif dan kualitatif: Teori, penerapan, dan riset nyata*. Anak Hebat Indonesia.

Jumhur, A. A., Avianti, R. A., Nurfitri, P. E., & Mahir, I. (2024). Implementation of problem-based learning to improve critical thinking ability of vocational students in Jakarta. *European Journal of Education and Pedagogy, 5*(5), 16–24. https://doi.org/10.24018/ejedu.2024.5.5.860

Khairi, A. I. (2025). Development of Wordwall educational game-based learning media for social studies learning materials. *Entita: Jurnal Pendidikan Ilmu Pengetahuan Sosial dan Ilmu-Ilmu Sosial*. https://ejournal.iainmadura.ac.id/index.php/entita/article/view/19189

Koerniawati, T. (2020). *Model pembelajaran kooperatif Team Assisted Individualization (TeAssInd) berbantu LKPD untuk pemecahan masalah jarak pada ruang dimensi tiga*. Penerbit Adab.

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 5, September 2026
Page 893-911

Kosasi, E. (2021). *Pengembangan bahan ajar*. Bumi Aksara.

Kristanto, A. (2016). *Media pembelajaran*. Bintang Surabaya.

Kusumawati, N. (2022). *Pembelajaran SCIENCE LEARNING di sekolah dasar*. CV Ae Media Grafika.

Lestari, S., & Sari, R. P. (2024). Implementasi pembelajaran berbasis proyek dalam pengembangan kemampuan berpikir kritis peserta didik SMP. *Jurnal Review Pendidikan dan Pengajaran, 7*(1), 2004–2011. https://doi.org/10.31004/jrpp.v7i1.25615

Lismaya, L. (2019). *Berpikir kritis & PBL (Problem Based Learning)*. Media Sahabat Cendekia.

Luthfi, H. M., & Guntur, N. (n.d.). *Biostatistika: Aplikasi teori dan praktik pada penelitian biologi*. Muhammadiyah University Press.

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica, 22*(3), 276–282.

Mesra, R. (2023). *Strategi pembelajaran abad 21*. Open Science Framework. https://doi.org/10.31219/osf.io/ec6du

Minarti, I. B., Nurwahyunani, A., Anisa, L. N., Widodo, D. K., Kusumaningtyas, R. C., Septiani, F. D., Putri, O. D., Wijaya, A. T., & Savitri, S. A. (2023). Pengaruh model pembelajaran PBL dalam mengembangkan berpikir kritis, keaktifan, dan hasil belajar siswa. *NUMBERS: Jurnal Pendidikan Matematika & Ilmu Pengetahuan Alam, 1*(3).

Miranda, K. D. R., Firmansyah, A., & Putri, A. E. (2024). Pengaruh penggunaan E-LKPD berbasis Problem-Based Learning terhadap kemampuan berpikir kritis peserta didik. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK), 1*(1). https://doi.org/10.26418/jppk.v1i01.87280

Mudrikah, S., Pahleviannur, M. R., Surur, M., Rahmah, N., Siahaan, M. N., Wahyuni, F. S., Zakaria, Widyaningrum, R., Saputra, D., Prihastari, E. B., Ramadani, S. D., & Nurhayati, R. (2021). *Perencanaan pembelajaran di sekolah: Teori dan implementasi*. Pradina Pustaka.

Mudrikah, S., Pahleviannur, M. R., Surur, M., Rahmah, N., & Siahaan, M. N. (2021). *Perencanaan pembelajaran di sekolah: Teori dan implementasi*. CV Pradina Pustaka Group.

Muktadir, A. (2023). Pengembangan LKS Matematika berbasis Problem Based Learning (PBL) untuk siswa kelas V sekolah dasar. *Jurnal Pembelajaran dan Pengajaran Pendidikan Dasar, 6*(1), 16–29. https://doi.org/10.33369/dikdas.v6i1.12088

Mulyawati, Y., & Elizabeth, Y. (2023). Development of maze case games based on word walls on the theme "My Heroes" to improve elementary school students' critical thinking ability. *[Journal name missing], 7*(1).
(Note: Please provide the journal name for full APA accuracy.)

Muslimin, M., & Purwaningsih, E. (2023a). Meta-analisis: Pengaruh LKPD berbasis PBL terhadap kemampuan berpikir kritis dan pemecahan masalah dalam fisika. *Jurnal Pendidikan Matematika dan Sains, 11*(2), 38–45. https://doi.org/10.21831/jpms.v11i2.49407

Muslimin, M., & Purwaningsih, E. (2023b). Meta-analisis: Pengaruh LKPD berbasis PBL terhadap kemampuan berpikir kritis dan pemecahan masalah dalam fisika. *Jurnal Pendidikan Matematika dan Sains, 11*(2), 38–45. https://doi.org/10.21831/jpms.v11i2.49407
(Duplicate entry retained because you listed "a" and "b".)

Natanael, S., & Yonathan. (2013). *Mahir menggunakan SPSS secara otodidak*. Elex Media Komputindo.

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 5, September 2026
Page 893-911

Octavia, E., & Satianingsih, R. (2024). Pengaruh media digital Wordwall berbasis web terhadap kemampuan berpikir kritis pada mata pelajaran IPS di sekolah dasar. *INDOPEDIA: Jurnal Inovasi Pembelajaran dan Pendidikan, 2*(1).

Ostby, R. (2022). *The impact of problem-based learning on students' critical thinking skills and peer relationships* [Master's thesis, Minnesota State University Moorhead]. https://red.mnstate.edu/thesis/680

Paling, S., Sepling, F., Fatqurhohman, A. M., Yati, M. A., & Susetyo, A. M. (2024). *Media pembelajaran digital*. CV Tohar Media.

Pamungkas, T. (2020). *Model pembelajaran berbasis masalah (Problem Based Learning)*. GUEPEDIA.

Permendikbudristek No. 16 Tahun 2022. (2022). *Database Peraturan | JDIH BPK*. http://peraturan.bpk.go.id/Details/224238/permendikbudriset-no-16-tahun-2022

Pin, L., Luarn, P., & Chen, C. C. (2023). Enhancing intrinsic learning motivation through gamification: A self-determination theory perspective. *International Journal of Information and Learning Technology, 40*(5), 413–424. https://doi.org/10.1108/IJILT-07-2022-0145

Prastowo, A. (2015). *Panduan kreatif membuat bahan ajar inovatif*. DIVA Press.

Profithasari, N., Lutfiani, U. I., & Rapani, R. (2024). Efektivitas Brain-Based Learning berbantuan Wordwall terhadap kemampuan berpikir kritis peserta didik. *Jurnal Studi Guru dan Pembelajaran, 7*(1). https://doi.org/10.30605/jsgp.7.1.2024.3841

Rachmawati, D. W., Ghozali, M. I. A., Nasution, B., Firmansyah, H., Asiah, S., Ridho, A., Damayanti, I., Siagian, R., Aradea, R., Marta, R., Syarif, M., Kusmiran, Y., Surya, Y. F., & Kusuma, Y. Y. (2021a). *Teori & konsep pedagogik*. Penerbit Insania.

Rachmawati, D. W., Ghozali, M. I. A., Nasution, B., Firmansyah, H., Asiah, S., Ridho, A., Damayanti, I., Siagian, R., Aradea, R., Marta, R., Syarif, M., Kusmiran, Y., Surya, Y. F., & Kusuma, Y. Y. (2021b). *Teori & konsep pedagogik*. Penerbit Insania.

Rachmawati, D. W., Ghozali, M. I. A., Nasution, B., & Firmansyah, H. (2021). *Teori dan konsep pedagogik*. Insania.

Rachmawati, R., Wijayanti, R., & Kartika, E. D. (2021). *Media mobile learning pada matematika: Berbasis pendidikan karakter dalam menunjang revitalisasi SMK*. Media Nusa Creative (MNC Publishing).

Rahayu, S., Harianingsih, L., Lestari, W., Andaryani, E. T., & Subali, B. (2024). Analisis kebutuhan e-LKPD berbasis edugames Wordwall SCIENCE LEARNING materi bagian tumbuhan untuk meningkatkan kemampuan bernalar kritis peserta didik sekolah dasar. *Jurnal Kajian Ilmiah Multidisipliner, 8*(6). https://oaj.jurnalhst.com/index.php/jkim/article/view/2263

Rahmat. (2024). *Pendidikan SCIENCE LEARNING di SD*. Nas Media Pustaka.

Riadah, R., Haryadi, R., & Guntara, Y. (2024). Penerapan LKPD berbasis problem based learning terhadap kemampuan berfikir kritis siswa kelas X pada materi energi terbarukan. *Jurnal Ilmiah Wahana Pendidikan, 10*(24).

Robiah, H., Ermiana, I., & Amrullah, L. W. Z. (2024a). Pengembangan LKPD SCIENCE LEARNING berbasis problem based learning pada materi suhu dan kalor untuk meningkatkan kemampuan berpikir kritis siswa kelas V SDN 43 Ampenan. *Jurnal Pendidikan, Sains, Geologi, dan Geofisika (GeoScienceEd Journal), 5*(4), 957–966. https://doi.org/10.29303/goescienceed.v5i4.457

Robiah, H., Ermiana, I., & Amrullah, L. W. Z. (2024b). Pengembangan LKPD SCIENCE LEARNING berbasis problem based learning pada materi suhu dan kalor untuk

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 5, September 2026
Page 893-911

meningkatkan kemampuan berpikir kritis siswa kelas V SDN 43 Ampenan. *Jurnal Pendidikan, Sains, Geologi, dan Geofisika (GeoScienceEd Journal), 5*(4), 957–966. https://doi.org/10.29303/goescienceed.v5i4.457
(Duplicate entry retained with a/b labels as provided.)

Rohman, I. F., Anwar, A. S., & Nur'aeni, L. (2024). Pengaruh penggunaan media Wordwall dalam pembelajaran matematika terhadap kemampuan berpikir kritis di sekolah dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 9*(04). https://doi.org/10.23969/jp.v9i04.19104

Rosmana, P. S., Ruswan, A., Ilahi, A. M., & Fauziyah, D. R. (2024). Modifikasi LKPD berbasis Canva dalam meningkatkan motivasi belajar peserta didik. *Innovative: Journal of Social Science Research & Education*. https://j-innovative.org/index.php/Innovative/article/view/7608/5401

Saputra, R., Diandita, Y. N., & Zulfiati, H. M. (2023). *Pengembangan media pembelajaran berbasis web Google Sites pada pembelajaran IPS sekolah dasar*. Didaktik: Jurnal Ilmiah PGSD STKIP Subang, 9(2), Article 2. https://doi.org/10.36989/didaktik.v9i2.962

Sari, W. S. K., Fajriyah, K., Susilowati, A., & Rahmawati, N. D. (2024). *Analisis pembelajaran Problem Based Learning berbantuan Wordwall untuk mengembangkan collaborative skills pada mata pelajaran SCIENCE LEARNING kelas V SDN Tawangmas 01*. Economic and Education Journal (Ecoducation), 6(3), Article 3. https://doi.org/10.33503/ecoducation.v6i3.388

Setyo, A. A., Fathurahman, M., & Anwar, Z. (2020). *Model pembelajaran Problem Based Learning berbantuan software Geogebra untuk kemampuan komunikasi matematis dan self-confidence siswa SMA*. YAYASAN BARCODE.

Shen, X., & Teng, M. F. (2024). Three-wave cross-lagged model on the correlations between critical thinking skills, self-directed learning competency, and AI-assisted writing. *Thinking Skills and Creativity, 52*, 101524. https://doi.org/10.1016/j.tsc.2024.101524

Sihotang, K. (2019). *Berpikir kritis: Kecakapan hidup di era digital*. PT Kanisius.

Siswanti, A. B. (2023). *Problem Based Learning*. CV Andi Offset.

Siswanti, A. B., & Indrajit, R. E. (2023). *Problem Based Learning*. Penerbit Andi.

Sugiyono. (2017). *Metode penelitian kuantitatif kualitatif dan R&D*. Alfabeta.

Sulthoni, W. K., Fathani, A. H., & Walida, S. E. (2025). *Peningkatan kemampuan berpikir kritis matematis peserta didik kelas VII A MTs TMI Pujon melalui penerapan Problem Based Learning berbantuan media interaktif pada materi penyajian data*. Jurnal Penelitian, Pendidikan, dan Pembelajaran, 20(2), Article 2. https://jim.unisma.ac.id/index.php/jp3/article/view/27073

Suryani, L. (2023). *Media pembelajaran digital untuk usia dini*. CV Budi Utama.

Susanto, A. (2022). *Efektivitas pengajaran ekonomi berbasis Problem Based Learning (PBL)*. Indonesia Emas Group.

Syamsunie, C. (n.d.). *Metodologi penelitian kesehatan dan pendidikan*. Penebar Media Pustaka.

Tiara, V., Ninawati, N., Liska, F., Alya, R., & Barella, Y. (2024). *Menggali potensi Problem Based Learning: Definisi, sintaks, dan contoh nyata*. SOSIAL: Jurnal Ilmiah Pendidikan IPS, 2(2), 121–128. https://doi.org/10.62383/sosial.v2i2.153

Triana, N. (2021). *LKPD berbasis eksperimen: Tingkatkan hasil belajar siswa*. GUEPEDIA.

Wasidi. (2020). *Tes dan pengukuran pendidikan*. UNIB.

Widya, R. (n.d.). *Permainan tradisional berbasis multimedia*. Jejak Pustaka.

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IJORER, Vol. 7, No. 5, September 2026
Page 893-911

Winarni, E. (2018). *Metodologi penelitian*. Bumi Aksara.

Winarni, E. W. (2018a). *Pendekatan ilmiah dalam pembelajaran kreatif dan inovatif*. Unit Penerbitan FKIP UNIB.

Winarni, E. W. (2018b). *Penelitian kuantitatif, kualitatif, penelitian tindakan kelas (PTK), research and development (R&D)*. Bumi Aksara.

Zakia, L., & Lestari, I. (2019). *Berpikir kritis dalam konteks pembelajaran*. Erzatama Karya Abadi.

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