Sistem-Among :
Jurnal Pendidikan Sekolah Dasar
2025, 5(1), 34-42
https://doi.org/10.56393/sistemamong.v5i1.3516

The Effect of E-LKPD Liveworksheet-Assisted Problem Based Learning Models on the Critical Thinking Skills of Students in Grade V

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Article History
Received: 13 July 2025;
Revised : 14 October 2025;
Accepted: 27 October 2025.

Keywords
Problem-Based Learning;
e-LKPD;
Liveworksheet;
Critical Thinking.

Abstract
Critical thinking skills are essential competencies for students. However, elementary school students in Indonesia still show weaknesses in this aspect, as they tend to emphasize memorization. This study aims to examine the effect of the E-LKPD Liveworksheet-assisted Problem Based Learning model on the critical thinking skills of fifth-grade students in Natural and Social Sciences (IPAS). The study uses a quantitative approach with a quasi-experimental design of the Pretest-Posttest Nonequivalent Control Group Design. The research subjects involved 58 students from two elementary schools in Pamekasan Regency, divided into an experimental group and a control group. The instrument was a multiple-choice critical thinking test consisting of 10 items that had been validated and proven reliable. The data were analyzed using normality, homogeneity, N-Gain, and independent t-tests with the help of SPSS 22. The results showed that the experimental group obtained higher post-test scores (M = 77.86) and N-Gain (0.6179, medium-high category) compared to the control group (M = 55.67; N-Gain = 0.3513, medium category), with a significant difference ($p < 0.05$). These findings confirm that integrating PBL with E-LKPD Liveworksheet effectively improves critical thinking skills. The novelty of this study lies in the integration of PBL with interactive digital worksheets in elementary school science education. It contributes theoretically to the study of digital-based PBL and provides practical benefits for teachers in designing innovative, student-centered learning in the digital age.

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How to Cite : Sari, A. P., Sulistyowati, P., & Sakdiyah, S. H. (2025). The Effect of E-LKPD Liveworksheet-Assisted Problem-Based Learning Models on the Critical Thinking Skills of Students in Grade V. *Sistem-Among : Jurnal Pendidikan Sekolah Dasar*, 5(1), 34–42. https://doi.org/10.56393/sistemamong.v5i2.3516

Introduction

In the global era of the 21st century, critical thinking skills have become a key competency that students must possess in order to face complex challenges in the digital world. UNESCO (2015) emphasizes that critical thinking and problem-solving skills are an integral part of 21st Century Skills. The results of the OECD survey through the Programme for International Student Assessment (PISA) also show that Indonesian students are still below average in literacy, numeracy, and science, indicating weak higher-order thinking skills (OECD, 2019). According to Alfiyah (2020), critical thinking is the process of analyzing, evaluating, creating solutions, and drawing conclusions from a situation or problem. This is in line with the research by Sejati et al. (2023), which emphasizes that critical thinking must be integrated from an early age so that students are able to face the dynamics of the 21st century.

This condition is in line with the findings of Susilo and Atun (2017), which show that learning practices in elementary schools are still dominated by lecture and memorization methods, which do not support the development of critical thinking. Observations at PUBLIC ELEMENTARY SCHOOLKacok 2 Palengaan and PUBLIC ELEMENTARY SCHOOLBandaran 3 also reinforce this, where IPAS learning still emphasizes basic cognitive abilities (C1–C3) through the use of conventional worksheets. Consequently, students are inclined to be less active and are not yet guided towards analytical and evaluative skills (C4–C5).

Previous studies have shown that the Problem Based Learning model is effective in improving critical thinking skills. Nugroho (2024) found that the application of PBL in science education can enhance students' comprehension of concepts and critical thinking skills. On the other hand, digital learning media such as Liveworksheet-based e-LKPD have also been proven effective in increasing student participation and supporting interactive learning (Nur Hamidah et al., 2024). Harahap et al. (2024) added that Liveworksheet facilitates more contextual and engaging thematic learning for students. However, most studies still discuss PBL and e-LKPD separately, with few integrating the two as an integrated learning model.

Theoretically, this study contributes to enriching the international literature on the integration of PBLmodels with interactive digital media, which is relevant to global efforts to improve higher order thinking skills at the primary education level. In practical terms, this research offers innovative strategies for teachers to develop more contextual, interactive, and 21st-century-appropriate science and mathematics learning. Thus, this research is important not only in the Indonesian context but also as a contribution to the global literature on effective learning strategies for developing critical thinking skills in primary education.

Method

The study applied a quantitative approach through a quasi-experimental framework adopting a pretest-posttest nonequivalent control group design type (Sugiyono, 2019). The participants of this study were fifth-grade students enrolled at Public Elementary School Kacok 2 (28 students) and Public Elementary School 3 (30 students) in Pamekasan Regency, using a saturated sampling technique, resulting in a total sample of 58 students. The experimental group received instruction using the PBL model assisted by E-LKPD Liveworksheet, while the control group used the Discovery Learning model without e-LKPD. The research instruments consisted of 10 multiple-choice pretest and posttest questions compiled based on critical thinking skill

indicators (C4–C5) according to Bloom's Taxonomy and critical thinking indicators according to Ennis (Sanjaya, 2014). The instrument grid is presented in detail in the appendix. The instrument was tested for validity using Product Moment correlation with the criteria that the instrument is valid if Sig. < 0.05 and r count > r table (Sugiyono, 2019). Reliability was tested using Cronbach's Alpha, where an alpha value > 0.60 indicates a reliable instrument (Supriadi, 2019). The data were analyzed using SPSS 22 through normality testing (Shapiro-Wilk), homogeneity testing (Levene's Test), N-Gain calculations, and hypothesis testing with an independent sample t-test.

Results and Discussion

Result

This study aims to examine the effect of the e-LKPD-assisted PBL model based on Liveworksheet on the critical thinking skills of fifth-grade students. Data were obtained through critical thinking skill tests in the form of pre-tests and post-tests. Analysis was conducted through stages of validity, reliability, normality, homogeneity, hypothesis testing, and N-Gain testing.

Validity test, consisting of 40 questions (20 pretest and 20 posttest) was tested using Pearson Product Moment correlation with the help of SPSS 21 for Windows. The results showed that 10 questions were valid in the pretest and 10 questions were valid in the posttest (Sig. < 0.05).

Table 1. Validity Test

Question	Question number	Number	Category
Pretest	1,3,5,6,7,8,9,10,11,12	10	Valid
	2,4,13,14,15,16,17,18,19,20	10	Not valid
Posttest	1,2,3,4,5,6,9,11,12,13	10	Valid
	7,8,10,14,15,16,17,18,19,20	10	Not valid

Reliability test, the instrument was tested using Cronbach's Alpha with the help of SPSS 21 for Windows. The results showed a value of 0.872 (> 0.6), so the instrument can be categorized as reliable and suitable for use. The results of the pretest and posttest reliability tests are shown below.

Table 2. Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
.872	20

Normality testing was performed using the Shapiro-Wilk method. The pretest and posttest results in both the control and experimental classes showed a Sig. value > 0.05, indicating that the data was normally distributed.

Tabel 3. Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pretest	Control	.152	30	.075	.943	30	.109
	Experimen	.158	28	.070	.936	28	.089
Posttest	Control	.159	30	.051	.941	30	.094
	Experimen	.144	28	.142	.933	28	.074

a. Lilliefors Significance Correction

The homogeneity test was conducted using Levene's Test, which produced a Sig. value > 0.05 in both the pretest and posttest, indicating that the data had homogeneous variance.

Table 4. Test Homogeneity

		Levene Statistic	df1	df2	Sig.
Pretest	Based on Mean	.244	1	56	.623
	Based on Median	.190	1	56	.665
	Based on Median and with adjusted df	.190	1	55.958	.665
	Based on trimmed mean	.243	1	56	.624
Posttest	Based on Mean	.492	1	56	.486
	Based on Median	.399	1	56	.530
	Based on Median and with adjusted df	.399	1	54.877	.530
	Based on trimmed mean	.513	1	56	.477

Hypothesis Testing (T-Test) Hypothesis testing is a statistical procedure used to test the validity of a statement or assumption about a population based on sample data (Sugiyono, 2019). Hypothesis testing in this study was conducted using an independent t-test to determine the effect of the e-LKPD-assisted PBL model based on Liveworksheet on the critical thinking skills of fifth-grade students. The experimental group consisted of fifth-grade students at Public Elementary School Kacok 2, who received learning using the PBL model assisted by Liveworksheet e-LKPD interactive. Meanwhile, the control group consisted of fifth-grade students at Public Elementary School Bandaran 3, who received learning using the Discovery Learning model without using Liveworksheet-based e-LKPD.
Based on the results of the analysis using SPSS for Windows 21, the t-test results are as shown in the following table:

Table 5. Average Pretest and Posttest Scores

Type	Class	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Control	30	33.00	13.933	2.544
	Experimen	28	47.14	13.012	2.459
Posttest	Control	30	55.67	15.687	2.864
	Experimen	28	77.86	13.973	2.641

As shown in Table 6, the pretest obtained a Sig. (2-tailed) value of 0.000, indicating a result lower than the 0.05 significance level. Consequently, H_0 was rejected while H_1 was accepted., These results suggest that the experimental and control groups showed a statistically significant difference before the implementation of the treatment. The t-value for the pretest is -3.988 with degrees of freedom (df) = 56 and a mean difference of -14.143, indicating that the pretest mean of the experimental group (47.14) is statistically higher than that of the control group (33.00), even though neither group has received any learning treatment.

In the posttest, a Sig. (2-tailed) value of 0.000 was obtained, which is also less than 0.05, so H_0 was again rejected and H_1 was accepted. This means that there is a significant effect between the application of the E-LKPD Liveworksheet-assisted PBL model and students' critical thinking skills. The posttest t-value of -5.673 with df = 56 and a mean difference of -22.190 indicates that the average critical thinking skills of students in the experimental group (77.86) were significantly higher than those in the control group (55.67). The 95% confidence

interval for the posttest difference was in the range of -30.026 to -14.355, which did not cross zero, thus reinforcing the conclusion that the difference was significant.

Table 6. Hypothesis Testing

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Pre test	Equal variances assumed	.244	.623	-3.988	56	.000	-14.143	3.547	-21.248	-7.038
	Equal variances not assumed			-3.997	56.000	.000	-14.143	3.538	-21.231	-7.055
Post test	Equal variances assumed	.492	.486	-5.673	56	.000	-22.190	3.911	-30.026	-14.355
	Equal variances not assumed			-5.696	55.885	.000	-22.190	3.896	-29.995	-14.386

However, to determine the extent of improvement in student learning outcomes based on initial abilities, a more objective analysis using N-Gain calculations is required. N-Gain calculations are performed to assess the effectiveness of the treatment in improving critical thinking skills by comparing the difference between pretest and posttest scores normalized to the maximum achievable score.

In this study, the N-Gain value was used to measure the extent of improvement in students' critical thinking skills after participating in learning using the E-LKPD Liveworksheet-assisted PBLmodel. Based on the results of the analysis using the SPSS for Windows 21 program, the N-Gain test results were obtained as shown in the following table:

Table 7. Average N-Gain Scores

Group Statistics

	Value	N	Mean	Std.Deviation	Std.Error Mean
NGAIN	Experimen	28	.617	.18892	.03570
	Kontrol	30	.3513	.12684	.02316

Based on Table 7 of the descriptive analysis results in the Group Statistics table, it is known that the experimental group obtained an average N-Gain value of 0.6179 with a standard deviation of 0.18892, while the control group obtained an average N-Gain of 0.3513 with a standard deviation of 0.12684The higher average scores in the experimental group indicate that the application of the E-LKPD Liveworksheet-assisted PBLmodel provides better learning outcomes compared to learning using the Discovery Learning model applied to the control group. This difference was then analyzed further using a t-test to determine the significance of the difference.

Table 8. N-Gain test results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		t	Sig	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
NGAIN	Equal variances assumed	3.507	.066	6.347	56	.000	.26652	.04199	3.507	.066
	Equal variances not assumed			6.263	46.787	.000	.26652	.04256		

According to the independent samples t-test findings on the N-Gain data analysis, the average increase in learning outcomes in the experimental group was 0.6175 and in the control group was 0.3503. The significance value (Sig. 2-tailed) of the t-test was 0.000, which was less than the significance level of 0.05. Thus, it can be concluded that there is a significant difference in learning outcomes between the experimental group and the control group. The results demonstrate that integrating the PBL model with E-LKPD Liveworksheet contributes significantly to fostering fifth graders' critical thinking competence in IPAS learning. However, because the pretest results showed significant differences between the experimental and control groups, the interpretation of the treatment effect must be done with caution. Ideally, these initial differences could be controlled for with further analysis such as ANCOVA, but this study only used t-tests and N-Gain, which is a limitation of the study.

Discussion

Based on the results of data analysis, this study shows that the interactive E-LKPD Liveworksheet-assisted PBL model has a significant effect on improving the critical thinking skills of fifth-grade students in IPAS subjects. This can be seen from the posttest t-test and N-Gain results, which show a significant difference between the experimental group and the control group. The experimental group achieved a higher posttest score average (77.86) than the control group (55.67) and a higher N-Gain average (0.6179, medium-high category) than the control group (0.3513, medium category). These findings indicate that the application of PBL assisted by E-LKPD Liveworksheet is able to encourage students to be more active in identifying problems, analyzing information, and drawing logical conclusions.. This active involvement is in line with the characteristics of PBL, which places students at the center of learning (student-centered learning). The use of Liveworksheet-based e-LKPD further strengthens this involvement by providing visual stimuli, instant feedback, and higher interactivity compared to printed LKPD. However, the pretest results showed a significant difference between the two groups, which means that the initial abilities of the students were not entirely equal. This condition has the potential to affect the interpretation of the posttest results. Nevertheless, the N-Gain analysis, which takes into account the initial differences, still shows a significant improvement in the

experimental group. Thus, it can be concluded that the influence of the learning model is more strongly demonstrated by the consistency of the increase in scores, not just the final scores.

This limitation also provides room for reflection that in quasi-experimental research, initial ability bias cannot be completely avoided. This is in line with Sugiyono's (2019) view that quasi-experimental designs are indeed prone to group inequalities, so that the analysis emphasizes growth (gain) rather than absolute scoresThe results of this study are in line with the findings of Septonanto et al. (2024), which state that the application of PBL in elementary school students can significantly improve critical thinking skills. Additionally, Ajeng et al. (2025) showed that interactive PBL-based e-LKPD is highly valid and practical for training elementary school students' critical thinking skills. This demonstrates the consistency that the integration of innovative learning models with digital media has an impact positive impact on students' cognitive achievements in Indonesia. When compared with international literature, the results of this study are also in line with Hmelo-Silver's (2004) study, which confirms that PBL consistently improves problem-solving and critical thinking skills at various levels of education.

In addition, the OECD (2019) emphasizes that critical thinking skills are a key 21st-century competency that needs to be trained from primary education through PBL strategies. UNESCO (2015) even emphasizes that interactive ICT-based learning will support the realization of SDG4, namely quality education that encourages higher-order thinking skills. The findings of this study support this view by showing that the integration of PBL and E-LKPD Liveworksheet is capable of delivering learning that is relevant to the global challenges of the 21st century.

All in all, this study confirms that integrating the PBL model with E-LKPD Liveworksheet has a significant positive impact on students' critical thinking skills. These results are in line with Ennis's (1993) theory on the components of critical thinking and are reinforced by various domestic and international studies. Thus, this study is not only relevant in the local context (Pamekasan Regency) but also has global significance in supporting adaptive, interactive learning practices that are in line with the needs of 21st-century education.

This study has limitations due to significant differences in initial abilities (pretest) between the experimental and control groups. This makes it impossible to fully generalize the conclusions regarding the influence of the learning model as a causal relationship. Therefore, the results of this study are more accurately understood as a tendency that the E-LKPD Liveworksheet-assisted PBL model is more effective in improving critical thinking skills. Future research is recommended to use ANCOVA analysis to control for these initial differences.

Conclusion

The findings of this study indicate that implementing the PBL model supported by the e-LKPD Liveworksheet enhances students' critical thinking skills. Model based on Liveworksheet has a significant effect on improving the critical thinking skills of fifth-grade students in IPAS subjects. This finding contributes scientifically by showing that the integration of the PBL model and interactive digital media can create a more contextual and collaborative learning process that stimulates higher-order thinking skills. Practically, the results of this study can be used as a reference for educators in implementing technology-supported PBLto optimize 21st-century skills. Schools are expected to provide adequate technological infrastructure support, while future researchers are advised to expand the research objects and variables so that the results are more comprehensive and applicable.

Acknowledgments

Appreciation is extended to the principals, teachers, and fifth-grade students of Public Elementary School Kacok 2 Palengaan and Public Elementary School Bandaran 3 Pamekasan for their participation and cooperation during the data collection process. Gratitude is also expressed to colleagues and peers for their ideas and encouragement that greatly supported the completion of this article. Finally, special thanks are dedicated to the families who provided continuous motivation and moral support throughout the research process.

Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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