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THE EFFECT OF IMPLEMENTING A PROJECT BASED LEARNING MODEL BASED ON LOCAL WISDOM POTENTIAL ON CONCEPT UNDERSTANDING AT SMP NEGERI 3 AIR BATU

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Abstract

This study aims to analyze the effect of the Project Based Learning (PjBL) model based on local wisdom on the understanding of mathematical concepts of junior high school students. The background of this study departs from the need for a more contextual and meaningful learning model in improving mastery of basic mathematical concepts. The research method uses a quasi-experimental design with a Nonequivalent Control Group Design, involving two classes VIII in UPTD SMP Negeri 3 Air Batu, namely class VIII-B as the experimental group and VIII-C as the control group. Data collection instruments are in the form of pretest and posttest, which are then analyzed using N-Gain to determine the improvement in learning outcomes and Independent Sample t-Test to test significant differences between groups. The results showed that the experimental group that received PjBL learning based on local wisdom experienced a higher increase in understanding of mathematical concepts, with an average posttest score of 78.26 and N-Gain 0.52 (medium category). In contrast, the control group obtained an average of 66.82 with N-Gain 0.29 (low category). The t-test results showed a p-value <0.05, thus concluding that local wisdom-based PjBL significantly improved students' understanding of mathematical concepts. Therefore, this model is considered effective in creating relevant, contextual learning, and connecting mathematical concepts to students' daily lives.

Keywords: Project Based Learning, Local Wisdom, Concept Understanding

Abstrak

Penelitian ini bertujuan untuk menganalisis pengaruh model Project Based Learning (PjBL) berbasis kearifan lokal terhadap pemahaman konsep matematis siswa SMP. Latar belakang penelitian ini berangkat dari kebutuhan terhadap model pembelajaran yang lebih kontekstual dan bermakna dalam meningkatkan penguasaan konsep dasar matematika. Metode penelitian menggunakan kuasi-eksperimen dengan desain Nonequivalent Control Group Design, melibatkan dua kelas VIII di UPTD SMP Negeri 3 Air Batu, yaitu kelas VIII-B sebagai kelompok eksperimen dan VIII-C sebagai kelompok kontrol. Instrumen pengumpulan data berupa pretest dan posttest, yang kemudian dianalisis menggunakan N-Gain untuk mengetahui peningkatan hasil belajar serta Independent Sample t-Test untuk menguji perbedaan signifikan antar kelompok. Hasil penelitian menunjukkan bahwa kelompok eksperimen yang menerima pembelajaran PjBL berbasis kearifan lokal mengalami peningkatan pemahaman konsep matematis lebih tinggi, dengan nilai rata-rata posttest 78,26 dan N-Gain 0,52 (kategori sedang). Sebaliknya, kelompok kontrol memperoleh rata-rata 66,82 dengan N-Gain 0,29 (kategori rendah). Hasil uji t menunjukkan nilai p < 0,05, sehingga dapat disimpulkan bahwa PjBL berbasis kearifan lokal berpengaruh signifikan terhadap peningkatan pemahaman konsep matematis siswa. Dengan demikian, model ini dinilai efektif dalam menciptakan pembelajaran yang relevan, kontekstual, dan mampu menghubungkan konsep matematika dengan kehidupan sehari-hari siswa.

Kata kunci: Project Based Learning, Kearifan Lokal, Pemahaman Konsep.

INTRODUCTION

The development of mathematics learning in the 21st century emphasizes conceptual understanding, problem-solving (Ramadhani & Andhany, 2025); Numeracy literacy as core

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competencies required in the Independent Curriculum procedures (Sanjaya, 2008). These competencies are also assessed through international evaluations such as PISA and national assessments such as the Minimum Competency Assessment (AKM)) (Padang & Lubis, 2023). However, national and international studies consistently show that Indonesian students' mathematical proficiency remains low, particularly in tasks that require conceptual reasoning and contextual interpretation (Arsyad, 2010).

The 2022 PISA results place Indonesia at the lower ranks among participating countries, with a national average score far below the OECD benchmark (Ulfa Dwi Indriani, 2024). Only 18% of Indonesian students reached Level 2, the minimum level required to apply mathematical concepts in real-life contexts. The achievement disparities across regions and socioeconomic levels also highlight structural gaps in mathematics education. This can be seen in the following data:

Table 1. Indonesian National Data (PISA 2022 – Mathematics)

Category	Average Math Score
National overall	366
Rural areas	341,9 (Level 1b)
Lowest SES quintile (43%)	354
Highest SES quintile	~388 (354 + 34)
SES gap	34 poin (vs OECD: 93 poin)

Source: Student performance (PISA 2022)

These data indicate that Indonesian students face persistent difficulties in conceptual reasoning, model representation, and multistep problem-solving. Such findings underscore the need for innovative pedagogical approaches that strengthen conceptual understanding and adapt to students' local contexts.

Regional data provide further evidence of these challenges. In Asahan Regency, the numeracy index for junior high schools remains below the national average. Internal assessment results from UPTD SMP Negeri 3 Air Batu show that the average mathematics score for the 2024/2025 academic year is 62.4, which does not meet the Minimum Mastery Criteria (KKM) of 75. Student performance across classes is shown in the following table:

Table 2. Average Final Summative Mathematics Score for the Odd Semester of 2024/2025

Class 8.1		Class 8.2		Class 8.3	
Initials	Mark	Initials	Mark	Initials	Mark
NA	67,4	AGS	52	ASF	59,7
RH	62,3	SS	59,1	DE	71,9
TP	68,6	RY	64,3	RF	66,2

RI	75,6	P	54,2	NGF	49,3
I	61,5	LH	66,4	FAS	66
NAD	61,5	RC	58,6	HB	60,3
WS	76,1	MI	61,1	SWC	58
KBSM	69,6	DM	58,6	VDS	68,3
MH	59,7	EL	78,2	KM	71,7
MR	67,8	MA	63,3	RF	70,9
RM	59,7	SY	55	IF	56,7
ZW	59,7	IS	70	LP	60,9
NN	65,4	RS	53,7	QA	66,1
F	48,1	FS	65,1	NB	71,2
AA	49,6	S	47,7	DA	59,6
ASA	58,9	FD	52,8	ZV	61,9
AHF	55,3	UT	65	MN	54,6
LM	65,9	IU	69,3	F	53,8
RH	56,2	F	64,8	SD	69,9
AMSH	52,1	AM	62,5	MN	74,3
BS	75,1	NM	61	HN	62,8
V	61,6	XP	51,6	HB	71,4
			57,7		

Source: internal data from UPTD SMP Negeri 3 Air Batu

Based on the table, students' mastery of fundamental concepts—such as ratios, algebraic relationships, and contextual problem-solving—is still limited. Interviews with mathematics teachers confirmed that students struggle to connect symbolic procedures with contextual meaning. Item analysis also showed that more than half of students made conceptual interpretation errors, especially in multi-step questions requiring reasoning.

To address these learning difficulties, various studies have examined the use of Project-Based Learning (PjBL). Previous research has shown that PjBL can improve conceptual understanding, critical thinking, and active engagement. However, several research gaps remain. First, most studies focus on a single outcome variable rather than examining conceptual understanding in conjunction with contextual application. Second, PjBL research is predominantly conducted in urban schools with adequate resources, whereas semi-rural public schools such as SMP Negeri 3 Air Batu face different challenges in terms of facilities and learning culture. Third, few studies integrate PjBL with local wisdom-based projects that utilize local community potential as learning resources.

The novelty of this study lies in integrating PjBL with contextual activities based on local potential—specifically a project involving the processing of empty palm-oil bunches into compost. This project requires students to apply mathematical concepts of comparison, proportion, measurement, and representation within authentic and culturally relevant activities. Such an approach is expected to promote deeper conceptual understanding consistent with the principles of the Independent Curriculum and numeracy rubric indicators.

Therefore, this study aims to analyze the effect of implementing a local wisdom-based Project-Based Learning model on students' conceptual understanding at SMP Negeri 3 Air Batu. The findings are expected to contribute to the development of contextual mathematics learning models that are relevant to semi-rural school environments and support the improvement of conceptual understanding among junior high school students.

METHODS

This study employed a quantitative approach with a quasi-experimental design using the Nonequivalent Control Group Design. This design was selected because class groupings in the school had been predetermined administratively, making random assignment impossible. Although the researcher did not have full control over class placement, the design allowed valid comparisons between groups through the administration of pretest and posttest. The pretest was used to ensure the initial equivalence of the two groups, while the posttest measured changes after the treatment.

The population of this study consisted of all 173 students enrolled in grades VII–IX at UPTD SMP Negeri 3 Air Batu. Sampling was carried out using purposive sampling based on two criteria: (1) similarity of average academic performance in the previous semester, and (2) accessibility for intervention activities (Muhajirin, 2017). Class VIII-B was designated as the experimental group and received the local wisdom–based Project-Based Learning (PjBL) treatment, while class VIII-C served as the control group and received conventional instruction. Prior to treatment, the equivalence of both classes was verified through pretest scores and teacher evaluation reports.

The implementation of PjBL in the experimental group followed five structured phases: (1) Project Orientation, where students were introduced to the project theme "Processing Empty Palm-Oil Bunches into Compost"; (2) Planning, in which students formed small groups, identified required materials, and formulated steps based on mathematical concepts; (3) Project Execution, where students collected empty palm-oil bunches, measured materials, calculated proportions, and documented each stage; (4) Monitoring and Guidance, during which the teacher observed, facilitated discussions, and ensured correct application of mathematical concepts; and (5) Product Presentation and Reflection, in which students presented the compost results and explained their mathematical reasoning.

During the treatment, students used a specially developed Project-Based Student Worksheet (LKPD) designed around local wisdom activities. The LKPD guided students through tasks involving ratio calculations, measurement of material quantities, and determination of mixture proportions in the composting process. The instrument also included conceptual representation tasks aligned with the indicators of mathematical conceptual understanding.

The instrument used to measure conceptual understanding consisted of descriptive test items covering six indicators: restating concepts, classifying objects, providing examples and non-examples, presenting concepts in multiple representations, connecting concepts, and applying concepts in problem-solving. The test items were adapted to the topic of equivalent and inverse ratios and contextualized within the local wisdom theme. Instrument validation was conducted through expert judgment by three specialists in mathematics education, language, and learning media. Content validity was determined using the Content Validity Ratio (CVR), while reliability was assessed using Cronbach’s Alpha, with a minimum acceptable threshold of $\alpha > 0.70$.

Data collection consisted of three stages: pretest, treatment, and posttest. The pretest established baseline conceptual understanding, the treatment applied the PjBL or conventional method according to group assignment, and the posttest measured conceptual gains. Documentation such as photos, videos, and project activity notes was also collected to support the quantitative findings.

Data analysis began with descriptive statistics followed by prerequisite tests (normality and homogeneity). If assumptions were met, hypothesis testing was conducted using the Independent Sample t-Test at a significance level of 0.05. Learning effectiveness was further analyzed using Normalized Gain (N-Gain).

RESULTS AND DISCUSSION

a. Pretest Data Description

Pretest data was obtained before treatment was given to both groups to determine students' initial ability to understand mathematical concepts.

Table 3. Descriptive Statistics of Pretest Scores

Group	N	Mean	Std. Deviation	Variance	Min	Max
Experiment	23	54,35	8,42	70,89	38	70
Control	22	53,18	9,15	83,72	35	68

Source: Data processed 2025

The pretest results presented in Table 3 indicate that the experimental and control groups had relatively equivalent initial abilities. The experimental group had a mean score of 54.35, while the control group had a mean score of 53.18. These small differences demonstrate initial equivalence, which is essential for quasi-experimental research.

Table 4. Frequency Distribution of Pretest Scores

Value Interval	Category	Experiment	%	Control	%
80-100	Very high	0	0%	0	0%
70-79	Tall	2	8,7%	1	4,5%
60-69	Currently	7	30,4%	6	27,3%
50-59	Low	9	39,1%	10	45,5%
<50	Very Low	5	21,7%	5	22,7%
Total		**23**	**100%**	**22**	**100%**

Source: Data processed 2025

Table 4 shows that the majority of students in both groups were in the low category (50-59) with a percentage of 39.1% for the experimental group and 45.5% for the control group. No students reached the very high category in the pretest stage, indicating low initial ability in understanding mathematical concepts of students.

b. Posttest Data Description

Posttest data was obtained after treatment was given to the experimental group using a local wisdom-based PBL model, while the control group used conventional learning.

Table 5. Descriptive Statistics of Posttest Scores

Group	N	Mean	Std. Deviation	Variance	Min	Max
Experiment	23	78,26	7,84	61,47	62	92
Control	22	66,82	8,91	79,39	48	82

Source: Data processed 2025

After the implementation of the learning model, Table 5 shows that the experimental group achieved a considerably higher posttest average score (78.26) compared to the control group (66.82). This indicates a substantial improvement in the conceptual understanding of students in the experimental group.

Table 6. Frequency Distribution of Posttest Scores

Value Interval	Category	Experiment	%	Kontrol	%
80-100	Very high	12	52,2%	3	13,6%
70-79	Tall	8	34,8%	9	40,9%
60-69	Currently	3	13,0%	7	31,8%
50-59	Low	0	0%	2	9,1%
<50	Very Low	0	0%	1	4,5%
Total		**23**	**100%**	**22**	**100%**

Source: Data processed 2025

Table 6 shows that after treatment, 52.2% of students in the experimental group achieved the very high category, while only 13.6% in the control group achieved the very high category. No students in the experimental group were in the low or very low category, demonstrating the effectiveness of the local wisdom-based PBL model.

c. Gain Analysis (N-Gain)

To determine the increase in the ability to understand mathematical concepts, an N-Gain calculation was carried out using the formula:

$$N_{gain} = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

Table 7. N-Gain Analysis of Mathematical Concept Understanding

Group	Mean Pretest	Mean Posttest	N-Gain	%	Category
Experiment	54,35	78,26	0,52	52%	Medium
Control	53,18	66,82	0,29	29%	Low

Source: Data processed 2025

The improvement in conceptual understanding is summarized in Table 7. The experimental group obtained an N-Gain score of 0.52 (medium category), while the control group achieved only 0.29 (low category). This shows that students taught with the PjBL model experienced more meaningful learning progress compared to those taught conventionally.

d. Testing of Analysis Prerequisites

1) Normality Test

The normality test was carried out using the Kolmogorov-Smirnov test to determine whether the data was normally distributed.

Table 8. Results of Data Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Pretest Eksperimen	.256	23	.170
Pretest Kontrol	.329	22	.127
Posttest Eksperimen	.321	23	.208

Posttest Kontrol	.273	22	.151

a. Lilliefors Significance Correction

Source: Data processed 2025

Based on Table 8, the results of the data normality test using the Kolmogorov-Smirnov test obtained significance values (Sig.) for each group, both in the pretest and posttest stages. In the experimental group, the Kolmogorov-Smirnov significance value for the pretest was 0.170 and for the posttest was 0.208. Meanwhile, in the control group, the Kolmogorov-Smirnov significance value for the pretest was 0.127 and for the posttest was 0.151.

The decision-making criterion in the normality test is that if the significance value (Sig.) is greater than 0.05, the data are considered normally distributed. Conversely, if the significance value is less than 0.05, the data are not normally distributed. Based on the test results, all Kolmogorov-Smirnov significance values were greater than 0.05. Thus, it can be concluded that the data in the pretest and posttest variables for both the experimental and control groups are normally distributed.

2) Homogeneity Test

The homogeneity test is used to determine whether the variances of two or more groups of compared data are similar. This test is important to ensure that analysis of variance (e.g., the t-test) can be performed correctly.

Data is considered homogeneous if the significance value (Sig.) in the Levene's test is greater than 0.05. This indicates that there is no significant difference in variance between groups. The results of the Experimental class homogeneity test can be seen in the following table:

Table 9. Homogeneity Test

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Hasil	Based on Mean	.613	1	38	.438
	Based on Median	.813	1	38	.373
	Based on Median and with adjusted df	.813	1	35.651	.373
	Based on trimmed mean	.728	1	38	.399

Source: Data processed 2025

Based on Table 9, the significance value for Based on Mean is 0.438 > 0.05. Therefore, it can be concluded that the data variance in the experimental and control groups is homogeneous. This means that the homogeneity assumption is met, allowing for further analysis of differences.

3) Hypothesis Testing

Hypothesis testing was conducted using Paired Sample t-test using IBS SPSS Statistics 25 for Windows to determine the effect of implementing a project-based learning model based on local wisdom potential on conceptual understanding at SMP Negeri 3 Air Batu.

Table 10. Paired Samples Test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Confidence Interval of the Difference Lower	Confidence Interval of the Difference Upper			
Pair 1	PreTest - PostTest	23.15385	11.08186	3.07356	19.85055	6.45714	4.280	12	.000

Source: Data processed 2025

Based on the results of the Paired Samples Test (PTS), shown in Table 10, the mean difference between the pretest and posttest was 23.15, with a standard deviation of 11.08 and a standard error of 3.07. The 95% confidence interval (CI) indicates a lower limit of 6.46 and an upper limit of 19.85, indicating that the average difference in scores falls within this range. The calculated t-value is 4.280 with 12 degrees of freedom (df) and a 2-tailed significance level of 0.000.

Because the significance level is less than 0.05 ($p < 0.05$), it can be concluded that there is a significant difference between the pretest and posttest scores in the experimental class. Thus, the null hypothesis (H_0) stating that there is no effect of implementing a Project-Based Learning model based on local wisdom potential on students' conceptual understanding is rejected, and the alternative hypothesis (H_1) is accepted.

These results indicate that implementing a Project-Based Learning model based on local wisdom potential has a positive and significant impact on improving students' conceptual understanding at SMP Negeri 3 Air Batu. This means that project-based learning linked to local wisdom potential can help students connect learned concepts to real-life contexts, increase active engagement in the learning process, and deepen their understanding of the concepts taught.

e. Discussion

The findings of this study show that the Project-Based Learning (PjBL) model based on local wisdom provides meaningful improvement in students' conceptual understanding. The better performance of the experimental group suggests that students benefited from authentic learning experiences that required active engagement and problem solving. This is consistent with the constructivist perspective, which asserts that meaningful knowledge is formed when learners interact with real tasks and situations (Al-Tabany, 2015). Through direct involvement in planning and completing a project, students were exposed to learning conditions that supported deeper conceptual processing.

The contextual nature of the project—processing empty palm-oil bunches into compost—also contributed significantly to the results. Learning becomes more effective when students can connect mathematical ideas to their lived experiences, enabling them to see relevance and meaning in the content they learn. (Sengkey, Deniyanti Sampoerno, & Aziz, 2023) emphasizes that contextualization strengthens mathematical understanding because students reconstruct mathematical ideas from realistic situations. The local wisdom context used in this study therefore served not only as an instructional medium but also as a bridge between abstract mathematics and real-life problems.

These results are aligned with previous studies that confirm the advantages of PjBL in improving conceptual mastery. (Aida, Kusaeri, & Hamdani, 2017) found that project-oriented activities help students articulate mathematical reasoning and develop stronger conceptual networks. Similarly, . (Nasobandi, 2022) reported that PjBL encourages exploration and inquiry, allowing students to build understanding through discovery. (Maysarah, Saragih, & Napitupulu, 2023) further demonstrated that contextual project-based activities support mathematical literacy by engaging students in reasoning and decision-making. The consistency between these findings and the present study reinforces the reliability of PjBL as an effective instructional model.

Another explanation for the superior conceptual understanding in the experimental group lies in the collaborative nature of PjBL. Students were required to work in groups, negotiate ideas, evaluate alternative solutions, and justify their conclusions. Such interactions help learners refine their thinking and resolve cognitive conflicts (Meidianti, Kholifah, & Sari, 2022) highlights that social interaction plays a central role in the development of higher-order thinking. The dialogic and collaborative environment created through PjBL therefore contributed to the cognitive advantages experienced by students in the experimental group.

The structured phases of the PjBL model also played a key role in supporting students' conceptual development. During the phases of orientation, planning, execution, monitoring, and presentation, students were repeatedly exposed to processes that demanded representation, reasoning, and reflection. Representing ideas through diagrams, measurements, and written explanations supports conceptual understanding by linking symbols, procedures, and real-world meanings (Hasibuan, Rakhmawati, & Ulfa Hasanah, 2024). This type of representational thinking emerged naturally in the PjBL environment but was far less evident in conventional instruction.

From a practical standpoint, the findings of this study highlight the potential of integrating local wisdom into mathematics instruction. Using familiar materials from the local environment allows teachers to contextualize abstract concepts and increase student engagement. This approach aligns with the competencies emphasized in the Kurikulum Merdeka, particularly related to contextual learning, collaboration, and problem solving. Overall, the results indicate that the local wisdom–based PjBL model is an effective strategy for promoting conceptual understanding while simultaneously supporting broader educational competencies needed for real-life application.

CONCLUSION

Based on the results of data analysis, hypothesis testing, and discussion, the following conclusions can be drawn:

a. There is a significant effect of the implementation of the Project-Based Learning (PjBL) model based on local wisdom potential on students' mathematical conceptual understanding at SMP Negeri 3 Air Batu. The results of the Paired Sample t-test showed a significance value of 0.000 < 0.05, with a mean difference of 23.15 points between the pretest and posttest scores. This indicates that the implementation of PjBL can significantly improve students' conceptual understanding compared to conventional learning.
b. The PjBL model has proven more effective than conventional learning in improving students' learning outcomes and understanding of mathematical concepts. The increase in the N-Gain score of 0.52 in the experimental group (medium category) is significantly higher than the increase in the control group (0.29) (low category). This means that the implementation of PjBL can have a practical impact on improving students' mathematical learning outcomes..

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