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The Effect of the Implementation of Project-Based Learning Model on Improving Literacy and Numeracy of Grade V Elementary School Students

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Abstract: The average literacy and numeracy scores of Indonesian students are still below the minimum standard, with PISA 2018 achievement in the level 1 category and only 30% of students achieving basic competencies in the National Assessment. This study aims to analyze the effect of the PjBL model on improving the literacy and numeracy skills of fifth-grade students at SD Negeri 1 Banyuasin III. PjBL was chosen because it is considered relevant to the cognitive development stage of students aged 10–11 years and supports the integration of real contexts in learning. This study used a quantitative method with a nonequivalent pretest-posttest control group quasi-experimental design. The sample consisted of 56 fifth-grade students divided into experimental and control groups. The instruments used included empirically validated literacy and numeracy questions and an analytical rubric based on cognitive and contextual indicators. Data analysis was performed using MANOVA. The results showed that the PjBL model had a significant effect on improving literacy and numeracy simultaneously (Pillai's Trace = 0.319; p = 0.000). Partially, literacy gains were higher (F = 18.195; R^2 = 0.252) than numeracy gains (F = 10.075; R^2 = 0.165), with an average N-Gain of 0.49 for literacy and 0.40 for numeracy. This effectiveness reflects the successful integration of literacy and numeracy through simple project activities. This finding implies the need to implement PjBL as a curricular strategy to support the strengthening of literacy and numeracy in the Independent Curriculum.

Keywords: Experiential Learning, Literacy and Numeracy, Project-Based Learning, Elementary School Students

A. Introduction

One innovation that can be implemented to improve student literacy and numeracy is the use of a Project-Based Learning (PjBL). PjBL is a learning approach that encourages students to actively engage in the learning process through real-life projects relevant to their lives (Prasetyo, 2020). This model is believed to improve literacy and numeracy skills because students are not only asked to memorize

information but also to deeply understand concepts and apply them in contextual situations.

The National Literacy Trust states that literacy skills encompass the ability to read, write, and critically comprehend texts. Literacy also encompasses the ability to analyze, evaluate, and use information effectively in everyday life. Numeracy, on the other hand, encompasses not only the ability to understand and apply basic mathematical concepts such as addition, subtraction, multiplication, and division, but also the ability to think logically and solve problems quantitatively. Low literacy and numeracy skills in students not only impact academic achievement but also their ability to adapt in society. Failure to build a strong literacy and numeracy foundation in elementary school students can lead to difficulties in understanding subject matter at higher levels, which ultimately impacts productivity and future employment opportunities (Azizah et al. 2025). Lack of literacy and numeracy skills in students will limit their participation in economic, social, and political life. Even though there have been many programs designed by the government and educational institutions to improve literacy and numeracy, the results are still not satisfactory. One of the main reasons is that the learning approach used is still too focused on memorization and conceptual understanding that is less connected to real life contexts. Therefore, more contextual, interactive and participatory learning approaches, such as PjBL, need to be considered as potential solutions.

PjBL is a pedagogical approach that places students at the center of the learning process. This model provides students with opportunities to learn in a deeper and more meaningful way through exploration, investigation, and solving real-world problems. According to Amir and Setiawan (2023), Project-Based Learning (PjBL) not only develops students' academic knowledge but also social, communication, and critical thinking skills, which are highly relevant to the demands of literacy and numeracy in the 21st century. In Project-Based Learning (PjBL), students are given the opportunity to work on projects designed around open-ended problems or questions that require creative investigation and resolution. These projects allow students to apply their literacy and numeracy skills in relevant contexts. For example, in environmental projects, students can read and analyze data, calculate environmental impacts, and present their solutions to their teachers and peers. Through this approach, students' literacy and numeracy are developed not only through theory but also through hands-on practice that enhances understanding and real-world application.

Research conducted by Putri et al. (2024) shows that project-based learning models are effective in improving students' literacy and numeracy skills. This is because PjBL provides students with the opportunity to engage in a deeper learning process, with more time for reflection, investigation, and collaboration. This learning also encourages students to develop critical thinking skills, analyze information, and use mathematical concepts to solve problems they encounter in the project. Based on the

Education Report Card data of SDN 1 Banyuasin III, the literacy and numeracy skills of fifth-grade students at this school are classified as low. Approximately 36.67% of students are in the literacy category "requires special intervention" (below basic level) and 0% reach the "proficient" category, while in the numeracy aspect, only 13.33% of students reach the "proficient" category and 20% require special intervention. This means that the majority of students have not achieved the minimum expected competencies, especially in understanding complex texts and applying mathematical concepts in real situations. The findings at SDN 1 Banyuasin III are in line with national trends, where the literacy and numeracy skills of elementary school students in Indonesia are generally still low (Faizah et al. 2025). Research by Pratiwi et al. (2025) shows that these low literacy and numeracy skills are influenced by various factors, including ineffective conventional learning approaches and a low reading culture among students. Teacher-centered and memorization-oriented learning models tend to render students passive, thus under-training them to think critically in reading comprehension and solving contextual mathematical problems. This situation demands innovation in the learning process in schools to improve student literacy and numeracy.

One proposed innovation is the implementation of PjBL as an effort to address these issues. PjBL is considered capable of increasing active student engagement and linking learning to real-world contexts, thus potentially strengthening their literacy and numeracy skills. This learning model requires students to be directly involved in real-life projects that require research, information collection, data analysis, and solution presentation, which indirectly trains reading, writing, and numeracy skills in meaningful situations (Chotimah et al. 2023). Several previous studies have proven the effectiveness of PjBL in improving learning outcomes and student literacy and numeracy skills compared to conventional models (Faridah et al. 2022). PjBL encourages students to collaborate, think critically, and solve problems, all of which contribute to improving students' basic literacy and numeracy skills (Fauziyah & Rakhmawati, 2023). Based on these reasons, this study was conducted to test the effectiveness of PjBL in improving students' literacy and numeracy skills at SDN 1 Banyuasin III. Several empirical studies have shown that the implementation of PjBL has a positive effect on improving students' literacy and numeracy skills. Rohim & Nugraha (2023) found that PjBL significantly improved elementary school students' numeracy skills (significance value <0.05). Meta-analytic studies indicate that PjBL generally improves students' academic learning outcomes, critical thinking, and affective attitudes compared to conventional learning approaches (Zhang & Ma, 2023). However, most of these studies are general in nature, meaning they do not specifically tailor or link the intervention to the cognitive developmental stage of children aged 10–11 years. Aspects such as reading comprehension, inference, numerical reasoning, and transfer of mathematical applications in this age range have their own developmental characteristics that have often not been addressed in depth by previous PjBL research.

In fact, cognitive development theory states that children in this age range are in a transitional phase between concrete operations and early formal operations, so learning interventions need to be tailored to encourage reasoning and generalization skills in literacy and numeracy (Miller et al. 2025). If PjBL interventions are not aligned with this cognitive stage, their effectiveness in improving literacy and numeracy may be suboptimal or not clearly visible. On the other hand, studies linking PjBL with literacy, particularly the integration of reading skills into projects, demonstrate the potential for PjBL to simultaneously strengthen literacy and numeracy through interdisciplinary and contextual activities (Fitzgerald, 2021). In Indonesia, research on literacy and numeracy through PjBL is still limited, relying on a cyclical CAR design (Ghozali et al. 2024). Previous research did not employ a rigorous quantitative control design and did not explicitly limit the research to the effects of PjBL. Therefore, this study focuses on testing the influence of PjBL on improving literacy and numeracy in fifth grade elementary school students, by measuring abilities quantitatively through reading questions and non-story mathematics questions that are adapted to the cognitive characteristics of children in the 10–11-year age range at SDN 1 Banyuasin III. Based on the background that has been described, the problem formulation in this study is 1) How does the project-based learning model influence the literacy skills of fifth-grade students of SD Negeri 1 Banyuasin III? 2) How does the project-based learning model influence the numeracy skills of fifth-grade students of SD Negeri 1 Banyuasin III? 3) How does the project-based learning model influence the literacy and numeracy skills of fifth-grade students of SD Negeri 1 Banyuasin III?

B. Methods

This study used a quantitative approach with a quasi-experimental method. A quantitative approach is a systematic and objective approach used to measure the relationship between variables through the collection and analysis of numerical data, allowing researchers to draw conclusions based on empirical facts (Koo et al. 2022). This study aimed to determine the effect of the PjBL model on improving the literacy and numeracy skills of fifth-grade elementary school students. The quasi-experimental method was chosen because, in practice, researchers do not have full control over the randomization of research subjects (Gunawan, 2023). This is due to the administratively established classroom conditions at the school. Nevertheless, this design still allows researchers to systematically measure the effects of the treatment and compare the results between the two groups. The research design used is the Nonequivalent Pretest-Posttest Control Group Design, which is a form of quasi-experiment. In this design, there are two groups: the experimental group and the control group. Both groups are given an initial test (pretest) to measure literacy and numeracy skills before treatment, and a final test (posttest) to measure changes after the treatment is given. The PjBL model will be applied to the experimental group for several learning sessions, while the control group will follow learning with conventional methods. The pretest and posttest results from both groups will then be analyzed statistically to determine any differences or significant effects of the

treatment given. This design is considered appropriate for educational research because it considers field limitations, while still providing the opportunity for valid and reliable evaluation of the effectiveness of the applied learning model. The following is a schematic of the research design used.

Table 1. Research Design Plan (Sugiyono, 2019)

Group	Pre-Test	PjBL	Post-Test
Experiment	O_1	X_1	O_3
Control	O_2	-	O_4

Information:
O_1 : Pre-Test Experiment
O_2 : Pre-Test Control
O_3 : Post-Test Experiment
O_4 : Post Test Control
X_1 : PjBL + Numeracy Literacy Intervention

This research was conducted at SDN 1 Banyuasin III located at JL. Mutiara No. 61, Banyuasin III District, Banyuasin Regency, South Sumatra Province 30913. Data collection was carried out in October-November 2025, which included pre-test activities, learning implementation, observation, and post-test. The following timeline of learning activities can be seen in table 2.

Table 2. Timeline for Implementing PjBL Learning

Meeting	Date	Topics	Experimental class activities	Duration (minutes)
1	2nd Week of October	Numeracy Literacy Pre-test	Numeracy Literacy Pretest	120
2	3rd Week of October	Fraction Exploration & Visual Representation	Paper folding activities, equivalent fractions, visualization on number lines and everyday life contexts	105
3	4th Week of October	Fraction Operations (Addition and Subtraction)	Discussion and group work with concrete media	105
4	5th Week of October	Fraction Operations (Common Denominators and Substitution)	Fraction conversion practice with number line simulation	105
5	1st Week of November	Everyday Life Fractions Project	Contextual projects (sharing cookies, milk, or simple shopping)	105
6	2nd Week of November	Contextual Ratio, KPK & FPB	Card games, group discussions, and ratio-building exercises	105
7	3rd Week of November	Measurement and Geometry	Calculating the circumference/area of flat shapes, introducing spatial shapes through real observation	105

8	3rd Week of November	Data Networks & Visualization	Making geometric nets, collecting simple data, presenting diagrams/tables	105
9	4th Week of November	Data Analysis and Project Presentation	Simple data interpretation, basic probabilities, presentation of project results	105
10	4th Week of November	Numeracy Literacy Post-Test	Post-Test and Reflection	120

The population in this study was all fifth-grade students of SDN 1 Banyuasin III, totaling 52 students, consisting of two parallel classes, namely class VA and class VB. This population was chosen because fifth-grade students were deemed to have an adequate level of cognitive development and basic literacy to participate in the PjBL model, which requires active involvement, cooperation, and critical thinking skills. The population in a study refers to all subjects who have certain characteristics and are relevant to the problem being studied. According to experts, a population is a collection of individuals who are the target of generalization of research results because they have uniform characteristics and are in accordance with the focus of the study (Makwana et al. 2023). Then, the sample is a portion of the population taken based on certain considerations to represent the characteristics of the population in general. This study used saturated sampling, a sampling technique in which all members of the population are used as research samples (Creswell, 2022). This technique was chosen because the population size was relatively small (52 fifth-grade students of SDN 1 Banyuasin III) and all students met the relevant criteria to be included in testing the effect of the PjBL model on literacy and numeracy. All students in the two classes were included because they met the inclusion criteria: 1) Registered as active fifth-grade students at SDN 1 Banyuasin III in the research academic year; 2) Age range 10–11 years, according to the cognitive development phase from concrete operational to early formal (Piaget), thus in accordance with the literacy and numeracy intervention targets; 3) Participated in the entire series of research activities, including the pre-test, eight learning meetings, and post-test; and 4) Did not have severe learning disabilities (e.g., severe visual/hearing impairments or special needs requiring different methods) based on school information. With total sampling, the analysis results are expected to represent the overall population without the risk of selection bias. The following is the distribution of the research groups.

Table 3. Distribution of Research Samples

Group	Class	Male	Female
Experiment	V A	14	13
Control	V B	10	15
Total		52 Students	

The instrument used was an objective test consisting of literacy and numeracy questions, designed according to indicators from Ministry of Education, Culture, Research, and Technology. This test was divided into two packages, namely a pretest and a posttest, with a total of 20 questions. The questions consisted of multiple-choice

and essay questions, covering both literacy and numeracy indicators proportionally. The use of this instrument aims to: 1) Measure students' initial abilities before treatment (pretest); 2) Measure students' final abilities after treatment (posttest); 3) Analyze the significant effect of the implementation of the PjBL model on improving student literacy and numeracy. The test questions in this study were structured based on three dimensions of numeracy: content, cognitive processes, and question context. In addition, the question structure also considered five aspects of literacy and numeracy: observation, planning, implementation, communication, and reflection. The types of questions developed consisted of multiple-choice and five essay questions, all of which refer to the Mathematics Phase C subject, specifically the sub-chapter on whole numbers and fractions.

The total number of pre-test and post-test questions was 20, consisting of 15 multiple-choice questions and 5 essay questions. This question design was adopted from the research of Pudjastuti et al. (2024) and Indirianisa & Nur Oktaviani, (2025) which has been proven effective in developing students' numeracy skills. The preparation of the questions was carried out by referring to the Grade V Mathematics Textbook Phase C for teachers (Meita et al. 2022) with reference to cognitive levels and question creation types based on Prasetyo's research (2020) so that the relevance and suitability of the questions with the national curriculum are maintained.

The data collection and retrieval procedures were carried out sequentially from the preparation stage to the analysis, so that the entire process could be documented completely and systematically (Creswell, 2022) 1) Preparation Stage; 2) Pre-Intervention Stage; 3) Intervention Stage; 4) Post-Intervention Stage; and 5) Data Processing. Data analysis in this study was carried out using statistical tests (t-test). Each analysis method was used to comprehensively answer the research questions: 1) Pre-Analysis Data Processing: Multiple Choice and Essay Score Assessment; then Pre-Test Post-Test Score Processing. Next, 2) Analysis Prerequisite Tests: Normality Test; Homogeneity Test; Factor Test; and Hypothesis Testing with MANOVA Test used to determine the effect of learning media simultaneously on two dependent variables, namely literacy and numeracy skills. MANOVA allows testing more than one dependent variable in one analysis by considering the relationship between variables. The results of the MANOVA test were reviewed from the Wilks' Lambda, Pillai's Trace, and Hotelling's Trace values.

C. Results and Discussion

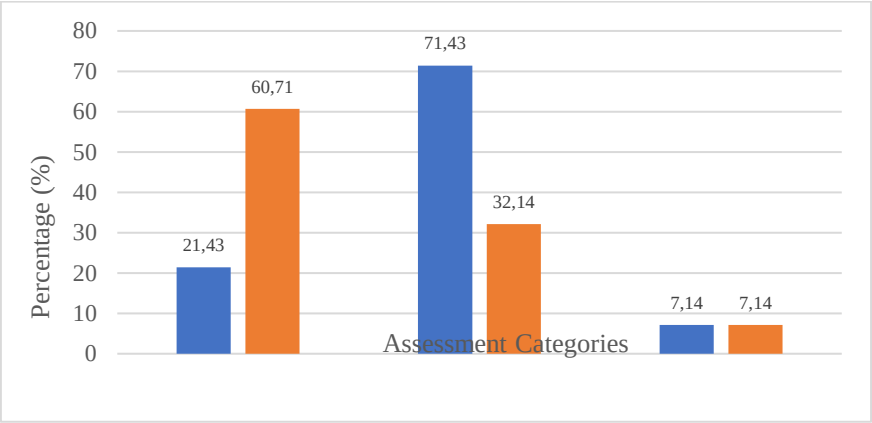

Figure 1. Distribution of Pretest Score Data

The diagram above shows the distribution of pre-test scores for the experimental class, with pre-test scores ranging from 51.11 (minimum) to 82.22 (maximum) with a median of 66.67. A standard deviation of approximately 7.20 indicates a relatively moderate distribution of scores (not too widely spread from the median). The distribution of initial ability categories in the experimental class is dominated by the moderate category, with 71.43% of students (20 people) in the score range of $60 < X \leq 73.87$. Only 21.43% of students (6 people) are classified as low (score ≤ 60) and 7.14% of students (2 people) are classified as high (score > 73.87). This indicates that most students in the experimental class have initial literacy-numeracy abilities at a moderate level, with a small proportion at very low or very high levels. A fairly concentrated distribution (with a standard deviation that is not too large) indicates relatively uniform initial abilities around a moderate level, without extreme differences between students. Then, the pre-test scores for the control class ranged from 43.70 to 78.52 with a median of 61.11. The standard deviation of 7.60 in the control class was similar in magnitude to the experimental class, indicating a moderate level of score variation. However, the distribution of categories skewed toward the low level, with 60.71% of students (17) having scores ≤ 60. Approximately 32.14% of students (9) were in the medium category ($60 < X \leq 68.71$), and only 7.14% (2) were in the high category (score > 68.71). With the majority of control class students in the low category, it can be concluded that their initial literacy and numeracy abilities tended to be weak. The median, which was close to the threshold for the medium category (61.11), and the lower minimum score than the experimental class, reinforced the impression that the control class had more students with inadequate initial abilities. Student scores in each class are distributed in a relatively homogeneous pattern around the median, without many outlier values. This data distribution suggests that the basic literacy and numeracy capacities of students in the experimental class are relatively stronger than those in the control class, which may later influence their ease in participating in subsequent learning programs.

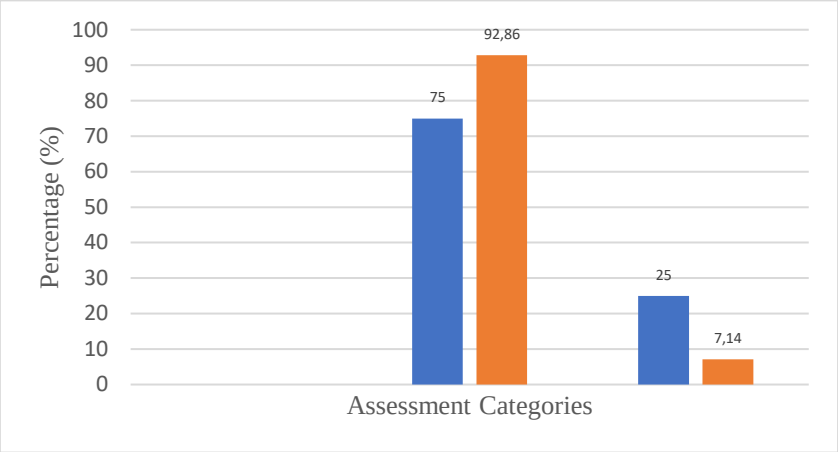

Figure 2. Distribution of Posttest Value Data

Based on Figure 2, the post-test scores for the control class ranged from 68.15 to 85.93 with a median of 77.03, while the experimental class ranged from 75.56 to 91.85 with a median of 83.70. No students in either class fell into the low ability category (≤60); all achieved at least the moderate category on this final test. This indicates that after the learning process, each student was above the basic competency threshold measured post-intervention. Based on the assessment category, the majority of students in the control class (26 people or 92.86%) were in the medium category (60 < score ≤ 81.93), and only 2 students (7.14%) achieved the high category (> 81.93). In contrast, in the experimental class there was a higher proportion of results, namely 7 students (25.00%) succeeded in entering the high category (> 87.84) while 21 students (75.00%) were in the medium category (60 < score ≤ 87.84). The median of the experimental class (83.70) which was higher than the median of the control class (77.03) strengthens the indication that the achievement of students' literacy-numeracy skills in the experimental class was better after the intervention. In addition, the standard deviation value of the experimental class score (4.14) was slightly lower than the control class (4.89), which indicates that the distribution of scores in the experimental class was more concentrated (homogeneous) around the middle value, while the control class had a slightly wider variation in scores. In other words, the post-test results of the experimental class were not only higher, but also more consistent across students, compared to the control class which showed slightly higher heterogeneity in ability.

The post-test results reflect the level of students' literacy and numeracy skills after the learning treatment in each class. The experimental class, which showed a higher median score and a greater proportion of high-level students, indicates that the intervention successfully strengthened students' literacy-numeracy competencies compared to the method applied in the control class. All students achieved at least a moderate level, indicating that both groups had achieved basic mastery of the literacy-numeracy material. However, the presence of 25% of students in the experimental class in the high-level category indicates that some students not only mastered basic

content but were also able to apply literacy and numeracy at an advanced level, for example in solving complex problems that require in-depth reasoning.

Table 4. Results of Simultaneous Hypothesis Testing

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0,920	306,525[b]	2,000	53,000	0,000
	Wilks' Lambda	0,080	306,525[b]	2,000	53,000	0,000
	Hotelling's Trace	11,567	306,525[b]	2,000	53,000	0,000
	Roy's Largest Root	11,567	306,525[b]	2,000	53,000	0,000
Group	Pillai's Trace	0,319	12,412[b]	2,000	53,000	0,000
	Wilks' Lambda	0,681	12,412[b]	2,000	53,000	0,000
	Hotelling's Trace	0,468	12,412[b]	2,000	53,000	0,000
	Roy's Largest Root	0,468	12,412[b]	2,000	53,000	0,000

Table 5. Partial Test Results of Numeracy Variables

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Numeracy	14895,597[a]	1	14895,597	10,075	0,002
	Residual for Numeracy	3520,444[b]	1	3520,444	18,195	0,000
Intercept	Numeracy	189003,949	1	189003,949	127,840	0,000
	Residual for Numeracy	107048,420	1	107048,420	553,282	0,000
Group	Numeracy	14895,597	1	14895,597	10,075	0,002
	Residual for Numeracy	3520,444	1	3520,444	18,195	0,000
Error	Numeracy	79836,121	54	1478,447		
	Residual for Numeracy	10447,872	54	193,479		
Total	Numeracy	283735,667	56			
	Residual for Numeracy	121016,736	56			
Corrected Total	Numeracy	94731,718	55			
	Residual for Numeracy	13968,316	55			

Table 6. Partial Test Results of Literacy Variables

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3520.444[a]	1	3520,444	18,195	0,000
Intercept	107048,420	1	107048,420	553,282	0,000
Group	3520,444	1	3520,444	18,195	0,000
Error	10447,872	54	193,479		
Total	121016,736	56			
Corrected Total	13968,316	55			

a. R Squared = .252 (Adjusted R Squared = .238)

When compared comprehensively, the results of the simultaneous and partial tests show a consistent pattern that PjBL has a significant effect on literacy and numeracy,

both simultaneously and separately. However, statistically, the effect on literacy appears more dominant, as reflected in the F value and the proportion of variation explained by the model. This finding strengthens the results of the simultaneous MANOVA test which shows that both abilities develop in an integrated manner, but with different levels of sensitivity to the learning treatment. Thus, the results of this hypothesis test provide a strong empirical basis that the implementation of the PjBL model is effective in improving students' literacy and numeracy skills, which will be discussed in more depth from a theoretical and pedagogical perspective in the discussion section.

PjBL Implementation Construct

Previous studies have shown that PjBL can significantly improve student learning outcomes compared to conventional methods (Zhang, 2023). Elementary school students who learn through PjBL achieve higher mathematics results than students taught conventionally, and this model is effective in improving mathematical performance even for low-achieving students (Himmi et al. 2025). The implementation of a project-based curriculum at the elementary school level has also been proven to be able to boost students' literacy skills with better information reading scores compared to students with conventional learning (Fitzgerald, 2021). The PjBL model is rooted in the constructivist paradigm, which encourages active student involvement in constructing knowledge through in-depth investigation and solving real-world problems (Condliffe et al., 2017). Students in PjBL actively explore concepts and become knowledge producers through contextual projects. Furthermore, the PjBL model aligns with Kolb's experiential learning theory, which emphasizes that knowledge is acquired through a cycle of concrete experience, reflection, conceptualization, and active experimentation (Mubarok et al., 2025). PjBL enables the literacy learning cycle to be understood as the ability to effectively access, understand, and evaluate information from various sources, while numeracy is defined as the ability to reason logically and solve mathematical problems in various real-world contexts (ISSED, 2024).

Child Ability Pattern Before Intervention

The sample composition and student characteristics also provide theoretical justification for why the learning design and instruments align with children's developmental stages. A total of 56 students, aged 10-11 years, were in the final transitional stage of the concrete operational stage according to Piaget's developmental theory. At this stage, children are able to investigate and solve concrete problems logically (Ahmad & Siew, 2022), so their conceptual understanding becomes stronger when learning is supported by real-world contexts, the use of visual representations, and meaningful activities related to everyday life (Marinda, 2020). Fifth-grade students begin to think logically about real and concrete events, but still require the support of real objects and visuals to maximize understanding of abstract

concepts. This aligns with the findings of Wasik and Hindman (2020) who stated that children aged 10-11 years can investigate and solve concrete problems rationally, so learning strategies that provide concrete experiences are very appropriate for this age range.

This entire process parallels assessment indicators, allowing students to test strategies and learn through a guided trial-and-error process. Students also hone their scientific critical thinking skills by directly observing data and interpreting empirical evidence collected during the project, and then enhance their communication skills by presenting findings and explaining the rationale behind proposed solutions to a real audience (Mlaverdi, 2024). The final stage, a structured reflection phase, encourages students to evaluate the effectiveness of the implemented solutions and deepen their conceptual understanding of the project experience. Project-Based Learning (PjBL) not only aligns with the cognitive developmental needs of 10–11-year-olds but also explicitly meets assessment criteria that emphasize problem-solving strategies, data analysis, scientific communication, and critical reflection on the learning process and outcomes.

Analysis of Student Observation Results

The experimental class implemented the PjBL model through systematic stages, starting from essential questions, project planning and scheduling, implementation and monitoring, to presentation of results and final reflection. In the initial stage, the teacher sparked students' curiosity with essential questions based on contextual problems that linked mathematics material to real-life situations. Next, students developed project plans and implementation schedules in groups (with teacher guidance as needed). This process is supported by the results of research by Albritton & Stacks (2019) that the PjBL model goes through systematic stages, starting from essential questions that challenge students to think investigative, then project planning and scheduling, implementation and monitoring of project activities, to presentation of results and final reflection. PjBL involves an extended inquiry process that begins with complex authentic questions (essential questions) and guides students through structured stages. Next, students in groups develop project plans and implementation schedules, including reading contextual text sources or problem scenarios and writing project plans (literacy), as well as estimating the time, tools, and data needed (numeracy). This stage reflects the integration of literacy and numeracy components in each phase of PjBL, which has been demonstrated in the practice of implementing the PjBL model in various educational contexts.

Throughout the process, the teacher monitors each group's progress by acting as a facilitator, providing feedback, and encouraging students to think critically rather than simply completing routine tasks. The final stage involves project presentations and reflection. Students present their project results to the class (either verbally or visually) and discuss their findings, displaying data in diagrams or tables to support

their explanations. Finally, through a collaborative reflection activity, students and the teacher evaluate the project process and results, identify any challenges or successes, and draw lessons for future improvement. Student behavior in the experimental class, which showed higher levels of activeness, participation, and collaboration compared to the control class, is in line with the characteristics of project-based learning, which places students as active subjects in the learning process. Student involvement through questioning, discussion, and collaboration in groups reflects the process of social knowledge construction, where students not only receive information from the teacher but also build understanding through interaction and direct learning experiences.

Partial Influence on Students' Literacy Skills

Project-Based Learning provides a pedagogical foundation for the integration of literacy and numeracy skills at the elementary school level. PjBL encourages students' active engagement in learning through contextual projects that require the simultaneous use of multiple competencies. Students not only read and write to find project information but also apply numeracy and mathematical reasoning skills to solve real-life problems (Himmi et al. 2025). This relationship also explains why students in the experimental class in this study demonstrated better abilities in communicating ideas and solving problems compared to the control class. PjBL inherently requires students to understand written information, process numerical data, and present results orally and visually as part of the project, as reported in previous research (Nurhayati et al. 2024). Therefore, the findings of this study strengthen the evidence that PjBL not only improves quantitative learning outcomes but also the quality of students' thinking processes. Furthermore, the numeracy gains observed in this study can be understood as the impact of using everyday life contexts in learning projects. When students encounter contextual problems, they are encouraged to interpret numbers, symbols, and mathematical information in an applied, rather than merely procedural, manner. This finding aligns with Samsiadi & Romelah (2022) who stated that PjBL is effective in improving numeracy literacy because it provides students with the opportunity to develop a deeper understanding of concepts through hands-on learning experiences. The integration of literacy and numeracy through PjBL aligns with the needs of 21st-century competencies, where both are foundational for critical thinking and solving complex problems (Puspitasari, 2025).

Based on the results of the partial hypothesis test, the PjBL model was proven to have a significant influence in improving students' literacy skills. The ANOVA test on the literacy variable produced an F value of around 18.19 with $p = 0.000$ (smaller than 0.05), and an R^2 of 0.25, indicating that approximately 25% of the variability in literacy improvement can be explained by differences in learning treatments. Thus, the class implementing PjBL experienced a significant increase in literacy skills compared to the control class. This finding is in line with the research of Imbaquingo and Cárdena

(2023), who found that the implementation of PjBL effectively increased students' motivation and reading skills, creating meaningful experiences so that students were more engaged in literacy activities, which in turn contributed to improving their literacy skills. These results are consistent with the literacy framework, which encompasses the cognitive processes of finding information, understanding content, and evaluating and reflecting on texts. The PjBL model provides a platform for students to experience these literacy processes within a learning context. Through projects, students are encouraged to seek and gather information from various sources, understand the material read to complete project assignments, and evaluate and reflect on the information obtained (Zainudin & Nawangsari, 2025). This aligns with Kavlu's (2015) findings, which show that PjBL encourages student engagement in reflective evaluation and inquiry-based learning, while simultaneously improving reading comprehension through the integration of explicit reading instruction and authentic materials. Based on the above theory, it can be concluded that activities in PjBL reflect literacy indicators as measured in the PISA assessment because students actively seek information, understand the content of project texts, and critically evaluate their own work (OECD, 2023).

Partial Influence on Students' Numeracy Ability

The results of the partial ANOVA test showed that the PjBL model had a significant effect on improving elementary school students' numeracy skills, with an F value of 10.075 and $p = 0.002$. This finding statistically indicates that the difference in mean numeracy scores between the experimental and control groups is an implication of the learning treatment. Interventions such as "Fractions in Everyday Life," "Ratio, LCM & Contextual GCF," and "Measurement & Geometry" require students to formulate problems from real-life situations, choose the appropriate mathematical operations, perform calculations, and interpret the results in real-life contexts, such as shopping, measuring, or dividing resources. Essentially, these activities reflect the definition of numeracy as the ability to reason using number and data concepts to solve contextual problems, involving the process of understanding, applying, and reasoning in various situations (OECD, 2023). The integration of content, process, and context dimensions in these projects demonstrates how numeracy is formed authentically through meaningful activities (Pratiwi et al. 2025).

The PjBL approach not only equips students with procedural skills but also fosters mathematical modeling skills, which are core to numeracy. In projects, students are encouraged to transform real-life narratives into mathematical representations: identifying variables, constructing calculation models, and verifying results. This process aligns with the numeracy competencies in ISSED (2024), which emphasize the ability to strategize, model, and evaluate results in real-life contexts. A study by Brown and Biddle (2023) also demonstrated that a project-based approach that relies on situational modeling improves students' ability to select mathematical procedures and explicitly explain relationships between mathematical concepts. It can be

concluded that students are not only trained to solve problems but also to understand why the approach was used and how the results are relevant to post-test work (Siregar et al. 2024). The consistency between these findings and previous research further strengthens the argument for the effectiveness of PjBL in strengthening numeracy, particularly at the elementary school level. A meta-analysis of 24 studies found that PjBL had an effect size of 0.97 on mathematical problem-solving skills, with the highest impact occurring in elementary school students (Yunita et al. 2021). Other research combining PjBL with ethnomathematics and STEM contexts also reported significant improvements in numerical literacy scores, both through written assessments and project outcomes (Kahraman, 2022). Therefore, the findings of this study have strong theoretical and empirical findings, namely that project-based learning with a local context and investigative activities can improve numeracy performance more than conventional learning approaches.

The Influence of Simultaneous Learning on Students' Numeracy Literacy Skills

The MANOVA analysis results show that the implementation of the PjBL model has a significant simultaneous effect on the combination of literacy and numeracy skills of fifth-grade students. Pillai's Trace value of 0.319, Wilks' Lambda 0.681, Hotelling's Trace 0.468, and Roy's Largest Root 0.468, with a significance value of $p = 0.000$ ($p < 0.05$) for all indicators, indicating that there is a significant difference in the mean vector of literacy-numeracy scores between the experimental and control groups. Among the four measures, Pillai's Trace was chosen as the primary basis for interpretation because it is more robust to violations of multivariate assumptions, especially when the sample size is moderate and there is a correlation between the dependent variables (Kristiantari et al. 2022). This finding supports the alternative hypothesis that PjBL does not only have a partial impact, but has a substantial combined effect on both cognitive domains. The study by Garg et al. (2021) also showed that multivariate analysis was more sensitive in capturing changes across competency domains when learning interventions contained integrative elements.

Pedagogically, these results confirm that PjBL operates through an integrative approach, not only developing one competency separately, but also encouraging the development of interrelated competency structures. In the intervention process, students are required to understand contextual texts (literacy activities), while simultaneously carrying out the processes of quantification, measurement, and data analysis (numeracy activities), all of which take place within a complete learning cycle. These activities align with the OECD (2023) framework, defined as the ability to locate, understand, and evaluate information and numeracy, including formulating, applying, and interpreting mathematical problems. The simultaneous effectiveness of PjBL detected by MANOVA reflects the successful integration of two cognitive pathways that were previously often separated in learning practices. This is reinforced by the results of research by Azuara and Lozano (2020), who found that a project-based approach can simultaneously improve functional literacy and mathematical

reasoning because it provides space for collaboration, exploration of data sources, and construction of meaning across symbolic and textual representations.

The relationship between literacy and numeracy in this research data is evident in the distribution of achievement per rubric indicator. Students who improved significantly in literacy indicators such as observation and communication also experienced improvements in numeracy indicators such as planning and strategy implementation, indicating that text or context comprehension skills strengthen their numerical thinking abilities. This finding is reinforced by the results of a study by Sa'dah et al. (2025) which emphasized that understanding the language structure in word problems is a crucial factor in building accurate mathematical representations. Conversely, students' involvement in numerical explorations such as reading tables and graphs also increased their awareness of the structure and meaning of information, forming what is known as quantitative literacy. This is in line with the finding that the integration of numerical activities in authentic social contexts promotes the development of data literacy, a key component of 21st-century literacy (Gustiani, 2019). Children aged 10–11 years are in the concrete operational phase according to Piaget's theory of cognitive development, where they begin to be able to think logically about real objects, master sequencing and classification, and develop problem-solving strategies based on direct experience. In the context of this research, statistical results indicate that the PjBL model is capable of facilitating this development. These findings strengthen the argument that learning through concrete projects designed contextually according to the students' social environment encourages the activation of logical and reflective thinking in accordance with children's cognitive structures at this stage. Projects allow students to develop strategic steps and reflect on their thinking processes through direct manipulation of real objects and situations, as recommended in the experiential learning approach (Zhang et al. 2024).

Implications and Limitations

The final analysis, namely the strong correlation between literacy and numeracy (χ^2 = 48.169; p = 0.000) found in the Bartlett test, strengthens the conclusion that these two domains develop in an integrated manner in project-based learning. Piaget's theory emphasizes that cognitive development is holistic and interdependent, while Vygotsky's theory highlights that the development of understanding occurs in a meaningful social context. PjBL bridges these two approaches through real-life projects involving social collaboration and simultaneous cognitive activity (Lu, 2024). The research provides empirical justification that project learning can develop cross-domain competencies simultaneously within the framework of elementary school students' cognitive development.

Previous studies have often focused on improving mathematics learning outcomes or reading comprehension separately, but few have analyzed the relationships between

domains through a systematic, rubric-based multivariate approach. Therefore, this study provides a conceptual contribution that innovative learning approaches such as PjBL need to be positioned not only as strategies for improving academic achievement, but as integrative curricular designs that align with the spirit of the Independent Curriculum and the national literacy-numeracy strengthening agenda. This reinforces the argument of Setiyani et al. (2025), that future learning designs must be able to bridge cross-domain capabilities to shape adaptive and competent learners in facing global challenges.

The results of this study provide theoretical implications that strengthen the position of PjBL as a constructivist approach capable of simultaneously integrating literacy and numeracy within a meaningful learning pathway. The finding that literacy and numeracy improved significantly supports the view that these two competencies do not stand alone, but are intertwined in the cognitive and social practices of elementary school students. This implication enriches the development of literacy and numeracy theory in the realm of elementary education, particularly in the Independent Curriculum approach, which demands meaningful, contextual, and competency-based learning across domains. Therefore, it is necessary to strengthen the conceptual model that positions literacy and numeracy as two integrated pillars, not separate domains, in thematic learning designs and subjects such as mathematics. Practically, this research provides guidance for teachers and policymakers in designing more strategic learning based on formative assessment. Teachers are advised to design mathematics projects that explicitly include indicators of literacy (e.g., finding, understanding, and evaluating information) and numeracy (e.g., strategic planning, calculating, and communicating results). The use of analytical rubrics, as implemented in this research, has been shown to help assess students' processes and products more objectively and orient them toward continuous learning. At the policy level, schools and education offices can make integrative PjBL part of a strategy to strengthen literacy and numeracy based on the Minimum Competency Assessment (AKM), with support from teacher training, provision of local teaching materials (e.g., in the Banyuasin context), and simple ICT tools to support the implementation of the Independent Curriculum in a more relevant and applicable manner.

D. Conclusions

The implementation of the project-based learning (PjBL) model had a significant impact on students' literacy skills, as indicated by the partial test results with an F value of 18.195 and a significance of $p = 0.000$ ($p < 0.05$). This value indicates that the difference in learning treatment between the experimental and control classes contributed significantly to the improvement of students' literacy scores. The PjBL model also had a significant impact on improving students' numeracy skills, with an F value of 10.075 and a significance of $p = 0.002$ ($p < 0.05$). This improvement was more prominent in the indicators of strategic planning and implementation of arithmetic operations, which require students to think systematically and apply mathematical

concepts in the context of real projects. Simultaneously, the PjBL model had a significant impact on the combination of students' literacy and numeracy skills, as evidenced by the MANOVA test results with a Pillai's Trace value of 0.319, F = 12.412, and a significance of p = 0.000. This shows that approximately 31.9% of the combined variation of the two competencies can be explained by differences in learning methods, and strengthens the understanding that literacy and numeracy develop integrative in experiential learning.

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References

Ahmad, J., & Siew, N. M. (2022). An entrepreneurial science thinking module based on the socioscientific issues approach with thinking wheel map for primary school students in STEM education. *Problem of Education in the 21th Century*, *7864*(2009).

Albritton, S., & Stacks, J. (2016). Implementing a Project-Based Learning Model in A Pre-Service Leadership Program. *NCPEA International Journal of Educational Leadership Preparation*, *11*(1).

Azizah, S. N., Gustiara, D., Fitrianto, A., Erfiani, & Silvianti, P. (2025). Identification Of Primary School Literacy Achievement Factors In Province X Using Ordinal Stepwise Logistic. *Jurnal Statistika Dan Aplikasinya*. https://doi.org/10.21009/jsa.09103

Brown, S. P., & Biddle, C. (2023). Testing a teacher costs to caring resilience model to identify burnout mediators. *Teaching and Teacher Education*, *127*, 104078. https://doi.org/10.1016/j.tate.2023.104078

Chotimah, U., Yanzi, H., Sumarni, S., Syarifuddin, S., & Ritonga, J. (2023). Implementation of Project-Based Learning Styles and Multiple Learning Objects to Promote the Pancasila Student Profile. *Jurnal Pendidikan Progresif*, *13*(3), 1323–1342. https://doi.org/10.23960/jpp.v13.i3.202332

Condliffe, B., Quint, J., Visher, M. G., & Bangser, M. R. (2017). Project-Based Learning. *Building Knowledge to Improve Sosial Policy*, *October*.

Creswell, J. W. (2022). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. SAGE Publication.

Faizah, W. N., Rahmawati, A. V., Putri, A. Y., Rahma, A., & Damayanti, R. (2025). Literacy-Based Learning and Numeracy in Improving Thematic Learning Outcomes in Elementary / MI. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *10*(2), 434–447.

Faridah, N. R., Afifah, E. N., & Lailiyah, S. (2022). The Effectiveness of the Project Based Learning Model on the Numeracy and Digital Literacy Skills of Madrasah

Ibtidaiyah Students. *Jurnal Basicedu*, *6*(1), 709–716. https://doi.org/10.31004/basicedu.v6i1.2030

Fauziyah, C., & Rakhmawati, N. I. S. (2023). The Influence of Numeracy Games (Ganu) Using the Steam Approach on the Numeracy Ability of Children Aged 5-6 Years. *JP2M (Jurnal Pendidikan Dan Pembelajaran Matematika)*, *9*(2), 231–238. https://doi.org/10.29100/jp2m.v9i2.4419

Fitzgerald, A. (2021, June 25). Pairing Literacy Instruction with Project-Based Learning Is a Win for Students. *International Literacy Association*. https://www.literacyworldwide.org/blog/literacy-now/2021/06/25/pairing-literacy-instruction-with-project-based-learning-is-a-win-for-students?utm_source=chatgpt.com

Garg, A., Zhang, W., Samaran, J., Savitha, R., & Foo, C.-S. (2021). An Evaluation of Anomaly Detection and Diagnosis in Multivariate Time Series. *IEEE Transactions on Neural Networks and Learning Systems*, *33*, 2508–2517. https://doi.org/10.1109/tnnls.2021.3105827

Ghozali, S., Fanindra, A. P., Putri, A., Sakinah, A. N., Nur, A., Utami, N. P., Handayani, P. S., Zahra, S. A., & Ragil, Y. A. (2024). *PBL Model Efforts to Improve Numeracy Literacy Through Wide, Roving Measurements in Students*.

Gunawan, A. (2023). Financial Literacy and Use of Financial Technology Payment for Consumptive Behavior. *International Journal of Business Economics (IJBE)*, *4*(2). https://doi.org/10.30596/ijbe.v4i2.14233

Gustiani, S. (2019). Research and Development (R&D) Method as a Model Design in Educational Research and Its Alternatives. *Holistics Journal*, *11*(2), 12–22. https://jurnal.polsri.ac.id/index.php/holistic/article/view/1849

Himmi, N., Armanto, D., & Amry, Z. (2025). Implementation of Project Based Learning (PjBL) in Mathematics Education : A Systematic Analysis of International Practices and Theoretical Foundations. *Science Insights Education Frontiers*, *26*(2), 4305–4321. https://doi.org/10.15354/sief.25.or699

Indirianisa, V., & Nur Oktaviani, R. (2025). The Use of Monopoly Learning Media on the Numeracy Literacy Ability of Grade IV Students of Tanwirul Afkar Elementary School. *IJPSE Indonesian Journal of Primary Science Education*, *5*(2), 240–247. https://doi.org/10.33752/ijpse.v5i2.8843

ISSED. (2024). The Development of PISA in Indonesia: Challenges and Hopes on International Literacy Day. In *Issed.Id*. ISSED. https://www.issed.id/the-development-of-pisa-in-indonesia-challenges-and-hopes-on-international-literacy-day

Kahraman, N. (2022). Investigating linear and curvilinear relationships between cognitive activation strategies and student achievement in science. *International Journal of Educational Research*, *116*, 102083. https://doi.org/10.1016/j.ijer.2022.102083

Kavlu, A. (2015). The Effect of Project – Based Learning on Undergraduate EFL Students ' Reading Comprehension Ability. *Journal of Education in Black Sea Region*, *1*(1), 39–44.

Kementerian Pendidikan Kebudayaan Riset dan Teknologi. (2021). *Strengthening*

Literacy and Numeracy. Direktorat Jenderal Pendidikan Anak Usia Dini, Pendidikan Dasar, dan Pendidikan Menengah, Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Pengarah.

Koo, H.-Y., Gu, Y.-E., & Lee, B.-R. (2022). Development of a Project-Based Learning Program on High-Risk Newborn Care for Nursing Students and Its Effects: A Quasi-Experimental Study. *International Journal of Environmental Research and Public Health*, *19*(9), 5249. https://doi.org/10.3390/ijerph19095249

Kristiantari, M. G. R., Wayan Widiana, I., Tristiantari, N. K. D., & Rediani, N. N. (2022). Impact of Prezi Media-Assisted Problem-Based Learning on Scientific Literacy and Independence of Elementary School Students. *Journal of Education and E-Learning Research*, *9*(3), 184–191. https://doi.org/10.20448/jeelr.v9i3.4185

Lu, X. (2024). Exploring Innovative Approaches to Integrate Child Development Theory in Primary Classrooms. *Communications in Humanities Research*. https://doi.org/10.54254/2753-7064/2024.18107

Makwana, D., Engineer, P., Dabhi, A., & Chudasama, H. (2023). *Sampling Methods in Research A Review*.

Marinda, L. (2020). Kognitif dan Problematika. *An-Nisa' : Jurnal Kajian Perempuan Dan Keislaman*, *13*(1), 116–152.

Meita, F., Surtiani, Ika, & Istiandaru, A. (2022). *Mathematics Teacher's Handbook for grade V SD/MI* (First). Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi.

Miller, E., Li, T., Chen, I.-C., Krajcik, J., & Codere Kelly, S. (2025). Designing for and investigating elementary students' cognitive flexibility, science, and literacy achievement in project-based science learning. *Disciplinary and Interdisciplinary Science Education Research*, *7*(1), 13. https://doi.org/10.1186/s43031-025-00131-1

Mlaverdi. (2024). *Incorporating Project-Based Learning in Elementary and Secondary Schools _ Marymount University*. Marymound University.

Morris, T. (2019). Experiential learning – a systematic review and revision of Kolb's model. *Interactive Learning Environments*, *28*, 1064–1077. https://doi.org/10.1080/10494820.2019.1570279

Mubarok, A. S., Nurazizah, Z., Herawan, E., & Putri, D. P. (2025). Deep Learning with Project-Based Learning (PjBL) Model for Student Creativity. *Pedagogia : Jurnal Pendidikan*, *14*(2), 239–252. https://doi.org/10.21070/pedagogia.v14i2.1957

Nurhayati, L., Djoehaeni, H., Mariyana, R., & Rahaju, I. (2024). Pegaruh Project Based Learning terhadap Kemampuan Literasi Numerasi Anak Usia Dini. *Aulad : Journal on Early Childhood*, *7*(2), 616–625. https://doi.org/10.31004/aulad.v7i2.645

OECD. (2023). PISA Results 2022: The state of learning and equity in education. In *OECD Publishing*. https://doi.org/10.1787/53f23881-en

Prasetyo, H. (2020). Development of PISA Model Mathematics Problems Using the Context of East Kalimantan. *Jurnal Padegogik*, *3*(1), 1–44. https://doi.org/10.35974/jpd.v3i1.2230

Pratiwi, W., Christianti, M., & Hayati, N. (2025). Systematic Literature Study on Early Numeracy: Relations between Early Numeracy in Early childhood and Children's Mathematics. *Jurnal PG - Paud Trunojoyo*, *12*(1), 31–48.

https://doi.org/10.21107/pgpaudtrunojoyo.v12i1.28635

Pudjastuti, K. T., Agustika, G. N. S., & Wiyasa, I. K. N. (2024). Improving the Numeracy Skills Elementary School Students by Problem Based Learning Model. *MIMBAR PGSD Undiksha*, *12*(1), 57–63. https://doi.org/10.23887/jjpgsd.v12i1.69233

Puspitasari, E. (2025). SDGs-based adaptive curriculum model to improve education quality in the digital age. *Inovasi Kurikulum*, *22*(1), 1–12. https://doi.org/10.17509/jik.v22i1.75791

Putri, N. M., Hakim, L. E., & Ristanto, R. H. (2024). Literature Study on the Application of Project-Based Learning (PjBL) in Chemistry Learning. *Ideguru: Jurnal Karya Ilmiah Guru*, *10*(1), 433–442. https://doi.org/10.51169/ideguru.v10i1.1251

Rohim, D. C., & Nugraha, Y. A. (2023). The Influence of the Project Based Learning Model on Students' Numeracy Skills at SD Jatiroto 01. *Jurnal Review Pendidikan Dasar: Jurnal Kajian Pendidikan dan Hasil Penelitian*, *9*(3), 183–189. https://doi.org/10.26740/jrpd.v9n3.p183-189

Sa'dah, N. R., Afri, L. E., Nurrahmawati, N., & Arcat, A. (2025). Exploring Numeracy Skills in Algebra: A Cognitive Reasoning Analysis of Middle School Students in Indonesia. *International Journal of Applied Learning and Research in Algebra*. https://doi.org/10.56855/algebra.v2i1.1332

Samsiadi, S., & Romelah, R. (2022). Model Project Based Leaning (Pjbl) Dalam Pembelajaran PAI Di SMK Negeri 1 Berau Kaltim. *Research and Development Journal of Education*, *8*(1), 363. https://doi.org/10.30998/rdje.v8i1.12993

Setiawan, A. V., Meilina, S. A., Hutauruk, S. M., Khairunnisa, F. S., Arofah, A. N., & Ardiansyah, A. S. (2024). Enhancing Numeracy Literacy through CBL-STEM: Developing Differentiated Learning Materials with Augmented Reality and Articulate Storyline Integration. *AL-ISHLAH: Jurnal Pendidikan*, *16*(4), 5611–5627. https://doi.org/10.35445/alishlah.v16i4.5789

Setiyani, S., Gunawan, G., Waluya, S. B., Sukestiyarno, Y., Cahyono, A. N., Mutia, M., & Yunianto, W. (2025). The role of scaffolding in shaping reflective mathematical thinking of dependent field students in numeracy problems. *Infinity Journal*. https://doi.org/10.22460/infinity.v14i2.p531-550

Siregar, T., Suparni, Hilda, L., Amir, A., & Nasution, M. (2024). *Challenge Based on Differentiated Learning: Efforts to Develop Numeracy Literacy and Facilitate Student Learning Needs*.

Sugiyono, P. D. (2019). *Quantitative, Qualitative and R&D Research Methods* (1st ed.). Alfabeta, Bandung.

Wasik, B. A., & Hindman, A. H. (2020). Increasing preschoolers' vocabulary development through a streamlined teacher professional development intervention. *Early Childhood Research Quarterly*, *50*, 101–113. https://doi.org/10.1016/j.ecresq.2018.11.001

Yunita, Y., Juandi, D., Kusumah, Y., & Suhendra, S. (2021). The effectiveness of the Project-Based Learning (PjBL) model in students' mathematical ability: A systematic literature review. *Journal of Physics: Conference Series*, *1882*. https://doi.org/10.1088/1742-6596/1882/1/012080

Zainudin, A., Nawangsari, D. (2025). Analysis of The Independent Curriculum (Independent Learning, Independent Transformation, And Independent Sharing). *Jurnal Studi Keislaman*, *16*(01). https://doi.org/10.62097/falasifa.v16i12054

Zhang, L. (2023). A study of the impact of project-based learning on student learning effects : a meta-analysis study. *Frontiers in Psychology*, *July*, 1–14. https://doi.org/10.3389/fpsyg.2023.1202728

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: A meta-analysis study. *Frontiers in Psychology*, *14*, 1202728. https://doi.org/10.3389/fpsyg.2023.1202728

Zhang, W., Guan, Y., & Hu, Z. (2024). The efficacy of project-based learning in enhancing computational thinking among students: A meta-analysis of 31 experiments and quasi-experiments. *Educ. Inf. Technol.*, *29*, 14513–14545. https://doi.org/10.1007/s10639-023-12392-2