Journal of Science Education Literacy (2026) Vol 1 Issue 1
https://doi.org/10.30872/jsel.v1i1.6613

The effect of a project-based learning model focused on higher-order thinking skills on the science learning outcomes of grade VI at Elementary School at Barito Kuala Regency

Amelia Shalehah[1], E.W.N. Sofianto[1]*
[1]Universitas Islam Negeri Antasari Banjarmasin, Banjarmasin, Indonesia
*ekowahyu@uin-antasari.ac.id

Article

Keywords:
Higher Order Thinking Skills; Project Based Learning; Science Learning Outcomes

Article History
Received: May 18, 2026
Accepted: May 31, 2026
Published: May 31, 2026

Abstract

This study aims to determine the effect of applying the Project Based Learning model to questions based on Higher Order Tinking Skills in natural sciences Grade VI SDN Sahurai I Barito Kuala district and to find out whether there is a change or not in the increase in student knowledge results in science material. Nature. In this study the chosen method was the quasi-experimental method because the sample was not randomly selected but had been formed in the form of classes. The result of descriptive analysis on learning interpretation showing changes in the average student learning outcomes before with after implementing learning with the Project Based Learning model with with a value pre-test experimental class minimum 50.00 and maximum general 75.00 mean 64.67 with a standard foreign exchange of 7.432 after testing and post-testing Student learning outcomes increased to a minimum score of 80.00 with a maximum value of 95.00 with a mean 87.00. This shows an increase in learning outcomes, and it can be concluded that there is an influence of the project-based learning learning model on the higher order thinking skills. The results of the Paired Sample T Test shows that the output on the data obtained is a Sig (2-Tailled) result of 0.000 < 0.05, meaning that it can be concluded that there is an average difference in student learning outcomes between learning models project-based learning.

INTRODUCTION

Education is a long-term investment in life, designed to provide the next generation with the best possible preparation to fulfil their future responsibilities. In a narrow sense, education refers to the process of teaching and learning, the essence of which is learning [1,2]. The world of education is where children receive information, whether cognitive (mathematics, physics, chemistry, and so on), emotion (social sciences, sociology, and so on), or psychomotor (religion, ethics, discipline, skills, Pancasila moral education, and so on) [3,4]. As a foundation for students to face the challenges of a competitive future, this involves knowledge that combines the application of cognitive, emotional, and psychomotor guidance [5,6]. The government's policy of nine years of compulsory education serves as a means of eradicating illiteracy, which is the root cause of poverty and despair.

High-quality, effective learning is defined as learning that meets students' learning objectives as set out in the achievement indicators. An efficient learning model consists of four main components: 1) quality of learning, 2) an appropriate amount of learning, 3) incentives, and 4) time. Meanwhile, the quality of learning refers to the activities developed and the actions taken by learners and students, including learning materials or experiences (curriculum) and the media used [7].

In line with developments both in government and in terms of curriculum development in Indonesia, the implementation has also evolved from the previous curriculum to the 2013 Curriculum (K13); in the 2013 curriculum, learning activities are required to achieve maximum learning outcomes, namely the integration of Higher Order Thinking Skills (HOTS), leading to guidance and support during the process of learning, assessing, and evaluating ideas or facts discovered, with the aim of developing

all the work that has been observed [8,9]. Learning today is simply described as learning that can develop students' interests and talents, particularly the 4Cs (communication, collaboration, critical thinking and problem-solving, as well as creativity and innovation) [10].

Teachers' skills can be defined as their ability to deliver lessons that provide pupils with meaningful and enjoyable learning experiences. This approach is student-centred and encourages pupils to tackle challenges. Wina Sanjaya argues that teachers play a vital role in the learning process. No matter how advanced technology becomes, the role of the teacher will remain essential. Technology, which can make it easier for people to search for and obtain information and knowledge, will not be able to replace the role of the teacher.

Wina Sanjaya divides the role of the teacher into six parts: the teacher as a source of learning, the teacher as a facilitator, the teacher as a manager, the teacher as a demonstrator, the teacher as a mentor, and the teacher as a motivator. In the teaching and learning process, the teacher's role is not only that of a source of learning, but also that of a facilitator. This is in line with the objectives of the 2013 curriculum regarding Higher-Order Thinking Skills (HOTS) in developing higher-order thinking through science education in primary schools, which requires pupils to be able to perform and discover things.

This is in line with the vision for 21st-century education, which is based on a paradigm oriented towards logical and rational thinking, problem-solving, independence and character-building, tolerance and cooperation. Science education in primary schools covers the aspects of products, processes, attitudes, and application. General science skills are taught to encourage pupils to think about science in their daily lives. High Order Thinking Skills (HOTS) refer to the ability to critically and creatively connect, apply, and modify existing knowledge and experience to find solutions to problems in new situations [11,12].

Pupils' marks that fall below the minimum standard serve as an indicator of problems and automatically prevent them from achieving their objectives. This occurs very frequently in practice, where many pupils' marks remain low during daily assessments and even during termly exams. Based on the researcher's initial observations of Year 6 pupils at SDN Sungai Sahurai I, according to the form teacher, several pupils still achieved marks below the Minimum Passing Criteria (KKM) in several subjects, including Natural Sciences (IPA). The standard required to meet the Minimum Passing Criteria (KKM) for Natural Sciences (IPA) at SDN Sungai Sahurai I is 70. This is certainly a cause for concern, given that the current educational paradigm in Indonesia no longer implies graduation standards based on the fulfilment of cognitive MPCs, but rather affective and social MPCs.

The main issues affecting the achievement of science learning outcomes at SDN Sungai Sahurai are the pupils' inability to meet the Minimum Passing Criteria (KKM) and their lack of engagement in lessons; this makes it difficult for them to understand the subject matter. From the results of observations and interviews with students, the majority of them stated that the subject lacked appeal and they felt bored in science lessons because the material was merely presented, and students considered the science material to be very monotonous. According to the teacher, he stated that in science lessons based on the 2013 curriculum (K13), the use of varied teaching models is not fully mastered in the teaching and learning activities, particularly in science lessons which predominantly require practical work; as a result, the lessons tend to be boring and fail to capture students' interest in learning [13,14].

Based on the facts presented, it can be seen that some scores fall short of the required standards, and therefore improvements are needed. This is because teachers play a vital role in the success of the learning process. The provision of models for the learning process is essential to ensure variety in learning activities and to address existing issues. The learning model proposed by the researcher to address this issue is the Project-Based Learning (PBL) model, incorporating science (IPA) content oriented towards Higher Order Thinking Skills (HOTS) in Year 6 at SDN Sungai Sahurai I in Barito Kuala District, to assess the significance of the impact on the desired improvement in learning outcomes. Based on the description presented in the background of the problem, the researcher is interested in

conducting research on the influence of thinking skills-oriented Project-Based Learning model on the science learning outcomes of Year 6 pupils at SDN Sungai Sahurai I in Barito Kuala District.

RESEARCH METHOD

The type of research employed was field research using a quantitative approach, with data analysis involving numerical figures. The methodology employed in this study utilised an experimental design to control conditions using a quasi-experimental method; this method was chosen because the sample had already been organised into classes [15]. This study was conducted at SDN Sungai Sahurai I in the village of Simpang Arja, Rantau Badauh Sub-district, Barito Kuala Regency, involving 31 pupils. The research design was a matched pretest-post test design. The population for this study comprised all Year 6 pupils. The study utilised two classes: an experimental class and a control class. In the experimental class, lessons were delivered using a Project-Based Learning model based on Higher Order Thinking Skills, whilst the control class used a conventional teaching model. The study utilised the Science curriculum for the 2022/2023 academic year. The data collection techniques used in this study were observation, interviews, tests, and documentation. The instruments used in this study were the Lesson Plans and the question matrices, which would serve as the basis for calculating the research results.

The hypothesis of this study is: H_a: There is an effect of the Higher Order Thinking Skills-oriented Project-Based Learning model on the science learning outcomes of Year 6 pupils at SDN Sahurai I in Barito Kuala Regency. Meanwhile, H_o: There is no effect of the Higher Order Thinking Skills-oriented Project-Based Learning model on the science learning outcomes of Grade VI pupils at SDN Sahurai I in Barito Kuala Regency. The data analysis used to support the findings of this study was carried out using SPSS version 22, employing the following data analysis techniques: Descriptive Analysis, Normality Test (to determine whether the data is normally distributed and to assess the requirements for conducting a paired t-test), Paired t-Test (to determine differences in means), Homogeneity Test (to determine whether the data is homogeneous or heterogeneous), and Independent Samples t-Test (to determine differences in means between two different groups) [16].

RESULTS AND DISCUSSION

This research was conducted from November to December 2022. The research was carried out on Jalan Kali Barito Kuala, RT.004, Sahurai Village, Rantau Badauh Sub-district. To determine the effect of Project-Based Learning (PBL) on students' Higher Order Thinking Skills (HOTS) in science lessons, the researcher used instruments in the form of Lesson Plansand critical thinking-based questions at the beginning and end of the lessons. The presentation of data in this study is as follows:

Instrument Trial Results

The results of the instrument pilot test in this study were based on expert judgement, specifically through a review of the lesson plan (RPP) framework and essay-type open-ended questions, to assess their alignment with the research objectives and the items to be tested in the study. The results of the instrument pilot test are stated in Table 1.

Table 1. Instrument Trial Results

No.	Content	Indicator	Validation Results
1	Plant Reproduction	Comparing the stages of development inplants	4,3,4
2	Plant Reproduction	Comparing the development of plants	3,4,4
3	Plant Reproduction	Showing sequence of images of the development of plant vegetable green beans	4,4,3

No.	Content	Indicator	Validation Results
4	Plant Reproduction	Explaining the stages of development inplants	3,3,4
5	Plant Reproduction	Identifying the parts of a perfect flower in plant development	4,4,4
6	How Animals adapt	Animals adapt with environment	4,4,4
7	How Animals adapt	Analysing how animals adapt with its surroundings	4,3,4
8	How Animals adapt	Creating a diagram about animal adaptations to the environment	4,4,3
9	How Animals adapt	Comparing how animals adapt to their environment	4,4,4
10	How Animals adapt	An analysis of how animals adapt to their environment	4,3,4

Data Test Results

Descriptive Analysis

The descriptive analysis in this study serves to present and describe the research data, including the total number of data points, the maximum value, the minimum value and the mean. This analysis was conducted to support the research calculations. The descriptive analysis in this study was carried out using SPSS version 22. Based on the descriptive analysis from SPSS version 22, the following results were obtained:

Table 2. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test Experiment	15	50	75	64.67	7.432
Post-Test Experiment	15	80	95	87.00	4.51
Pre-Test Control	15	40	80	64.33	11.159
Post-test Control	15	65	85	75.33	7.188
Valid N (listwise)	15				

Table 2 shows that the lowest pre-test score for the experimental group was 50 (fifty) and the highest was 75 (seventy-five), with a mean of 64.67. As for the control group, the lowest pre-test score was 40 (forty) and the highest was 80 (eighty). The lowest post-test score for the experimental group was 80 (eighty) and the highest was 95 (ninety-five). Meanwhile, the lowest post-test score for the control group was 65 (sixty-five) and the highest was 85 (eighty-five).

Normality Test

Normality tests were conducted in this study to determine whether the research data were normally distributed or not; normal data are an absolute prerequisite before performing parametric statistical analyses such as the paired-sample t-test and the independent-sample t-test. In this study, the researcher used the Kolmogorov-Smirnov and Shapiro-Wilk normality tests. In the normality test, the data is considered normal if $p > 0.05$. For this normality test, the researcher used SPSS version 22:

Table 3. Tests of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	Df	Sig.
Pre Test	,185	15	,180

		Kolmogorov-Smirnov[a]		
		Statistic	Df	Sig.
Students Outcome	Experiment PBL Post Test	,278	15	,006
	Experiment PBL Pre Test Control	,149	15	,200*
	Post Test Control	,185	15	,177

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results in Table 3, the data are found to have a significance value (SIG) for Kolmogorov-Smirnov test: 0.180 > 0.05 (pretest), 0,006 > 0.05 (postest). This means that the significance values for both are greater than 0.05, so it can be concluded that the research data are normally distributed.

Paired Sample T-Test

A paired t-test can be performed if the data in the study are normally distributed, as determined by the normality test. The researcher used the Paired t-test to determine whether there was a difference in the means of the two paired samples. In this study, the Paired t-test was performed on the pre-test data of the experimental class against the post-test data of the experimental class (PBL model), and then on the pre-test data of the control class against the post-test data of the control class (Inquiry model). If the results of the Paired t-test for Pairs 1 and 2 yield a Sig (2-tailed) value 0.05, then the research data indicates a significant difference in learning outcomes. The researcher conducted the Paired Sample t-test using SPSS version 22:

Table 4. Paired Samples Test

	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre-test-Post-Test (Experiment)	-22.333	5.936	1.533	-25.621	-19.046	- 14.571	14	.000
Pre-Test-Post-test (Control)	-11.000	7.121	1.839	-14.944	-7.056	- 5.982	14	.000

The results in Table 4 show that output pair 1 indicates a significance value (two-tailed) of 0.000 0.05; the results indicate that there is a change in the average learning outcomes of students between the pre-test and post-test of the experimental class (PBL model). Based on output pair 1, it can be concluded that the problem-based learning model, which is oriented towards higher-order thinking skills, has an effect on the science learning outcomes of Year 6 pupils at SDN Sahurai I, Barito Kuala Regency. This is because the interpretation of the learning process shows a change in the average learning outcomes of pupils before and after the implementation of the Project-Based Learning model. The descriptive analysis of the means shows that the pre-test score for the experimental class was 64.67 and the post-test score was 87.00, indicating an improvement in learning outcomes [17,18].

Homogeneity Test

Homogeneity testing is used to determine whether the variance of the post-test data from the experimental class and the post-test data from the control class is homogeneous or heterogeneous. The data is considered homogeneous if the significance value (SIG) based on the mean is greater than 0.05. In conducting the homogeneity test, the researcher used SPSS version 22:

Table 5. Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Student Learning Outcomes	Based on Mean	2.660	1	28	.114
	Based on Median	1.800	1	28	.190
	Based on Median and with adjusted df	1.800	1	27.949	.191
	Based on trimmed mean	2.708	1	28	.111

In Table 5, the data is considered homogeneous if a > 0.05; after testing using SPSS version 22, the result was. The interpretation of the homogeneity test shows that the significance value (SIG) based on the mean is 0.114 > 0.05, indicating that the data in this study is homogeneous.

Independent Sample T Test

The independent samples t-test was conducted in this study to determine whether there was a difference in means between two unpaired groups. The key requirements for this independent samples t-test are that the data should be normally distributed and homogeneous (though this is not an absolute requirement). The results of the analysis of normality and homogeneity indicated that the data were normally distributed and homogeneous. In conducting the independent samples t-test, the researcher utilised SPSS version 22:

Table 6. Indepedent Samples Test

		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
Student Learning Outcomes	Equal variances assumed	2.660	.114	5.311	28	.000	11.667	2.197	.167	16.166
	Equal variances not assumed			5.311	23.671	.000	11.667	2.197	7.130	6.204

The results in Table 6 show that the interpretation of the Paired Sample t-test indicates a Sig (2-tailed) value of 0.000; this means that, based on these results, it is evident that 0.000 < 0.05 or the calculated r is less than the critical r. Therefore, H0 is rejected and Ha is accepted. It can thus be concluded that there is a difference in the average learning outcomes of students between the project-based learning model and the conventional model.

Based on the results of the statistical analysis above regarding the treatment administered by the researcher, it can be seen that the experiment had an effect on the students' level of engagement in science learning; however, this effect was not particularly significant. This was due to the learning process in the experimental class not being optimised and the limited time allocated to the lesson; the learning model used by the researcher required more time, both for preparation and during the experiments themselves.

Improvements in the affective domain in this study were achieved by delivering instruction using a project-based learning model to pupils; this approach involved not only presenting various theories but also incorporating simple project-based learning activities related to the subject matter. Following the implementation of this learning model, pupils' enthusiasm for science subjects increased in cognitive, affective and psychomotor terms. This improvement indicates that the education has succeeded in

fostering development in both physical and spiritual aspects, the ultimate aim being the formation of a well-rounded personality.

Data Analysis

In this study, the data analysis employed was descriptive statistical analysis, with the aim of presenting and describing the research data, including the mean, median, mode, standard deviation, lowest score and highest score. The data analysis in this study is as follows:

Analysis of Student Learning Outcomes

The results before and after the implementation of the Project-Based Learning model among Year 6 pupils at SDN Sahurai I show the progress in learning, with the class pre-test scores. The pre-test scores ranged from a minimum of 50.00 to a maximum of 75.00, with a mean of 64.67 and a standard deviation of 7.432. Following the trial and post-test, the students' learning outcomes improved, with scores ranging from a minimum of 80.00 to a maximum of 95.00, and a mean of 87.00. The researcher obtained this data from calculations using SPSS version 22.

Table 7. Student Learning Outcomes

	Experiment		Control	
	Pre-test	Post-test	Pre-test	Post-test
Minimum	50	80	40	65
Maximum	75	95	80	85
Mean	64.67	87	64.33	75.33
Standar Deviation	7.432	4.551	11.159	7.188

Based on Table 7 and the results presented in the diagram above, it can be seen that the implementation of the project-based learning model has had a significant impact on the learning outcomes of Year 6 pupils at SDN Sahurai I. Prior to the implementation of the project-based learning model in science lessons at SDN Sungai Sahurai I, the majority of pupils felt bored because they found science lessons to be very tedious and monotonous. Following the implementation of project-based learning, significant results were observed [19,20]. This is evident from the pupils' marks, which indicate that the learning model has been successfully implemented and that there has been progress as a result of its application [8,21].

An Analysis of the Impact of the Project-Based Learning (PBL) Model on Student Learning Outcomes

In the teaching and learning process, the use of appropriate teaching methods can have a significant impact on improving pupils' learning activities and outcomes. Essentially, all teachers want the learning process to be successful; however, to achieve this, significant changes are required to the learning process itself, so that high-quality learning can be achieved and the set indicators met [22,23].

Following an analysis using a paired-sample t-test in SPSS Version 22 on the learning outcomes of pupils at SDN Sungai Sahurai I, the results showed a significance value (two-tailed) of $0.000 < 0.05$. The results indicate that there was a change in the average learning outcomes of students in the pre-test and post-test of the experimental class using the Project-Based Learning model. Based on the output of pair 1, it can be concluded that there is an effect of the implementation of the Problem-Based Learning model on the higher-order thinking skills of Year 6 students at SDN Sahurai I.

The interpretation of the findings indicates a change in the average learning outcomes of students between before and after the implementation of the Project-Based Learning model [24,25]. The descriptive analysis of the means shows that the pre-test score for the experimental class was 64.67 and the post-test score was 87.00; this indicates an improvement in learning outcomes. Based on these results, it is evident that the calculated r is greater than the table r, so it can be concluded that H0 is rejected and Ha is accepted.

CONCLUSION

Based on the presentation and analysis of research data, it indicates that there was a change in the average student learning outcomes between the pre-test and post-test of the experimental class (PBL model). The change in the average student learning outcomes indicates an increase in learning outcomes and leads to the conclusion that there is an effect. Therefore, it can be concluded that there is a difference in the average student learning outcomes between the Project-Based Learning model and the Higher-Order Thinking Skills questions.

AUTHOR CONTRIBUTIONS

Conceptualization, A.S. and E.W.N.S.. Methodology, A.S.. Software, A.S.. Validation, A.S. and E.W.N.S.. Formal Analysis, A.S.. Investigation, A.S.. Resources, A.S.. Data Curation, A.S.. Writing Original Draft Preparation, A.S.. Writing Review and Editing, Amelia Shaleha and E.W.N.S.. Visualization, E.W.N.S.. Supervision, E.W.N.S.. Project Administration, A.S.. No Funding Acquisition. All authors must review and approve the final version.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

[1] Acesta A, Sumantri MS, Fahrurrozi. Development of Natural Science Learning Models Based on Multiple Inteligences to Improve Higher Order Thinking Skills in Elementary Schools. J Phys Conf Ser 2020;1477:042036. https://doi.org/10.1088/1742-6596/1477/4/042036

[2] Marisda DH, Handayani Y, Rahmawati. The combination of interactive conceptual learning models and multimedia interactive to minimize misconceptions on the science content. J Phys Conf Ser 2020;1572:012069. https://doi.org/10.1088/1742-6596/1572/1/012069

[3] Susanto A. Teori Belajar dan Pembelajaran di Sekolah Dasar. Jakarta: Prenamedia Group; 2013.

[4] Handayani IDAT, Karyasa NIW, Suardana IN. Komparasi Peningkatan Pemahaman Konsep Dan Sikap Ilmiah Siswa Sma Yang Dibelajarkan Dengan Model Pembelajaran Problem Based Learning Dan Project Based Learning. J Pendidik Dan Pembelajaran IPA Indones 2015;5:1–12.

[5] Febriana Eka Handayani, Imaniar Purbasari, Gunawan Setiadi. Pengaruh Model Kooperatif Tipe Scramble Melalui Kemampuan Kognitif Sosial untuk Meningkatkan Hasil Belajar pada Pembelajaran IPS Kelas V di SD 5 Bae Kudus. Didakt J Ilm PGSD STKIP Subang 2023;9:221–5. https://doi.org/10.36989/didaktik.v9i04.1599

[6] Rusydiana M, Nuriman N, Wardoyo AA. Pengaruh Model Project Based Learning Terhadap Higher Order Thinking Skills Pada Siswa Kelas V Sekolah Dasar. EduStream J Pendidik Dasar 2022;5:13–6. https://doi.org/10.26740/eds.v5n1.p13-16

[7] Okta Pia NA, Masnur M, Elihami E. Pengaruh Model Pembelajaran Problem Based Learning Terhadap Higher Order Thinking Skills (HOTS). Mahaguru J Pendidik Guru Sekol Dasar 2021;2:72–89. https://doi.org/10.33487/mgr.v2i2.2880

[8] Utami AU, Setyawan B, Anggraeni SL, Afandi A, Moniz JPG da C. The Effectiveness of The Development of Digitalization of IPAS Textbooks Based on Higher Order Thinking Skills (HOTS) in The Independent Curriculum. JPPS (Jurnal Penelit Pendidik Sains) 2025:124–37. https://doi.org/10.26740/jpps.v14n2.p124-137

[9] Siswanto E. Pengembangan Model Project Based Learning Tentang Kenampakan Alam Dengan Media Diorama Untuk Peningkatan High Order Tingking Skill (Hots) Siswa Kelas 4 Sdn Punten 01 Kota Batu. J Pendidik Taman Widya Hum 2023;2:751–74.

[10] Qiftiyah M. Muatan HOTS pada Pembelajaran Tematik Materi IPA Kelas 5 Sekolah Dasar. Sch

J Pendidik Dan Kebud 2023;13:28–38. https://doi.org/10.24246/j.js.2023.v13.i1.p28-38

[11] Raga SD, Fitriyah CZ, Finali Z. The Effect of Implementing Problem-based Learning on the Fifth Grade Students' Higher Order Thinking Skills on Heat and Transfer Theme at Sdn Kepatihan 06 Jember. Prim J Pendidik Guru Sekol Dasar 2020;9:482–91. https://doi.org/10.33578/10.33578/jpfkip.v9i4.7959

[12] Karsono K. Pengaruh penggunaan LKS berbasis hots terhadap motivasi dan hasil belajar IPA siswa SMP. J Pendidik Mat Dan Sains 2017;5. https://doi.org/10.21831/jpms.v5i1.13540

[13] Setyosari P. Menciptakan Pembelajaran Yang Efektif Dan Berkualitas. Jinotep (Jurnal Inov Dan Teknol Pembelajaran) Kaji Dan Ris Dalam Teknol Pembelajaran 2014;1:20–30.

[14] Lestari H, Fauziah A, Amaliyah P. Model Problem Based Learning (PBL) Untuk Meningkatkan Pemahaman Konsep IPA Siswa Kelas IV SD. J Kaji Islam Mod 2024;11:1–10. https://doi.org/10.56406/jkim.v11i01.496

[15] Sugiyono. Metode penelitian kuantitatif, kualitatif, dan R&D. 3rd ed. Bandung: Alfabeta; 2021.

[16] Arikunto S. Pengembangan Instrumen Penelitian dan Penilaian Program. Jakarta: Pustaka Belajar; 2017.

[17] Djonomiarjo T. Pengaruh Model Problem Based Learning Terhadap Hasil Belajar. Aksara J Ilmu Pendidik Nonform 2020;5:39. https://doi.org/10.37905/aksara.5.1.39-46.2019

[18] Hutabarat R. Peningkatan High Order Thinking Skill (Hots) Pada Pembelajaran Sifat dan Perubahan Wujud Benda Melalui Pendekatan Sains Teknologi Masyarakat (STM) Kelas IV SD Negeri 167959 Kota Tebing Tinggi Tahun Pelajaran 2017/2018. Elem Sch J 2019;9:159–68. https://doi.org/10.24114/esjpgsd.v9i2.14326

[19] Wini Media Putri, Tiok Wijanarko. Penerapan Model Problem Based Learning (PBL) dalam Meningkatkan Hasil Belajar IPAS di Kelas V SDN 16 Pulau Karam Kabupaten Pesisir Selatan. Edukasi Elit J Inov Pendidik 2025;2:185–200. https://doi.org/10.62383/edukasi.v2i2.1449

[20] Fatonah H, Handini O, Musthofa M. Analisis Soal Cerita Berbasis HOTS Pada LKPD Mata Pelajaran IPAS Materi Daerahku Kelas IV SDN Kestalan. Prim Educ Journals (Jurnal Ke-SD-An) 2025;5:606–14. https://doi.org/10.36636/primed.v5i2.5501

[21] Ana Mariana, Berliana Novia Fitri Yani, Eka Lina Yunita, Oktavia Kharisma Pertiwi, Umi Samsiyah. Studi Literatur: Penggunaan Model Problem Based Learning (PBL) Untuk Meningkatkan Pembelajaran IPA di SD/MI. Indones J Elem Educ 2025;1:160–5. https://doi.org/10.62567/ijete.v1i2.1766

[22] Fatimah S. Elementary School Pre-Teacher Prospective on the Application of HOTS-Based Questions in Improving Analytical Critical Thinking Ability in Science Lessons. MISOOL J Pendidik Dasar 2024;6:32–41. https://doi.org/10.47945/misool.v6i1.1688

[23] Nasution M, Hasairin A, Hasruddin. Development of IPAS worksheet using problem-based learning to improve critical thinking. Inov Kurikulum 2025;22:1685–700. https://doi.org/10.64014/jik.v22i3.99

[24] Rosida FA, Nuvitalia D. Analisis Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis Pada Pembelajaran IPAS Kelas IV SDN Gayamsari 02 Semarang. Innov J Soc Sci Res 2024;4:7954–7963. https://doi.org/10.31004/innovative.v4i2.10240

[25] Santika DGAW, Kertih IW, Arnyana IBP. Media Micro Content Berorientasi HOTS Untuk Meningkatkan Hasil Belajar IPAS pada Siswa Kelas IV Sekolah Dasar. J Educ Action Res 2025;9:202–9. https://doi.org/10.23887/jear.v9i2.92009