INTERNATIONAL JOURNAL OF CONTEMPORARY STUDIES IN EDUCATION
IJ-CSE
https://journals.eduped.org/index.php/ijcse
E-ISSN 2963-0282, P-ISSN 2963-5993

The Effect of The PjBL Model on Student Learning Outcomes in The Science Subject Based on Marharoan Bolon of Elementary School

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Received: 29/06/2025 Revised: 29/07/2025 Accepted: 12/08/2025

ABSTRACT

Purpose – This study aims to investigate the impact of the Project-Based Learning (PjBL) model on students' learning outcomes in the science subject (IPAS) based on Marharoan Bolon for Grade IV students at UPTD SD Negeri 122345 Pematangsiantar. The study is designed to assess the effect of this teaching model on student performance.

Methodology – A pre-experimental research design using the One-Group Pretest-Posttest Design was employed. The sample consisted of 26 fourth-grade students from UPTD SD Negeri 122345 Pematangsiantar. The study utilised various instrument tests, including validity, reliability, difficulty level, and discrimination index tests. Data were collected through tests and documentation. Data analysis involved normality testing, t-test, and N-Gain to determine the effect of the PjBL model on learning outcomes.

Findings – The study found a significant positive effect of the PjBL model on students' science learning outcomes, with a significance value of 0.00 ($p < 0.05$) and a t-value of 16.11, exceeding the critical t-value of 1.70. These results indicate that the PjBL model improves students' academic performance in IPAS.

Novelty – This research contributes to the field by exploring the application of the PjBL model in teaching science (IPAS) based on Marharoan Bolon, offering a culturally relevant approach for students in Pematangsiantar.

Significance – The findings benefit educators and curriculum developers, especially in primary education, by providing evidence of effective teaching methods that enhance student learning outcomes in science.

Keywords: Learning improvement; Project-based learning; Science education; Student outcomes; T-test; Teaching models; Validity test.

How to cite: Tambunan, D. M., Thesalonika, E., & Simanjuntak, M. M. (2025). The Effect of The PjBL Model on Student Learning Outcomes In The Science Subject Based on Marharoan Bolon of Elementary School. *International Journal of Contemporary Studies in Education.* 04(3), pp. S, doi: https://doi.org/10.56855/ijcse.v4i3.1729

1. Introduction

Education is a conscious and planned effort to create a learning atmosphere and learning atmosphere and process that enables students to actively develop their potential, including spiritual and religious strength, self-control, personality, intelligence, noble morals and skills needed by themselves and society (Astuti et al., 2024; Brown & Usoro, 2023; Rismayani, 2024). Therefore, education is not only directed at delivering academic content but also at shaping students' character and attitudes through structured learning interactions. In the learning process, students serve as the central subjects whose development reflects the effectiveness of educational practices (Başaran, 2022; Fitri Andriyanti et al., 2023; Pravitasari & Bagus Paripurna, 2024; Sumer et al., 2021; Uya, 2023). For this reason, understanding students' responses, learning behaviours, and academic outcomes becomes crucial. Accordingly, this study adopts a quantitative approach to systematically measure and analyse students' experiences and outcomes in the learning environment, allowing for objective data interpretation and generalizable conclusions regarding the factors that influence their learning.

According Rahman et al. (2022) educational goals are what is desired to be achieved in the learning process and the direction toward which guidance is directed. In general, educational goals are abstract because they contain abstract values (Nasrullah et al., 2024; Nkeiru & Rose, 2023; Putri & Nurhuda, 2023). Such goals are general, ideal, and very broad in content, making them difficult to implement in practice. Meanwhile, education must be an action aimed at students under specific conditions, in specific places, and at specific times, using specific (PjBL).

The Independent Curriculum (Curriculum Merdeka) merges Natural Sciences (IPA) and Social Sciences (IPS) into Natural and Social Sciences (IPAS) at the elementary school level. This integration is based on the understanding that elementary-aged students tend to perceive knowledge holistically rather than as separate disciplines (Arenas, 2024; Lamo et al., 2023; Suhaeni, 2023; Vithanage & Nakashima, 2025). Integrated learning encourages students to understand their natural and social environment as a unified reality. To support this holistic approach, learning models must also promote meaningful, contextual, and inquiry-based learning experiences. The Project-Based Learning (PjBL) model aligns with this need because it engages students in exploring and solving real-life problems through interdisciplinary projects. PjBL helps students connect concepts from both natural and social sciences, apply their understanding in practical situations, and develop collaboration, reasoning, and communication skills. Thus, integrating IPAS with PjBL strengthens the learning process by making it more relevant, experiential, and closely linked to students' daily lives.

The subject of natural sciences (IPAS), particularly in the social context, often encounters problems related to students' lack of interest because learning is predominantly conducted through a lecture-only approach. This approach tends to position students as passive

recipients of information, resulting in limited engagement, low motivation, and reduced opportunities for inquiry and collaboration (Caingcoy, 2021; Ilmiah, 2024; Nur & Pratiwi, 2024; Sidi & Ackerman, 2024). Therefore, an alternative instructional strategy is needed to create a more active, meaningful, and contextually relevant learning experience. One promising innovation is IPAS learning based on local wisdom, which incorporates cultural and natural resources into the learning process. Local wisdom-based learning not only strengthens students' understanding of their environment but also nurtures character values rooted in their community. When combined with the Project-Based Learning (PjBL) model, this approach encourages students to collaboratively explore real-life issues within their own cultural context. Thus, local wisdom-based PjBL can enhance student engagement, promote deeper learning, and support the formation of character that reflects local values (Mayangsari et al., 2024)

One of the local wisdoms that can be associated with the Project-Based Learning (PjBL) model is Marharoan Bolon. Marharoan Bolon is a tradition that is still carried out by the Simalungun community to this day. Marharoan Bolon comes from two words, namely the words haroan bolon and marharoan bolon, which mean simultaneous, compact, and together. In the Simalungun community, haroan bolon is used for shared interests. The meaning of the term marharoan bolon in Indonesian itself is working together. When carrying out marharoan bolon, the community will first agree in determining the time for carrying out this cooperation. In some areas in Simalungun, the term marharoan bolon is used for annual work activities (Damanik & Damanik, 2023). This principle aligns closely with the core characteristics of the PjBL model, where learning activities are carried out collaboratively through project work. Both Marharoan Bolon and PjBL emphasise cooperation, mutual responsibility, democratic participation, and the importance of contributing to the community. Therefore, integrating Marharoan Bolon into PjBL can strengthen students' social interaction skills, sense of responsibility, problem-solving ability, and respect for cultural values while engaging them in meaningful, real-world learning experiences.

Based on the results of initial interviews at elementary schools on May 26-27, 2025, information was obtained on the Semester Exam Scores of fourth-grade students of the UPTD SD NEGERI 122345 Jl. Thamrin Pematangsiantar, that there are still sudents whose Semester Exam Scores have not achieved the Learning Objectives (KKTP) which have been found at the UPTD SD Negeri 122345 Jl Thamrin Pematangsiantar with the semester exam scores for the subject of Social Studies in fourth-grade students, including students who pay less attention to the teacher when teaching, students who are bored during the learning process, and students' curiosity is still low. This can be seen when the teacher asks questions to students, and some students who do not respond are still busy playing with their friends.

Table 1 - Semester Exam Scores for the Social Sciences Subject for Class

No.	KKTP	Number of Students	Completed	Not Completed
1	70	26	9	17

Based on the data in the table above, it shows that students who get a score of 70 are categorised as incomplete ≤70, and several students complete≥70 during the student's

Semester Exam Score. Where the percentage of students' Semester Exam Scores who complete is 35% (9 people), and incomplete is 65% (17 people). The number of students who do not complete is due to teachers who only use conventional methods in learning science in class. Teachers who only use lecture models in the learning process so that learning becomes boring, many students are not focused because they play with their friends, there is no interaction between teachers and students which results in a lack of cooperation in learning between teachers and students so that learning objectives have not been achieved optimally by students.

Because of the learning outcomes of students at UPTD SD Negeri 122345 Jl Pematangsiantar are still not optimal, the researcher is motivated to implement an effective learning model that aligns with science learning material, namely the Project-Based Learning (PjBL) model. The PjBL model encourages students to be actively engaged in the learning process through planning, formulating, implementing, and evaluating project activities. This approach not only promotes student engagement but also fosters creativity as students are given opportunities to explore and express their ideas. Moreover, by being directly involved in project implementation, students develop a sense of responsibility for their learning outcomes. The collaborative nature of PjBL further supports cooperation and teamwork, enabling students to work together in solving problems and achieving shared goals. Therefore, PjBL is expected to bridge the existing learning gaps and improve students' overall learning outcomes.

From the description, it is evident that the low learning outcomes in science among students need to be addressed through the implementation of an appropriate learning model. Therefore, the researcher considers it necessary to conduct a study focusing on the Project-Based Learning (PjBL) model as an alternative solution to improve student learning outcomes. This research is entitled "The Effect of the PjBL Model on Student Learning Outcomes in the Subject of Science Based on Marharoan Bolon in Class IV at UPTD SD Negeri 122345 Pematangsiantar." Through this study, it is expected that the PjBL model can enhance students' engagement, creativity, responsibility, and collaboration, ultimately leading to improved learning achievement.

2. Methods

The type of research used in this study is a quantitative approach with an experimental design. Experimental research involves manipulating a specific variable and observing its effect on other variables to determine a cause-and-effect relationship. In this study, the researcher applies the pretest–posttest design, where students are given a pretest before the treatment to measure their initial learning abilities. After the treatment using the Project-Based Learning (PjBL) model, students are then given a posttest to assess the improvement in their learning outcomes. The difference between the pretest and posttest results indicates the effectiveness of the learning model applied.

This research uses a quantitative experimental approach with a one-group pretest–posttest design. In this design, students' learning outcomes are measured twice: the pretest is

administered before the Marharoan Bolon–based Project-Based Learning treatment to determine their initial learning level, and the posttest is administered after the treatment to assess any improvement. The difference between the pretest and posttest scores indicates the effectiveness of the learning intervention.

Table 2 - Research Design

Class	Pre -test	Treatment	Post -test
Eksperimen	1	X	O2

In this study, the population consisted of 26 fourth-grade students at UPTD SD Negeri 122345, consisting of 10 males and 16 females aged 9–10 years. This population was chosen because it is directly relevant to the learning problem identified at the school, namely, the low science learning outcomes. In addition, the class was accessible to the researcher, making it feasible to carry out the implementation and observation of the Project-Based Learning (PjBL) model effectively.

The sample in this study was determined using total sampling, so all 26 fourth-grade students (10 males and 16 females) were included as the research sample. The entire population was used because saturated sampling was applied. The variables in this study consist of the Independent Variable (X): Marharoan Bolon–based Project-Based Learning (PjBL) Model Dependent Variable (Y): Student Learning Outcomes in Science. The data collection techniques used in this study were tests and documentation. The test instrument (pretest and posttest) was used to measure students' science learning outcomes before and after the implementation of the Marharoan Bolon–based Project-Based Learning model. Meanwhile, documentation was used to collect supporting data such as school profiles, the number of students, photos of learning activities, and lesson implementation records. Furthermore, the test instrument underwent validity, reliability, difficulty level, and discriminating power analyses. The data were then analysed using normality testing, t-test, and N-Gain to determine the effectiveness of the learning model.

3. Results and Discussion

3.1. Results

This study aimed to determine the influence of the Marharoan Bolon–based Project-Based Learning (PjBL) model on student learning outcomes in the Natural Sciences (IPAS) subject. The research employed a one-group pretest–posttest design, in which students were given a pretest before the implementation of the PjBL model and a posttest afterwards. The difference between the pretest and posttest scores was used to measure the improvement in learning outcomes.

The learning outcome test instrument was analysed for validity and reliability before use. From the validity test results, 20 out of 25 items were declared valid. The reliability test showed a Cronbach's alpha value of 0.871, which falls within the high reliability range ($0.80 < r \leq 1.00$). These results indicate that the test instrument used in this study is both valid and reliable.

This indicates that items 1-25 used in the pretest and posttest have high reliability. In terms of item difficulty, 12 items fall into the easy category and 8 into the medium category. The results of the item discrimination test show that 3 items are in the excellent category, 14 items are in the good category, and 3 items are in the sufficient category. These findings suggest that the test items vary in difficulty and are generally capable of distinguishing between students with higher and lower levels of mastery. Therefore, the instrument is considered appropriate for measuring student learning outcomes in this study.

Based on the validity, reliability, difficulty level, and discriminatory power analyses, items 1–20 were deemed appropriate for measuring students' science learning outcomes. The pretest scores ranged from 20 to 87, with an average of 52.50, while the posttest scores ranged from 65 to 100, with an average of 86.83. This increase in both the minimum, maximum, and mean scores indicates a substantial improvement in student learning outcomes after the implementation of the Marharoan Bolon-based Project-Based Learning model. Thus, the instrument not only functioned effectively in data collection but also revealed a positive learning effect.

The results show a clear improvement in students' learning outcomes after the treatment. Overall, the posttest scores were consistently higher than the pretest scores, indicating that most students achieved better mastery of the material following the implementation of the Marharoan Bolon-based Project-Based Learning model. This trend demonstrates that the learning model had a positive impact on students' understanding and performance, as shown by the increase in average scores from the pretest to the posttest.

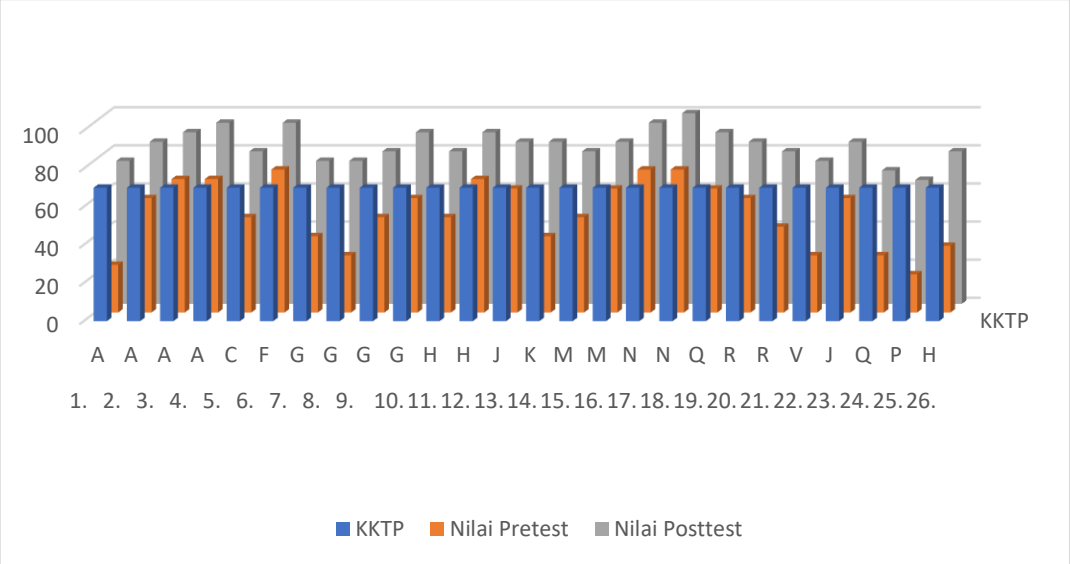

Figure 2. Diagram of Average Learning Outcomes of Grade IV Students

Based on the bar chart above, it can be seen that the average pretest score was 52.5 and the posttest score was 86.83. It can be concluded that there was an increase in student learning outcomes in the posttest after being given treatment using the Project Based Learning model for fourth grade students.

The following are the results of the normality test using SPSS 20 with the basis for decision making in the test, namely:

Table 4 - Normality Test

	class	Shapiro-Wilk		
		Statistic	**df**	**Sig.**
results	pretest	.931	26	.082
	postest	.970	26	.625

(Source: SPSS 20 Output Data)

Based on the table above, the pretest data obtained was 0.82 > 0.05, so the data was normally distributed; likewise, the posttest data 0.62 > 0.05 was normally distributed.

Data analysis using a paired sample test to see the influence of the Project-Based Learning model on the science subject of class IV UPTD SD Negeri 122345 Pematangsiantar can be seen in the following table:

Table 5 - t-Test Results

Information	**Mark**
t_{count}	16,11
t_{table}	1.70
Significance	0,00

(Source: SPSS 20 Output Data)

Based on the results of the t-test above, it can be assessed as significant at 0.00, which means a significant value <0.05. It can be concluded that there is an influence of the PjBL Model on student learning outcomes in the Marharoan Bolon-based science subject of class IV UPTD SD Negeri 122345 Pematangsiantar. In addition, it can be seen from the t count of 16.11 with t table 1.70, which means there is an influence of the PjBL Model on student learning outcomes in the Marharoan Bolon-based science subject of class IV UPTD SD Negeri 122345 Pematangsiantar.

The N-Gain test is used to measure the extent to which the learning model is active before treatment (pretest) to the target learning outcomes after treatment (posttest). The N-Gain value in this study is seen as follows:

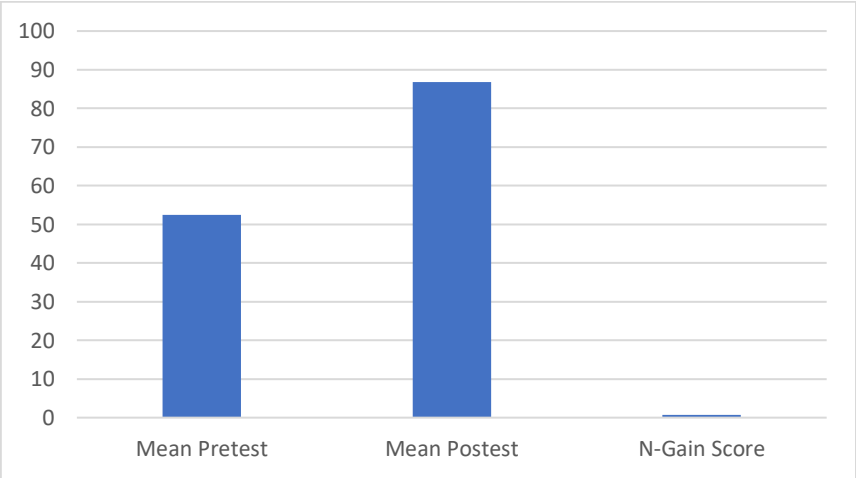

Figure 3. N-Gain Test

Based on the image above, the N-Gain score is 0.66 with a moderate category, with a moderate category of 0.30 ≤ g ≤ 0.70 with a fairly effective category. And the mean Pretest is 52.50, while the mean posttest is 86.83. So this data shows that the PjBL Model on student learning outcomes in the Marharoan Bolon-based Science subject can improve the learning outcomes of fourth-grade students of UPTD SD Negeri 122345 Pematangsiantar.

3.2. Discussions

This study discusses the application of the Project-Based Learning (PjBL) model that incorporates the value of Marharoan Bolon (mutual cooperation) to improve student learning outcomes in the fourth grade of UPTD SD Negeri 122345 Pematangsiantar on the topic "My Region, My Natural Wealth." The learning intervention began with instrument validation followed by the administration of a pretest and posttest. The pretest results showed an average score of 52.50. After the implementation of the PjBL model, the posttest average increased to 86.83, indicating an improvement of 34.33 points. This significant increase suggests that integrating collaborative cultural values within the PjBL model effectively enhances students' learning outcomes.

The improvement in students' learning outcomes can be explained through the core principles of the Project-Based Learning (PjBL) model applied in this study. First, the learning activities were designed to be authentic, as students explored real local natural resources in their surrounding environment, making the learning experience more meaningful and relevant. Second, the integration of collaboration was strengthened through the cultural value of Marharoan Bolon, where students worked together to plan, produce, and present their project outcomes, which fostered mutual support and shared responsibility. Third, autonomy was encouraged by allowing students to make decisions and manage their project tasks independently under teacher guidance. These three principles collectively contributed to increased student engagement and understanding, as reflected in the rise of the average score from 52.50 in the pretest to 86.83 in the posttest.

The implementation of the Project-Based Learning model in this study not only improved students' cognitive understanding but also fostered essential learning skills. Through the project activities, students were required to plan, investigate, create, and present their work, which helped develop problem-solving and critical thinking abilities. The integration of Marharoan Bolon (cooperation) played a central role in this process. This cultural value encouraged students to collaborate, share responsibilities, and support one another throughout the project stages. As a result, students became more engaged and confident in expressing ideas, while also strengthening their communication and teamwork skills. Therefore, the improvement in learning outcomes is not merely the result of receiving instructional material, but rather the outcome of students actively constructing knowledge and skills through collaborative, culturally grounded project work. learning outcomes in the Marharoan Bolon (cooperation) based science subject in grade IV, researchers found that all students had real experiences and were in accordance with the material studied, namely regarding the material My Region My Natural Wealth? making Simalungun batik patterns. Students, together with each group, prepared the project to the maximum and had a full sense

of responsibility as students by instilling a sense of full cooperation and enthusiasm until the project was ready and as expected. In making jumputan batik where students were instilled with a spirit of cooperation, responsibility, discipline, in working on projects and how each group tried to make jumputan batik with Simalungun patterns which were initially only plain white cloth and dye into a beautiful jumputan batik result, students who helped each other to make projects and did not want to win alone or be selfish, but students worked together and helped each other so that the jumputan batik project was completed by grateful students as a form of student group work in making projects.

The implementation of the Project-Based Learning (PjBL) model integrated with the cultural value of Marharoan Bolon (cooperation) in the IPAS subject for fourth-grade students encourages active engagement throughout the learning process. Through project activities, students not only learn concepts but also experience meaningful learning by planning, creating, and completing their own project products. The value of Marharoan Bolon fosters collaboration, shared responsibility, and mutual support among students, creating a participatory and cooperative learning environment. This direct and experiential learning process helps students understand the topic of local natural resources more deeply and retain the knowledge for a longer period. Consequently, this approach contributes.

Future research may expand the scope of this study by involving a larger and more diverse sample to strengthen the generalizability of the findings. Researchers are also encouraged to apply the Project-Based Learning model in different subject areas or grade levels to examine its consistency and effectiveness across various learning contexts. Additionally, qualitative approaches—such as interviews or classroom observations—may provide deeper insights into students' engagement, and the role of Marharoan Bolon (cooperation) in shaping collaborative learning behaviours can also be proven by the hypothesis test of the student's t-test results above, which can be assessed as significant at 0.00, meaning a significant value <0.05. It can be concluded that the PjBL Model has an effect on student learning outcomes in the Marharoan Bolon-based science subject for grade IV at the UPTD of Elementary School 122345 Pematangsiantar. Furthermore, it can be seen from the t-count of 16.11 and the t-table of 1.70, which indicates the influence of the PjBL Model on student learning outcomes in the Marharoan Bolon-based science subject for grade IV at the UPTD of Elementary School 122345 Pematangsiantar.

This study also found that students experienced an increase from the initial test score (pretest) of 20 and also the posttest score (posttest) of 65, where students experienced an increase with a difference of 45 but still did not meet the KKTP (Competency Minimum Competency) because these students still had difficulty reading and understanding the questions given in both the pretest and posttest questions and students did not have much time to understand the questions given. Therefore, it is recommended for future researchers to use media that focuses students on practising reading by using the Project-Based Learning model on student learning outcomes in the Science subject, based on Marharoan Bolon (cooperation) to improve student learning outcomes.

This study also supports previous studies, which state that the use of the Project-Based Learning model on student learning outcomes in the subject of science, based on Marharoan Bolon (cooperation), improves student learning outcomes. Research conducted by (Sari, 2025) the Project-Based Learning (PjBL) learning model affects student learning outcomes in the subject of Science, because during the learning process, students are required to be active in completing a project and group work between students, so that it can foster a sense of competition between students and learning in the classroom can be more interesting. And research conducted by (Elang, 2024) the Project-Based Learning model on student learning outcomes in the material of types of community environmental conservation efforts. This Project-Based Learning model can provide meaningful learning experiences for students, because students are actively involved in the learning process through project learning, and the process of transferring knowledge is carried out independently by students through project assignments.

4. Conclusions

Based on the results of this study, it can be concluded that the implementation of the Project-Based Learning (PjBL) model positively influenced students' learning outcomes in the Marharoan Bolon-based science learning for fourth-grade students at UPTD SD Negeri 122345 Pematangsiantar. The PjBL model encouraged students to be actively involved in constructing their knowledge through hands-on project activities, collaboration with peers, and contextual learning experiences connected to their local environment. These learning processes fostered deeper understanding and improved students' mastery of the material, which was evidenced by significant increases in post-test scores compared to the pre-test results. The results of the t-test show a significance value of 0.00 (< 0.05) and a t-count of 16.11, which is greater than the t-table value of 1.70. These findings indicate that there is a statistically significant difference in students' learning outcomes before and after the implementation of the Project-Based Learning (PjBL) model. Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted, meaning that the PjBL model effectively improves students' learning outcomes.

Conflict of Interest

The authors declare no conflicts of interest.

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