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THE EFFECT OF IMPLEMENTATION PROJECT BASED LEARNING (PJBL) MODEL ON STUDENTS' MATHEMATICS LEARNING OUTCOMES IN GRADE IV AT UPTD SD NEGERI 1 WERU LOR

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Abstract
This research is motivated by the results of observations and interviews with homeroom teachers which indicate that the mathematics learning outcomes of fourth-grade students at UPTD SD Negeri 1 Weru Lor, Weru District, Cirebon Regency are still relatively low. This is because learning is still teacher-centered, the learning model is less innovative, the learning methods are less varied, and the use of learning media is not used. Thus, students are less able to analyze, conclude, and create concepts for data analysis and opportunities for data presentation materials in the form of bar charts. Therefore, the purpose of this study is to determine the effect of the implementation of the Project Based Learning (PjBL) model on students' mathematics learning outcomes. This study uses a quantitative method with a research design, namely a pre-experimental type one group pretest posttest. The sample of this study, namely 24 fourth-grade students selected through a total sampling technique. The research instruments are observation sheets and learning outcome tests. The results of the study show a significant increase before and after the implementation of the Project Based Learning (PjBL) model, including aspects of teaching modules, teacher performance, learning outcomes (cognitive, affective, and psychomotor). This can be proven by the results of the hypothesis test which obtained a t-count of 65.987 and a significance value of 0.000. Thus, it can be concluded that the application of the Project Based Learning (PjBL) model has an effect on student learning outcomes in mathematics learning in grade IV of UPTD SD Negeri 1 Weru Lor.
keywords: *Project Based Learning (PjBL) Model; Learning Outcomes; Mathematics.*

Abstrak
Penelitian ini dilatarbelakangi oleh hasil observasi dan wawancara bersama wali kelas yang mengindikasikan bahwa hasil belajar matematika peserta didik kelas IV UPTD SD Negeri 1 Weru Lor, Kecamatan Weru, Kabupaten Cirebon masih tergolong rendah. Hal ini dikarenakan pembelajaran masih berpusat pada guru (teacher-centered), model pembelajaran kurang inovatif, metode pembelajaran kurang bervariasi, dan tidak menggunakan media pembelajaran. Sehingga, peserta didik kurang mampu menganalisis, menyimpulkan, dan membuat konsep analisis data dan peluang materi penyajian data dalam bentuk diagram batang. Oleh karena itu, tujuan dari penelitian ini adalah untuk mengetahui pengaruh penerapan model Project Based Learning (PjBL) terhadap hasil belajar matematika peserta didik. Penelitian ini menggunakan metode kuantitatif dengan desain penelitian, yaitu pre-experimental tipe one group pretest posttest. Sampel penelitian ini, yaitu peserta didik kelas IV sebanyak 24 peserta didik yang dipilih melalui teknik total sampling. Instrumen penelitian ini berupa lembar observasi dan tes hasil belajar. Hasil penelitian menunjukkan adanya peningkatan yang signifikan sebelum dan sesudah penerapan model Project Based Learning (PjBL), meliputi aspek modul ajar, kinerja guru, hasil belajar (kognitif, afektif, dan psikomotorik). Hal ini dapat dibuktikan dengan hasil uji hipotesis yang memperoleh t_{hitung} sebesar 65,987 dan nilai signifikansi 0,000. Sehingga, dapat disimpulkan bahwa penerapan model Project Based Learning (PjBL) berpengaruh terhadap hasil belajar peserta didik pada pembelajaran matematika di kelas IV UPTD SD Negeri 1 Weru Lor.
Kata Kunci: Model Project Based Learning (PjBL); Hasil Belajar; Matematika

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Introduction

Dewantara stated that education is a necessity in children's development, as it serves to direct their full natural potential so they can achieve the highest level of safety and happiness as individuals and members of society (Pristiwanti et al., 2022: 7911). Education plays a crucial role in directing and optimizing students' potential, enabling them to achieve high levels of happiness and safety as individuals and members of society. One of these educational demands can be achieved through learning in elementary school.

Learning in elementary schools is an activity designed to help students acquire the knowledge, skills, and attitudes necessary for daily life and to continue their education to a higher level. As a system, learning has several interrelated components, namely objectives, materials, students, teachers, methods, situations, and evaluation (Widiawati, Wahyuningsih, Yulianti, 2022: 617). All these elements and components must be integrated in a conducive learning environment to support optimal student development and maximize learning outcomes. This environment plays a crucial role in influencing student development, both directly and indirectly, on their nature and character (Nurmalia, et al., 2024: 55). Moreover, in 21st-century learning, students must develop critical thinking, communication, collaboration, and creativity skills (Sunita, Sati, and Nurkholis, 2024: 3563).

However, in practice, teachers still tend to implement conventional learning. This is evidenced by research conducted by Lestari, Dantes, and Sariyasa (2018: 2), which shows that conventional learning is still widely used in elementary schools. In practice, this learning is dominated by the teacher, and student involvement during the learning process is minimal. This leads to decreased student motivation and learning outcomes. Despite this, conventional learning is still frequently implemented due to limitations in time, resources, and the learning environment.

This is supported by the results of observations and interviews conducted with the fourth grade homeroom teacher of UPTD SD Negeri 1 Weru Lor, Weru District, Cirebon Regency, who still applies conventional learning. Consequently, students' mathematics learning outcomes remain low. Of the 24 students, 0 (0%) completed the course and 24 (100%) did not. This is due to teacher-centered learning, a less innovative learning model, less varied learning methods, and the lack of use of learning media. Consequently, students are less able to analyze, conclude, and create bar charts; and are less actively involved during learning.

The above conditions indicate that teachers must be able to implement innovative and varied learning, as well as the use of relevant and interesting learning media, so as to improve student learning outcomes and learning activities. One innovative learning model is the Project Based Learning (PjBL) model. According to Nababan, Marpaung, and Koresy (2023: 706), the Project Based Learning (PjBL) model is a learning model that places students as the main subject or focus in the learning process, emphasizing learning experiences that produce products as the final result. Second, Wena (2014) in Sastradiharja and Febriani (2023: 603) stated that the PjBL model is a learning model that allows teachers to manage learning in the classroom by involving project activities. Finally, Nurasiah (2022) in Alhayat, et al. (2023: 106-107) argues that the PjBL model is a learning model that aims to develop students' abilities in designing and solving problems.

Thus, it can be concluded that the Project Based Learning (PjBL) model is a learning model that places students at the center of learning, with the teacher's role as a facilitator who accompanies them in the process of formulating and completing projects. The PjBL model not only encourages active student involvement in identifying and planning solutions to real problems but also emphasizes the importance of producing products as learning outputs.

Through this model, students can develop creativity, collaboration, critical thinking, as well as communication and presentation skills, thus creating a deeper and more meaningful learning experience and optimizing their learning outcomes.

Previous research by Putri Fatimah, Muhammad Makki, and Umar (2023) showed that the implementation of the PjBL model has a positive impact on students' mathematics learning outcomes. Furthermore, research on PjBL has largely focused on science subjects or at the junior high/senior high school level. Few studies have quantitatively examined its impact on elementary school students' mathematics learning outcomes, particularly in fourth grade. Therefore, this study aims to fill this gap by quantitatively analyzing the effect of PjBL on improving fourth grade elementary school students' mathematics learning outcomes. This research is important because it provides more specific empirical evidence at the elementary education level and in mathematics subjects, thus serving as a reference for developing more effective learning models at this level.

Although many studies have shown the influence of the Project Based Learning (PjBL) model on students' mathematics learning outcomes, there are still gaps in its application, especially in the aspect of research focus, where the focus of this study is the influence of the PjBL model on students' mathematics learning outcomes on data analysis material and opportunities for data presentation material in the form of bar charts. Then, the subject and location of this study are more specific and adapt to local needs, namely fourth-grade students of UPTD SD Negeri 1 Weru Lor.

Thus, the purpose of this study is to determine the effect of the application of the Project Based Learning (PjBL) model on students' mathematics learning outcomes. Meanwhile, the urgency of this study lies in both theoretical and practical aspects, especially for students. Through this study, it can be known the effect of the application of the PjBL model on students' mathematics learning outcomes; can increase understanding of effective project-based learning models that focus on creative thinking, problem solving, and interaction between students to create and use new knowledge; and can improve students' cognitive aspects in creating original projects. Then practically, for students, this study can improve students' mathematics learning outcomes, so that students are able to analyze, conclude, and create bar charts.

Based on the description above, a study will be conducted with the title "The Effect of Implementing the Project Based Learning (PjBL) Model on the Mathematics Learning Outcomes of Class IV Students of UPTD SD Negeri 1 Weru Lor" which aims to determine the effect of implementing the Project Based Learning (PjBL) model on the mathematics learning outcomes of class IV students of UPTD SD Negeri 1 Weru Lor, Weru District, Cirebon Regency.

Research Methods

This study uses a quantitative method with a pre-experimental research design, namely one group pretest posttest. According to Syahroni (2022: 46) quantitative methods are scientific methods that utilize data in the form of numbers, graphs, and tables, and conduct quantitative or statistical analysis to test predetermined hypotheses. The quantitative method chosen by the researcher aims to measure and analyze the effect of the Project Based Learning (PjBL) model on the mathematics learning outcomes of fourth-grade students of UPTD SD Negeri 1 Weru Lor objectively using numerical data, as well as to test the proposed hypothesis. Meanwhile, pre-experimental research design is research that has not been carried out seriously because the dependent variable is more influenced by external variables (Noviyanti, Ruswan, and

Nurmahanani, 2023: 93). There are several types of pre-experimental research designs, one of which is the one group pretest posttest design. The pre-experimental design research type one group pretest posttest design is an experimental design that uses one sample group and takes measurements before and after the action is given to the sample (Sugiyono, 2019: 74 in Arliana, Putri, and Sari, 2020: 1120).

This research was conducted at the UPTD of SD Negeri 1 Weru Lor, because after conducting observations and interviews with the fourth grade homeroom teacher, it was identified that learning still uses a conventional and teacher-centered model. In this case, the learning model is less innovative, the learning method is less varied, and does not use learning media. Thus, students' mathematics learning outcomes are still low, where students are less able to analyze, conclude, and create concepts for data analysis and opportunities for data presentation materials in the form of bar charts. And the population of this study, namely fourth grade students as many as 24 students through a total sampling technique. For more details, the research design can be seen in Figure 1 below:

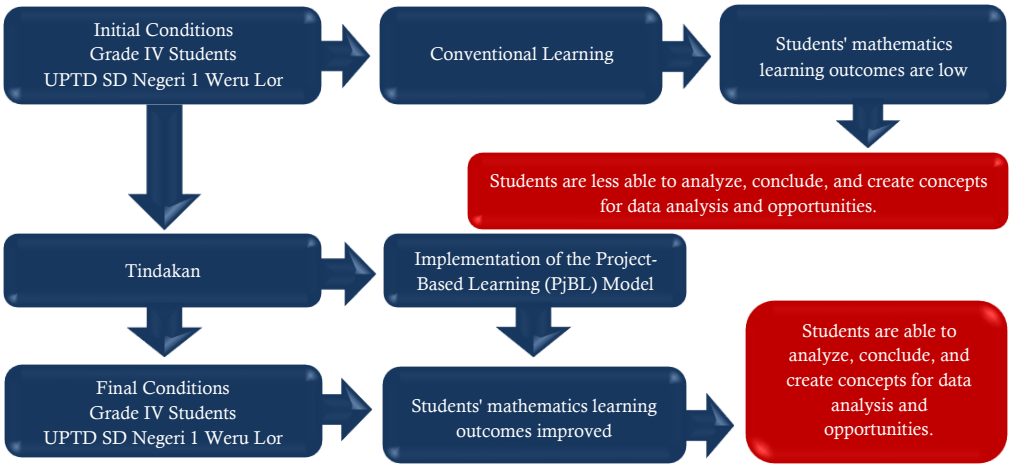

Figure 1. Research Design

The Project Based Learning (PjBL) model is a learning model that places students as the center of learning, with the teacher's role as a facilitator who accompanies them in the process of formulating and completing projects. The steps for implementing the PjBL model include: (1) Providing essential or fundamental questions; (2) Designing student project work; (3) Preparing steps for making student projects; (4) Conducting regular monitoring of student project development; (5) Conducting assessments of student work results (6) Conducting evaluations of the experiences gained by students. Meanwhile, learning outcomes are comprehensive changes in students, which include cognitive, affective, and psychomotor aspects. Learning outcomes are not only focused on increasing knowledge and understanding, but also include the development of attitudes, values, and practical skills acquired through learning experiences.

The steps for implementing research include the following:

1. Preparation Stage

   This stage includes the preparation of PjBL-based teaching modules, the creation of research instruments in the form of observations of teaching modules, teacher performance, and student learning activities that include affective and psychomotor aspects. In addition, a learning outcome test in the form of an essay consisting of two questions was created to

measure students' abilities in analyzing, concluding, and creating bar charts. Next, a trial of the instrument was conducted to measure validity using the product moment correlation formula and reliability using the Cronbach's Alpha formula with the help of Statistical Product and Service Solutions (SPSS) version 22. The results of the validity and reliability tests are as follows:

Table 1. Results of the Validity Test of the Learning Outcomes Test

Question Number	r-count	r-table	Information
1	0,919	0,361	Valid
2	0,987	0,361	Valid

Table 2. Results of the Reliability Test of the Learning Outcomes Test

r-count	r-table	Information
0,784	0,361	Reliabel

2. Implementation Stage

This stage begins with the implementation of learning before the implementation of the PjBL model on Wednesday, May 14, 2025. Before learning begins, students are given a pretest. Learning is carried out in one meeting without using models or learning media, only relying on LKS (Student Worksheets). After the learning is completed, students are given a posttest. Next, learning is carried out using the PjBL model on Thursday and Saturday, May 15 and 17, 2025. Before learning at this stage, students are given another pretest. The learning implementation is carried out in two meetings. In the first meeting, activities include providing essential questions, designing project work by students, and compiling project creation steps. In the second meeting, activities include project work, regular monitoring of project development, assessment of student work results, and evaluation of experiences gained during the learning process. After the learning process is completed, students are given another posttest to measure learning outcomes after the implementation of the PjBL model.

3. Data Analysis Stage

After the research was conducted, the data were then analyzed using a paired sample t-test with the help of Statistical Product and Service Solutions (SPSS) software version 22 to determine the differences in learning outcomes before and after the implementation of the PjBL model. However, before that, prerequisite tests were conducted to ensure that the data to be analyzed were in accordance with the assumptions required by certain statistical methods using normality and homogeneity tests.

Results and Discussion

The results of observations of teaching modules before and after the implementation of the Project Based LEarning (PjBL) model can be seen in Table 3 below:

Table 3. Results of Observations of Teaching Modules

Aspect	Before Implementing the PjBL Model	After Implementing the PjBL Model
Score	15	24
Percentage (%)	55,56%	100%
Criteria	Enough	Very Good

Observations of teaching modules before and after the implementation of the Project Based Learning (PjBL) model showed significant improvements. This indicates an increase in teachers' ability to plan and manage learning, thus improving the feasibility and quality of teaching modules. Because teaching modules based on the Project Based Learning (PjBL) model require project-based learning activities and active student interaction, the teaching modules become more applicable and in-depth. This makes the learning process more effective and engaging for students. Ultimately, student motivation and learning outcomes will also improve. This is in line with research by Rikado, Halidjah, and Pranata (2024: 2763), which revealed that teaching modules based on the Project Based Learning (PjBL) model used in the learning process make students feel enthusiastic and passionate. In addition, these teaching modules can be used by students with various levels of ability, both fast and slow. Thus, the implementation of the Project Based Learning (PjBL) model contributes positively to improving the quality of teaching modules and overall learning outcomes.

In addition, the results of observations of teacher performance before and after implementing the Project Based Learning (PjBL) model can be seen in Table 4 below:

Table 4. Results of Observations of Teaching Modules

Aspect	Before Implementing the PjBL Model	After Implementing the PjBL Model
Score	12	20
Percentage (%)	57,14%	95,23%
Criteria	Enough	Very Good

Observations of teacher performance before and after implementing the Project-Based Learning (PjBL) model also showed significant improvements. This indicates an increase in teachers' ability to manage learning, develop materials, and facilitate students in a more interactive and meaningful manner. The Project-Based Learning (PjBL) model requires teachers to design learning with careful planning, active guidance, and authentic evaluation. Therefore, during the implementation of the Project-Based Learning (PjBL) model, teachers must be able to act as facilitators and motivators who emphasize active student involvement in real-life projects and collaboration. Teachers must also improve their professionalism and creativity in teaching students, resulting in an increase in the quality of teacher performance that directly impacts student learning outcomes. This is in line with research by Rani et al. (2021: 268), which revealed that the Project-Based Learning (PjBL) process offers many benefits, including making students more active, creative, and innovative. This is because students have a high curiosity about what is being taught. Thus, the Project Based Learning (PjBL) model plays an important role in encouraging improved teacher performance which has a positive impact on student learning outcomes.

Meanwhile, student learning outcomes before implementing the Project Based Learning (PjBL) model can be seen in Table 5 below:

Table 5. Learning Outcomes Before Implementing the PjBL Model

Aspect	Pretest	Postest
Average Value	3,417	31,771
Number of Students Completed	0 (0%)	0 (0%)
The Number of Students is Not Yet Complete	24 (100%)	24 (100%)

Student learning outcomes before the implementation of the Project Based Learning (PjBL) model showed a significant increase. However, this increase has not reached the research success target, which is 80%. This is because, in both the pretest and posttest, the number of students who completed was 0 (0%) students, while the number of students who did not complete was 24 (100%). Thus, it proves that conventional learning is not effective in achieving student learning success according to the set target. This indicates the need for the implementation of learning models that can improve the achievement of learning objectives better, such as the Project Based Learning (PjBL) model.

Meanwhile, the results of observations of student learning activities (affective and psychomotor) before implementing the Project Based Learning (PjBL) model can be seen in Table 6 below:

Table 6. Observation Results of Student Learning Activities (Affective and Psychomotor) Before Implementing the PjBL Model

Aspect	Affective	Psychomotor
Number of Students with Good Criteria	3	3
Percentage (%)	12,5%	12,5%

Observations of student learning activities, both in the affective and psychomotor aspects, showed that only 3 students (12.5%) met the good criteria. This means that both aspects of learning activities have not met the research success target of 80%. This indicates that most students have not demonstrated active involvement and adequate psychomotor abilities during the learning process. Thus, student learning activities in the current learning process need to be improved, especially in the affective and psychomotor aspects. A more effective and interactive learning approach, such as the Project Based Learning (PjBL) model, can be a solution to increase student motivation, involvement, and overall abilities in order to achieve the success target.

After implementing the Project Based Learning (PjBL) model, student learning outcomes also showed significant improvement. Student learning outcomes after implementing the PjBL model can be seen in Table 7 below:

Table 7. Learning Outcomes After Implementing the PjBL Model

Aspect	Pretest	Postest
Average Value	31,771	94,708
Number of Students Completed	0 (0%)	24 (100%)
The Number of Students is Not Yet Complete	24 (100%)	0 (0%)

Student learning outcomes after implementing the Project Based Learning (PjBL) model showed significant improvement and achieved the research success target of 80%. All students successfully passed the Learning Objective Achievement Criteria (KKTP) of 70, which illustrates the effectiveness of this learning model in improving student abilities and understanding. By achieving this success target, the implementation of the PjBL model has

proven to be very effective in encouraging overall improvement in learning outcomes. Therefore, the Project Based Learning model is worthy of continued implementation as a learning method that supports the achievement of optimal learning outcomes.

Meanwhile, the results of observations of student learning activities (affective and psychomotor) after implementing the Project Based Learning (PjBL) model can be seen in Table 8 below:

Table 8. Observation Results of Student Learning Activities (Affective and Psychomotor) After Implementing the PjBL Model

Aspect	Affective	Psychomotor
Number of Students with Good Criteria	23	24
Percentage (%)	95,83%	100%

The results of observations of student learning activities, both in the affective and psychomotor aspects after the implementation of the PjBL model showed a significant increase compared to before the implementation of the model. This indicates that student learning activities in both aspects have met and even exceeded the research success target of 80%. The implementation of the PjBL model was able to optimally increase emotional (affective) involvement and psychomotor abilities of students. With this achievement, it can be concluded that the Project Based Learning (PjBL) model is effective in increasing student learning activities, both in terms of affective and psychomotor. Therefore, the implementation of the PjBL model should be maintained and made the main learning method to improve the quality of the learning process and outcomes as a whole.

The significant increase in learning outcomes between pretest and posttest scores before and after the implementation of the Project Based Learning (PjBL) model can be attributed to internal and external factors that influence learning outcomes. Learning outcomes are comprehensive changes in students, which include cognitive, affective, and psychomotor aspects. Learning outcomes are influenced by two factors, namely internal factors and external factors. Slameto (2010: 54) in Putri, Ramadhanti, and Rusli (2024) states that internal factors are factors from within the students, such as fatigue, physical health, and talent. In addition, Yandi, Putri, and Putri (2023) state that external factors are factors that come from outside the students, such as learning resources, the school environment, and school culture.

After obtaining the pretest and posttest learning results, the next step was to conduct a normality test, homogeneity test, and hypothesis test on student learning outcomes using the Statistical Product and Service Solutions (SPSS) version 22 application. The normality test was conducted using the Shapiro-Wilk test because this test is commonly used for small samples. The purpose of the normality test is to determine whether the data is normally distributed or not. Data is considered normally distributed if the significance value sig > 0.05, while the data is declared abnormal if the sig value < 0.05. The results of the normality test on student learning outcomes can be seen in Table 9 below:

Table 9. Results of the Normality Test for Learning Outcomes Tests

		Test of Normality					
		Kolmogorof-Smirnov			*Shapiro-Wilk*		
	Category	***Statistic***	***Df***	***Sig.***	***Statistic***	***Df***	***Sig.***
Results	*Pretest*	,219	24	,004	,934	24	,118
	Posttest	,125	24	,200	,923	24	,070

Lilliefors Significance Correction

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Based on Table 1 above, the results of the normality test for student learning outcomes (pretest) obtained a significant value of 0.118 and the results of the normality test (posttest) obtained a significant value of 0.70. This means that the results of the normality test for student learning outcomes in mathematics learning are declared normally distributed because they meet the criteria of a sig value > 0.05.

Next, a homogeneity test was performed using Levene's test to determine whether the sample groups had equal variances. The variances of both groups were considered homogeneous if the sig. 0.05 was greater than 0.05, while the variances were considered heterogeneous if the sig. 0.05 was less than 0.05. The results of the homogeneity test for the learning outcome test can be seen in Table 10 below:

Table 10. Results of the Homogeneity Test of Learning Outcomes Test

Test of Homogeneity of Variances					
		Levene Statistic	***Df1***	***Df2***	***Sig.***
Results	*Based on Mean*	1.766	1	46	,190
	Based on Median	,562	1	46	,457
	Based on Median and with adjusted df	,562	1	35,138	,458
	Based on trimmed mean	1.609	1	46	,211

Based on Table 2 above, the results of the homogeneity test of student learning outcomes (pretest and posttest) obtained a significant value of 0.190. This means that the results of the homogeneity test of student learning outcomes in mathematics learning (pretest and posttest) are declared to have homogeneous variance because they meet the probability criteria of sig > 0.05.

Thus, the results of the normality and homogeneity tests indicate that the data used are normally distributed and have homogeneous variance. Therefore, the study can proceed to the hypothesis testing stage. Hypothesis testing was conducted using a paired sample t-test, which is a test to compare two paired samples. This hypothesis test aims to test temporary assumptions in the study with the following provisions: if the sig value > 0.05 then H0 is accepted and H1 is rejected; conversely, if the sig value < 0.05 then H0 is rejected and H1 is accepted. The results of the learning outcome test hypothesis test can be seen in Table 11 below:

Table 11. Results of Hypothesis Testing of Learning Outcomes Test

Paired Samples Test									
		Paired Difference							
		Mean	***Std. Deviation***	***Std. Error Mean***	***95% Confidence Interval of the Difference***		***T***	***Df***	***Sig. (2 tailed)***
					Lower	***Upper***			
Pair 1	***Pretest-Posttest***	-62,9375	4,6726	,9538	-64,9106	-60,9644	-65,987	23	,000

Based on Table 11 above, the results of the pretest and posttest learning outcome hypothesis tests obtained a significance value of 0.000. This means that the results of the pretest and posttest learning outcome hypothesis tests had a sig value <0.05, so H0 was rejected and

H1 was accepted. Meanwhile, the results of the paired samples correlation test can be seen in Table 12 below:

Table 12. Sample Pair Correlation Test

Paired Samples Correlation				
		N	Correlation	Sig.
Pair 1	Nilai Pretest & Nilai Posttest	24	,483	,017

Based on Table 4 above, the results of the paired samples correlation test show a significance value of 0.017 with a correlation value of 0.483. The sig. value of 0.017 < 0.05, which indicates that there is a significant correlation between learning outcomes before and after the implementation of the Project Based Learning (PjBL) model. The correlation value of 0.483 indicates a moderate correlation between the two results. This moderate correlation indicates that although there is an influence of the implementation of the Project Based Learning (PjBL) model on learning outcomes, the relationship between before and after the use of the model is not very strong, but still significant. Thus, it can be concluded that there is an influence of the implementation of the Project Based Learning (PjBL) model on the mathematics learning outcomes of fourth-grade students of UPTD SD Negeri 1 Weru Lor.

This is in line with the research conducted by Putri Fatimah, Muhammad Makki, and Umar (2023), entitled "The Effect of Project Based Learning (PjBL) Learning Model on Mathematics Learning Outcomes". The results of the study showed that the application of the PjBL model had a positive impact on the learning outcomes of the experimental class that used the PjBL learning model, better than the control class that did not apply the PjBL model. These results were obtained through a t-test or hypothesis test conducted on the difference in posttest and pretest scores of the two groups, namely the experiment and control using SPSS 26 for Windows which produced a t-value ≥ t-table, namely 2.353 ≥ 1.671 at a significance level of 5%. Based on these calculation values, Ha is accepted and Ho is rejected. The calculation results also show a sig. (2-tailed) value of 0.23 ≤ 0.05, so Ha is accepted and Ho is rejected. This shows that the implementation of the PjBL learning model has an impact on the mathematics learning outcomes of fifth-grade students at SDN 19 Cakranegara, Mataram City in the 2022/2023 academic year. This research is also in line with research conducted by Astria Ayu Ramadianti (2021), entitled "The Effectiveness of the Project Based Learning Model on Elementary School Mathematics Learning Outcomes". The results of the study show that the Project Based Learning model is able to improve elementary school mathematics learning outcomes with student learning outcomes ranging from the lowest 11.30% to the highest 37.48% with an average of 24.72%.

According to Airlanda, Dwikurnaningsih, and Hardini (2025: 69), the implementation of appropriate and suitable learning models is a major factor in improving the quality of student learning outcomes, one of which is the Project Based Learning (PjBL) model. The Project Based Learning (PjBL) model has a significant influence on improving learning outcomes, especially in mathematics subjects, the material on presenting data in the form of bar charts. Rafsanzani, Surbakti, and Sikumbang (2020: 44) revealed that the implementation of the PjBL model has a significant influence on student learning outcomes in the cognitive aspect. Through the implementation of this PjBL, students not only learn theoretically, but also actively participate in projects that require them to collect, organize, and present their own data in the form of bar charts. This has been proven to develop cognitive abilities such as analyzing data, concluding information, and creating accurate and informative bar charts.

In addition, the quality of the teaching modules used has improved because they are adjusted to clear and structured project stages, making them more engaging and easier for

students to understand the material. Rismawanda and Mustika (2024: 36) revealed that teachers' ability to develop teaching modules can be measured through five indicators, including the ability to analyze data regarding students, teachers, and the condition of the educational unit; the ability to identify and determine the Pancasila Student Profile; the ability to design a learning objective flow (ATP) which will later be developed into a teaching module; the ability to develop teaching modules according to existing components; and the ability to evaluate and follow up on the evaluation results of the module. The ability of teachers to develop teaching modules in a structured manner is an important prerequisite for the effective implementation of the PjBL model, because the teaching modules must be able to facilitate active learning for students according to ATP standards and the characteristics of Pancasila Students, while supporting all steps of project-based learning with continuous evaluation.

Another positive impact of implementing the Project-Based Learning (PjBL) model is improving the quality of teacher performance. Teachers no longer merely serve as material presenters but also as facilitators, guiding students through the project's stages, from planning and implementation to presentation. Teachers become more creative in developing contextual and meaningful learning scenarios, improving their instructional skills, and responding more appropriately to students' learning needs. Saffer and Payne (2017) in Khasinah (2020: 6) stated that one of the advantages of PjBL is that teachers spend less time teaching individuals. This means that implementing the PjBL model helps teachers avoid having to spend a lot of time teaching or serving each student individually. The systematic steps of PjBL provide space for students to learn independently and collaboratively. This model also has advantages such as increased learning motivation, active student involvement, and the relevance of learning to the real world, although sometimes experiencing obstacles such as limited time in working on projects. Therefore, Epifania, Hero, and Bunga (2020: 6) stated that to address this issue, teachers can adjust the time according to the project's duration. This means the project can be completed in two sessions, outside of class hours, or even as homework.

In addition to cognitive aspects, the implementation of Project Based Learning (PjBL) also significantly develops affective skills. In the affective aspect, students can demonstrate a spirit of mutual cooperation by being able to help friends in groups, respect opinions, and gain positive social experiences. This is supported by the opinion of Pratiwi, et al. (2018) in Erlina, Hartoyo, and Erlina (2023: 329) who stated that the implementation of the PjBL model can indeed help improve students' mutual cooperation attitudes. In addition, students also hone critical reasoning through the ability to ask questions and provide logical reasons in the problem-solving process. This is supported by the opinion of Ramadhani, Rintayati, and Chumdari (2023: 25) who stated that critical reasoning skills are an important element that must be mastered by students, one of which is by implementing the PjBL model and other learning models that support the development of information systems and technology. In the final affective domain, students can demonstrate creativity in generating unique ideas to complete projects. This is supported by Kusmiati's (2022: 209) opinion, which states that student creativity is maximally encouraged through the implementation of projects that are carried out directly and involve them from the beginning to the end of the learning process. Therefore, the implementation of the PjBL model has an impact on the affective aspect, not only on mutual cooperation, critical reasoning, and creativity, but also on other skills.

In the psychomotor aspect, students are able to organize and arrange bar chart elements neatly, divide scales precisely, and articulate the data presentation process coherently and clearly. This ability demonstrates comprehensive and in-depth learning, connecting mastery of

mathematical material with social competencies and technical skills needed in everyday life. This is supported by the opinion of Masruriyah, Handayani, and Rakhmawati (2025: 255) who revealed that the implementation of the Project Based Learning (PjBL) model has an influence on students' psychomotor development. The PjBL model can improve practical skills that are useful for students, for example the use of tools, media creation, and speaking skills to present the results of their projects (Ansya and Salsabilla, 2023: 188). In addition, through planning, implementation, and evaluation activities, students not only gain conceptual understanding but also develop important practical skills (Meme, et al., 2024: 84).

Students' cognitive development is best supported in a social environment that encourages active participation and helps them reflect on their learning (Fisher, Kusumah, and Dahlan, 2020:1). Furthermore, from a pedagogical perspective, the PjBL model is most effective when implemented in small groups of 4-5 students because this group size can produce optimal learning outcomes (Zhang and Ma, 2023:01). This is because the basic idea of the PjBL model is to encourage students to actively engage in the entire learning process so they can think critically, ask questions, and explore independently. This way, they can make decisions and consciously control their learning process (Lazic, Knežević, and Maričić, 2021:1).

Thus, the Project Based Learning (PjBL) model has been proven to have a significant positive effect on improving student learning outcomes, especially in the material on presenting data in the form of bar charts, with a good impact on cognitive, affective, and psychomotor aspects.

This study has several limitations that should be considered. First, the focus of the study was limited to one learning material and one class, so the results obtained may not be generalizable to other materials, subjects, or grade levels. Furthermore, the duration of the Project Based Learning (PjBL) model implementation in this study was also limited, so a long-term picture of the model's effectiveness on student learning outcomes and activities is not yet clear. External factors such as variations in students' initial abilities, the condition of learning facilities, and supportive learning environments were also not fully controlled, which could influence the research results.

Based on the limitations above, it is recommended that further research expand its scope by testing the implementation of the Project Based Learning (PjBL) model across different materials, subjects, and grade levels. This aims to obtain a more comprehensive picture of the effectiveness of the PjBL model in a broader learning context. Furthermore, further research can also use more varied research methods and measure the long-term impact of the PjBL model implementation, including its influence on students' critical thinking skills, creativity, and soft skills. Research can also include other supporting variables, such as learning motivation and the role of teachers in facilitating project-based learning, to provide a deeper understanding and practical recommendations for the implementation of the PjBL model in various school settings.

Conclusion

Based on research in grade IV of UPTD SD Negeri 1 Weru Lor, the implementation of the Project Based Learning (PjBL) model significantly improved mathematics learning outcomes in the material of data presentation in the form of bar charts. This model is effective in developing students' cognitive, affective, and psychomotor abilities as well as improving the quality of teaching modules and teacher performance. With the PjBL approach, learning becomes more contextual and interactive, motivating students to participate actively and improving the social and technical skills needed for future challenges. This study also strengthens empirical evidence on the effectiveness of PjBL at the elementary school level by

adding a local perspective from Cirebon, Indonesia. As a limitation, this study only focused on one material and one class, so it is recommended that further research test the PjBL model on different materials, subjects, and grade levels to obtain a more comprehensive picture.

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