

THE EFFECT OF PROJECT-BASED LEARNING IMPLEMENTATION ON STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY FROM MATHEMATICAL DISPOSITION

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ABSTRACT

Mathematics is a compulsory subject at every level of education, aimed at developing students' problem-solving abilities. However, Indonesian students' mathematical problem-solving skills remain relatively low, as evidenced by numerous studies showing that students still experience difficulties in understanding, planning, and interpreting mathematical problem-solving processes. One alternative to improve these abilities is the implementation of the Project Based Learning (PjBL) model, which emphasizes active student engagement in project activities, along with the enhancement of mathematical disposition, reflecting students' positive attitudes toward mathematics. This study employed a factorial experimental design, involving two classes: an experimental class taught using the PjBL model and a control class taught through conventional instruction. Research instruments included a mathematical problem-solving ability test and a mathematical disposition questionnaire. Data were analyzed using two-way ANOVA. The results indicate that: (1) there is a significant difference in mathematical problem-solving ability between students taught using the PjBL model and those taught using conventional learning ($F_{\text{calculated}} = 4.52 > F_{\text{table}} = 3.97$); (2) there is a significant difference among students with high, moderate, and low mathematical disposition ($F_{\text{calculated}} = 108.77 > F_{\text{table}} = 3.12$); and (3) there is no interaction effect between learning model and mathematical disposition on students' problem-solving ability ($F_{\text{calculated}} = -5.80 < F_{\text{table}} = 3.12$). Therefore, it can be concluded that the Project Based Learning model and mathematical disposition each have a significant positive effect on students' mathematical problem-solving abilities of senior high schools students.

Keywords: mathematical disposition; mathematical problem solving ability; project based learning model.

ABSTRAK

Matematika merupakan mata pelajaran wajib di setiap jenjang pendidikan yang bertujuan mengembangkan kemampuan pemecahan masalah. Namun, kemampuan pemecahan masalah matematis siswa di Indonesia masih tergolong rendah, sebagaimana terlihat dari berbagai hasil studi dan penelitian yang menunjukkan kesulitan siswa dalam memahami, merencanakan, dan menafsirkan hasil penyelesaian masalah matematis. Salah satu alternatif yang dapat digunakan untuk meningkatkan kemampuan tersebut adalah penerapan model Project Based Learning (PjBL) yang menekankan keterlibatan aktif siswa dalam kegiatan proyek, serta penguatan disposisi matematis yang mencerminkan sikap positif terhadap matematika. Penelitian ini menggunakan metode desain faktorial eksperimen yang melibatkan dua kelas, yaitu kelas eksperimen dengan model PjBL dan kelas kontrol dengan pembelajaran konvensional. Instrumen penelitian terdiri dari tes kemampuan pemecahan masalah matematis dan angket disposisi matematis. Data dianalisis menggunakan ANAVA dua arah. Hasil penelitian menunjukkan bahwa: (1) terdapat perbedaan kemampuan pemecahan masalah matematis antara siswa yang diajar dengan model PjBL dan model konvensional ($F_{\text{hitung}} = 4,52 > F_{\text{tabel}} = 3,97$); (2) terdapat perbedaan kemampuan pemecahan masalah matematis antara siswa dengan disposisi matematis tinggi, sedang, dan rendah ($F_{\text{hitung}} =$

108,77 > tabel = 3,12); dan (3) tidak terdapat interaksi antara model pembelajaran dan disposisi matematis terhadap kemampuan pemecahan masalah matematis ($F_{hitung} = -5,80 < F_{tabel} = 3,12$). Dengan demikian, model Project Based Learning dan disposisi matematis secara signifikan berpengaruh terhadap kemampuan pemecahan masalah matematis siswa SMA.

.Kata kunci: disposisi matematis, kemampuan pemecahan masalah matematis, model project based learning



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Introduction

Mathematics, as the foundation of science and technology, is a compulsory subject at all levels of education, from primary to higher education. This status highlights the recognition of mathematics as essential for developing logical, analytical, and systematic thinking skills that are crucial for individual and national development. According to the Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 21 of 2016, one of the main goals of mathematics education is to cultivate students' ability to solve problems. The National Council of Teachers of Mathematics (NCTM) identifies problem-solving as the central focus of mathematics learning because it fosters real-world application and enhances students' interest in mathematics (Suryawan, 2020). Furthermore, Polya emphasized that continuous engagement in problem-solving trains students to face life challenges creatively and effectively. Thus, the Indonesian mathematics curriculum is designed to strengthen students' problem-solving skills through diverse instructional approaches.

However, empirical evidence shows that Indonesian students' mathematical problem-solving ability remains low. Results from the Programme for International Student Assessment (PISA) indicate that Indonesia's average score is still below the international benchmark, reflecting students' difficulty in tackling higher-order thinking and contextual mathematical problems. These findings are consistent with the studies ofutama, Sofia, and Novitasari (2019) as well as Evidiasari and Subanji (2018), who affirmed that PISA outcomes can be used to assess students' mathematical problem-solving competencies. The persistent low achievement suggests a need for more engaging and meaningful mathematics instruction.

Previous studies have also confirmed this issue. Research by Nufus, Wira, and Kurniati (2019) found that many students struggled to identify relevant problem elements, apply appropriate formulas, and verify their answers. Similarly, Ningsih, Anggraini, and Kartini (2023) reported that only a small percentage of students successfully completed problem-solving steps, from identifying problems (38.89%) to planning (25%) and implementing solutions (5.56%). None of the students were able to draw correct conclusions. Ningsih et al. (2023) also noted that students rarely developed mathematical models effectively and were less active during learning, contributing to low performance. These findings indicate that classroom instruction remains predominantly procedural and teacher-centered, providing limited opportunities for exploration, reasoning, and reflection.

In the Indonesian context, sociocultural factors significantly influence mathematics learning. Traditional classroom norms emphasize obedience and accuracy over inquiry and collaboration, while examination-oriented practices

restrict creative problem-solving. Consequently, students often perceive mathematics as rigid and disconnected from everyday life. To address this, teachers play a crucial role in selecting instructional models that foster active engagement, collaboration, and contextual understanding. One promising approach is the Project Based Learning (PjBL) model, which allows students to engage in authentic projects that develop their ability to analyze, plan, and solve problems collaboratively (Rusman, 2018).

The PjBL model emphasizes learning through projects involving investigation, decision-making, and reflection. This approach aligns with sociocultural theories of learning, where knowledge is constructed through interaction and participation in meaningful contexts. Susilowati (as cited in Rahman, 2022) stated that project-based learning enhances conceptual understanding by involving students directly in learning activities that connect abstract mathematical ideas with real-life experiences. Such experiences make learning more relevant and memorable.

Several studies have demonstrated the effectiveness of PjBL in improving students' mathematical problem-solving skills. Nurfitriyanti (2016) found that students taught using PjBL showed higher enthusiasm and achievement compared to those taught through conventional methods. Likewise, Safithri, Syaiful, and Huda (2021) revealed that PjBL enabled students to reconstruct their mathematical understanding independently through projects, leading to deeper conceptual mastery. These findings highlight the importance of learner-centered and contextual approaches in mathematics education.

In addition to instructional methods, the affective domain—particularly mathematical disposition—plays a significant role in shaping students' problem-solving performance. Mathematical disposition refers to a student's positive attitude toward mathematics, including persistence, curiosity, and confidence in facing mathematical challenges (Depi, Suendarti, & Liberna, 2022). Students with strong mathematical dispositions tend to be resilient, diligent, and responsible, enabling them to achieve optimal learning outcomes (Rezita & Rahmat, 2022). Empirical studies by Islamiati, Lapele, and Sari (2021) as well as Aprilianti et al. (2022) confirmed that students with high mathematical dispositions performed better in problem-solving than those with lower dispositions.

In Indonesian classrooms, fostering mathematical disposition aligns with cultural values such as *gotong royong* (collaboration), perseverance, and mutual learning. Encouraging students to view mathematics as a cooperative and exploratory activity rather than a solitary cognitive task aligns with the sociocultural fabric of Indonesian education.

Based on these theoretical and empirical considerations, this study aims to examine the effect of the Project Based Learning model and mathematical disposition on students' mathematical problem-solving ability. Therefore, the present research is titled "The Influence of the Project Based Learning Model on Mathematical Problem-Solving Ability Viewed from Students' Mathematical Disposition."

Research Methods

This study employed a factorial experimental design, a research method that allows for the analysis of both main effects and interaction effects between two or

more independent variables on a dependent variable. This design was selected because it aligns with the purpose of the study, namely to examine the effects of the Project Based Learning (PjBL) model and mathematical disposition on students' mathematical problem-solving ability, both individually and interactively.

Population and Sample

The population of this study consisted of all tenth-grade students at SMA Negeri 8 Pekanbaru in the 2024/2025 academic year. The sampling technique used was cluster random sampling, in which the sample was selected based on entire groups (classes) chosen at random. Prior to determining the sample classes, a pretest was administered to all tenth-grade classes to assess the homogeneity of students' initial abilities. The results indicated that all classes had relatively homogeneous initial abilities. Therefore, two classes were randomly selected as the research samples: Class X.6 as the experimental group, which was taught using the Project Based Learning model, and Class X.7 as the control group, which received instruction through a conventional learning model involving lectures and practice exercises.

Research Design

The study utilized a factorial design with two independent variables: Learning model (PjBL and conventional), and Mathematical disposition. The dependent variable was students' mathematical problem-solving ability. This design enabled the analysis of:

1. the effect of the learning model on mathematical problem-solving ability,
2. the effect of mathematical disposition on mathematical problem-solving ability, and;
3. the interaction between the learning model and mathematical disposition on mathematical problem-solving ability.

Data Collection Techniques

Data were collected through the following techniques:

1. Mathematical problem-solving test, used to measure students' ability to solve mathematical problems based on Polya's indicators, including understanding the problem, devising a plan, carrying out the plan, and interpreting the results.
2. Mathematical disposition questionnaire, used to assess students' positive attitudes toward mathematics, such as confidence, perseverance, curiosity, and responsibility in learning mathematics. The questionnaire was constructed using a Likert scale.
3. Observation, conducted to record teacher and student activities during the learning process, particularly student engagement and group collaboration during the implementation of PjBL in the experimental class.
4. Documentation, consisting of photographs and learning activity records, to support observational data and strengthen descriptive analysis results.

Data Analysis Techniques

Prior to hypothesis testing, assumption tests were performed, including:

1. Normality test, to ensure that the data were normally distributed, using the Chi-Square
2. Homogeneity test, to confirm the equality of variances among groups, using Bartlett and Fisher Test

After confirming that the data met these assumptions, hypothesis testing was conducted using Two-Way Analysis of Variance (Two-Way ANOVA). This test was applied to determine:

- (1) the main effect of the learning model on mathematical problem-solving ability,
- (2) the main effect of mathematical disposition on mathematical problem-solving ability, and
- (3) the interaction effect between the learning model and mathematical disposition on mathematical problem-solving ability. If the ANOVA results indicated significant differences, a post hoc test using Tukey's test was conducted to identify which groups differed significantly.

Results and Discussion

This study was conducted over a period of more than one month, from January 6 to February 13, 2025. Prior to the implementation of classroom learning in the experimental and control groups, all research instruments—including the mathematical problem-solving ability test, the mathematical disposition questionnaire, and the observation sheets for teacher and student activities—were validated by experts in mathematics education to ensure content validity. This validation process aimed to confirm that each item accurately represented the intended indicators and was appropriate for use in data collection.

Following the validation stage, an instrument trial was conducted with students of Class XI.12 as the pilot group. The purpose of this trial was to assess item clarity, level of difficulty, discrimination index, and instrument reliability. The trial results indicated that all developed instruments met the required criteria for validity and reliability, making them suitable for use in the main study.

The implementation of the study in both the experimental and control classes took place over seven sessions. These sessions consisted of one pre-test to measure students' initial mathematical problem-solving ability before the treatment, five learning sessions in which different instructional models were applied (Project-Based Learning in the experimental class and conventional learning in the control class), and one post-test at the end of the learning cycle to measure students' final problem-solving performance.

Before determining the sample classes, a pre-test was administered to all tenth-grade students at SMA Negeri 8 Pekanbaru. The purpose was to obtain a general overview of students' initial mathematical problem-solving abilities and to ensure that the classes selected as samples had relatively equivalent starting levels. The pre-test data were analyzed using a One-Way Analysis of Variance (ANOVA), after conducting normality and homogeneity tests to verify that the data met the statistical assumptions required for ANOVA.

The analysis results showed that all classes demonstrated normally distributed and homogeneous data, indicating no significant differences in students' initial mathematical problem-solving abilities prior to treatment. Based

on these results, two classes were randomly selected as the experimental class and the control class for the main study.

A summary of the pre-test results of students' mathematical problem-solving abilities for all tenth-grade classes at SMA Negeri 8 Pekanbaru is presented in the Table 1.

Table 1. Results of the Normality Test

Kelas	χ^2_{hitung}	χ^2_{tabel}	Kriteria
X.1	2, 5328	12, 59159	Berdistribusi Normal
X.2	3, 0820		Berdistribusi Normal
X.3	6, 5672		Berdistribusi Normal
X.4	7, 0764		Berdistribusi Normal
X.5	11, 2472		Berdistribusi Normal
X.6	7, 2568		Berdistribusi Normal
X.7	2, 7914		Berdistribusi Normal
X.8	3, 5404		Berdistribusi Normal
X.9	7, 7465		Berdistribusi Normal
X.10	3, 8001		Berdistribusi Normal
X.11	6, 5477		Berdistribusi Normal
X.12	2, 7274		Berdistribusi Normal

Based on Table 1, the results of the normality test conducted using the Chi-Square (χ^2) test show that, for all twelve classes analyzed, the calculated Chi-Square value χ^2_{hitung} is smaller than the Chi-Square table value χ^2_{tabel} at the predetermined significance level. Therefore, it can be concluded that the data from all classes are normally distributed.

These results indicate that the students' initial mathematical problem-solving abilities in each class exhibit a consistent distribution pattern and do not significantly deviate from a normal distribution. Hence, the data meet one of the fundamental assumptions required for conducting the homogeneity test in the subsequent stage of analysis. The result can be seen in Table 2.

Table 2. Results of the Homogeneity Test

χ^2_{hitung}	χ^2_{tabel}	Kesimpulan
0,57655	19,675119	Homogen

Based on the results of the homogeneity test, it was found that the calculated χ^2_{hitung} was smaller than the χ^2_{tabel} value at the predetermined significance level. This indicates that the variances among the tested classes did not differ significantly, allowing it to be concluded that all classes had homogeneous variances.

Thus, the data obtained met the homogeneity assumption, which is an essential requirement before conducting further statistical analysis. The homogeneity of variances also implies that the students' initial mathematical problem-solving abilities across classes were relatively balanced, ensuring that any differences observed in subsequent stages could be more accurately attributed to the instructional treatments rather than initial class differences.

Since the data met the assumptions of normality and homogeneity, the next step was to conduct a one-way ANOVA test to determine whether there were significant differences in the students' initial mathematical problem-solving abilities before the implementation of different learning treatments. This test aimed to ensure that the initial conditions between the experimental and control classes were at a comparable level of ability, allowing the effect of the treatment to be examined objectively. The results of the one-way ANOVA analysis on students' initial mathematical problem-solving abilities are presented in Table 3.

Table 3. Results of the One-Way ANOVA Test on Pre-Test Scores

F_{hitung}	F_{tabel}	Kesimpulan
0,82	1,809798	Tidak memiliki perbedaan kemampuan pemecahan masalah matematis

Based on the data presented in Table 3, the results of the one-way ANOVA test show that the calculated F-value (F_{hit}) is smaller than the F-table value at the specified significance level. This indicates that there is no significant difference in the mean scores among the classes tested. In other words, the students' initial mathematical problem-solving abilities across the twelve classes were statistically equivalent.

The data analysis further confirms that there were no significant differences in the average ability among the populations, suggesting that the twelve classes possessed a homogeneous level of ability prior to the implementation of the treatments. This homogeneity ensures that the observed effects in subsequent stages of the research can be attributed to the instructional interventions rather than to pre-existing differences in ability levels.

Based on this finding, two classes were randomly selected as the research samples: Class X.6 as the experimental group, in which the Project-Based Learning model was implemented, and Class X.7 as the control group, which received conventional instruction.

After the research classes were determined, students were administered a mathematical disposition questionnaire to categorize them according to their levels of mathematical disposition—high, medium, or low. The results of this categorization were used to support the subsequent analysis of the interaction between learning models and students' mathematical dispositions. The following table presents a summary of the mathematical disposition questionnaire results for both the experimental and control groups can be seen in Table 4.

Table 4. Categories of Students' Mathematical Disposition Grouping

Kategori	Syarat	Eksperimen	Kontrol	Jumlah
Tinggi	$X \geq 95,23$	10 siswa	9 siswa	19 siswa
Sedang	$62,91 < X < 95,23$	18 siswa	26 siswa	44 siswa
Rendah	$X \leq 62,91$	12 siswa	5 siswa	17 siswa

Based on Table 4, students were classified into three categories of mathematical disposition: high, medium, and low. A total of 19 students were in the high category, 44 in the medium category, and 17 in the low category. Most students fell into the medium category, indicating a moderately positive

mathematical disposition. Overall, the distribution of mathematical disposition between the experimental and control groups was relatively balanced, suggesting that both groups had comparable initial conditions before the learning treatments were implemented.

Following the classification of students' mathematical disposition, the next section presents the recapitulation of learning activities during the implementation of the Project-Based Learning (PjBL) model. This includes both the activities carried out by the researcher and the students throughout the learning process. The table 5 summarizes the observed activities during each meeting.

Table 5. Recapitulation of Teacher and Student Activities Using the Project-Based Learning Model

Pertemuan Ke	Hasil Observasi Peneliti		Hasil Observasi Siswa	
	\bar{X}	%	\bar{X}	%
1	3,19	79,7%	3,14	78,5%
2	3,47	86,9%	3,42	85,71%
3	3,81	95,2%	3,76	94,04%
4	3,9	97,6%	3,9	97,6%
5	4	100%	4	100%
Rata-Rata	3,67	91,9%	3,64%	91,2%

Based on the recapitulation of observation results over five meetings, the implementation of the learning process showed a significant improvement from one session to the next. This progress was reflected in the increasing percentage of successful implementation observed in both teacher and student activities. At the beginning of the Project-Based Learning (PjBL) implementation, students mainly focused on understanding the basic concepts and adapting to the stages of project-based instruction. However, in the subsequent meetings, students demonstrated greater engagement, improved collaboration, and enhanced independence in learning. The teacher's role as a facilitator also became more effective in guiding discussions, providing feedback, and motivating students to think critically and creatively in completing their projects.

Overall, these observations indicate that the implementation of the Project-Based Learning model was carried out successfully and in accordance with the designed instructional plan. The model not only increased student engagement but also encouraged the development of higher-order thinking skills through meaningful and contextual learning experiences.

After the completion of all learning sessions, a post-test was administered to both the experimental and control groups to measure students' final mathematical problem-solving abilities. The post-test data revealed the average scores for each group, as presented in the Table 6:

Table 6. Average Post-Test Scores of Students in the Experimental and Control Classes

No.	Kelas	Skor
1	Eksperimen	27,225
2	Kontrol	24,85

Based on the data presented in the table, there was a noticeable difference in the average post-test scores between the experimental and control groups. Specifically, the experimental group, which was taught using the Project-Based Learning (PjBL) model, achieved a higher average score than the control group, which received conventional instruction. This finding suggests that the implementation of the Project-Based Learning model may have a positive impact on students' mathematical problem-solving abilities.

Furthermore, the results indicate that active student engagement in project-based learning encouraged them to think more critically, creatively, and reflectively when solving mathematical problems. In contrast, students in the conventional learning environment tended to be more passive, focusing primarily on applying formulas without fully understanding the problem context, which contributed to their lower post-test scores.

Before testing the research hypotheses, it was necessary to verify the statistical assumptions required for inferential analysis, namely normality and homogeneity of variance. Therefore, a normality test was conducted to ensure that the post-test data were normally distributed, and a homogeneity test was performed to confirm that the variances between the two groups were equal. The results of the normality and homogeneity tests for the students' post-test data are presented in Table 7.

Table 7. Results of the Post-Test Data Normality Test

Kelas	χ^2_{hitung}	χ^2_{tabel}	Kriteria
Eksperimen	9,142	12,59159	Normal
Kontrol	6,5634	12,59159	Normal

Based on the data presented in the table, it was found that the calculated Chi-square values for both the experimental and control classes were smaller than the Chi-square table values. This indicates that the data for both groups are normally distributed, fulfilling one of the statistical assumptions required before conducting further inferential analysis.

Having met the normality assumption, the next step was to perform a homogeneity test to determine whether the variances between the experimental and control groups were statistically equal. This test ensures that the comparison between the two groups can be conducted validly using parametric statistical methods. The results of the homogeneity test are presented in the Table 8.

Table 8. Results of the Post-Test Data Homogeneity Test

Kelas	Ekperimen	Kontrol
Variansi	97,0225	77,7924
Jumlah	40	40
<i>df</i>	39	39
F_{hitung}		1,2471
F_{tabel}		1,7044

Based on the results of the homogeneity test, the calculated (F value = 1.2471) was smaller than the F table value ($F_{table} = 1.7044$). This means that $F_{calculated} < F_{table}$, or $1.2471 < 1.7044$, indicating that the variances of the post-test scores for the experimental and control classes are homogeneous. In other words, there is no significant difference in the data variance between the two groups, which fulfills the homogeneity assumption required for further statistical testing.

The fulfillment of both normality and homogeneity assumptions confirms that the data meet the necessary conditions for conducting parametric analysis. Therefore, hypothesis testing was carried out using a two-way ANOVA test to examine the effects of the Project-Based Learning model and mathematical disposition, as well as their interaction, on students' mathematical problem-solving abilities. The results of the two-way ANOVA analysis are presented in the following table.

Table 9. Results of the Two-Way ANOVA Test

Sumber Variansi	Antar Baris (Model)	Antar Kolom (Disposisi Matematis) B	Interaksi (Model, Disposisi Matematis) A x B
	A	B	A x B
dk	1	2	2
JK	112,81	7563,72	-2417,24
RK	112,81	3781,86	-1208,62
F_h	4,52	108,77	-5.80
F_t	3,97	3,12	3,12

In the first hypothesis test using the two-way ANOVA, the calculated F value ($F_{calculated} = 4.52$) exceeded the F table value ($F_{table} = 3.97$). Thus, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was accepted. This result indicates a significant difference in mathematical problem-solving abilities between students taught using the Project-Based Learning (PjBL) model and those taught using conventional learning methods. The experimental group achieved a higher mean score (27.225) compared to the control group (24.85), demonstrating that students who learned through Project-Based Learning performed better in solving mathematical problems.

These findings are consistent with those reported by Astria, Haji, and Sumardi (2024), who found that students taught through Project-Based Learning demonstrated superior mathematical problem-solving skills compared to those who received conventional instruction. Their data showed that the experimental group achieved an average problem-solving score of 65.10, while the control group averaged only 42.88. This significant difference underscores the effectiveness of the Project-Based Learning model in improving students' mathematical problem-solving abilities.

In the second hypothesis test using the same two-way ANOVA approach, the calculated F value ($F_{calculated} = 108,77$) was greater than the F table value ($F_{table} = 3.12$). Consequently, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was accepted. This indicates a significant difference in mathematical problem-solving ability among students with high, moderate, and low mathematical dispositions. The mean scores show clear variations: students

with high disposition achieved the highest average score (38), followed by those with moderate disposition (25.25), and students with low disposition (14.705). These results confirm that a higher level of mathematical disposition is positively correlated with better problem-solving performance.

This finding aligns with the research of Aprilita, Zulkarnain, and Septhiani (2024), who concluded that mathematical disposition has a significant positive influence on mathematical problem-solving ability. Mathematical disposition reflects traits such as curiosity, perseverance, confidence, and interest in mathematics—all of which support the development of effective problem-solving skills. Therefore, students with a stronger mathematical disposition tend to approach mathematical challenges with greater motivation and persistence, leading to higher performance outcomes.

For the third hypothesis test, the two-way ANOVA results showed that $F_{\text{calculated}} < F_{\text{table}}$ ($-5,80 < 3.12$), meaning the null hypothesis (H_0) was accepted and the alternative hypothesis (H_a) was rejected. This indicates that there was no interaction effect between the learning model and mathematical disposition on students' problem-solving ability. In other words, the impact of Project-Based Learning on mathematical problem-solving ability does not depend on students' mathematical disposition level, and vice versa. Each factor independently contributes to the improvement of mathematical problem-solving ability without influencing each other's effect.

This outcome is consistent with the findings of Suprpto (2017), who stated that there is no interaction between independent and moderator variables when both exert strong individual effects on the dependent variable. Similarly, Kerlinger's theory explains that interaction effects tend to weaken when independent variables already have strong direct impacts on the dependent variable. This is evident in the present study, where both Project-Based Learning and mathematical disposition independently influence mathematical problem-solving ability, making their interaction statistically insignificant.

In conclusion, both Project-Based Learning and mathematical disposition independently make positive contributions to enhancing students' mathematical problem-solving skills. Although no interaction effect was found between the two variables, the findings emphasize the importance of implementing Project-Based Learning and fostering strong mathematical disposition among students as essential strategies for optimizing mathematical problem-solving ability. Future research could explore additional factors that may mediate or moderate the relationship between learning models, mathematical disposition, and mathematical problem-solving skills.

Conclusion and Suggestion

The conclusion should be in answer to the question or objective study. This study demonstrates that both the Project-Based Learning (PjBL) model and mathematical disposition, when applied independently, can effectively enhance students' ability to solve mathematical problems. However, no interaction was found between the two variables in influencing students' mathematical problem-solving skills. These findings are consistent with the research objective, which was to examine the effect of the Project-Based Learning model on students'

mathematical problem-solving ability while taking into account their level of mathematical disposition.

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