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Enhancing Students' Problem-Solving Abilities: The Role of Project-Based Learning, Problem-Based Learning, and Learning Motivation

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Abstract: Enhancing Students' Problem-Solving Abilities: The Role of Project-Based Learning, Problem-Based Learning, and Learning Motivation. Objective: This study aims to examine the effect of Project-Based Learning (PjBL), Problem-Based Learning (PBL), and learning motivation on students' problem-solving abilities at the secondary education level. **Methods:** This study uses a quantitative approach with SmartPLS 4 data analysis techniques to test the relationship between the variables involved. The research sample consisted of students at the secondary education level who were divided into three experimental groups. Each group received project-based learning (PjBL), problem-based learning (PBL) interventions, as well as the influence of learning motivation as a factor influencing students' problem-solving abilities. **Findings:** The results of the study indicate that both PjBL and PBL have a positive and significant effect on students' problem-solving abilities. In addition, learning motivation has also been shown to have an important role in strengthening the development of students' problem- solving abilities. These findings indicate that project-based and problem-based learning can improve students' skills in solving complex problems. **Conclusion:** The findings of this study provide evidence that Project-Based Learning and Problem-Based Learning methods can be effective alternatives to improve students' problem-solving abilities. Learning motivation also plays a crucial role in supporting the learning process. Therefore, it is important for teachers to create a learning environment that can motivate students to be more active and participate. By combining these two methods, students are expected to develop critical and creative thinking skills, which are very much needed in facing challenges in the real world. Further research is needed to explore other factors that may affect students' problem-solving abilities, such as social and emotional factors.

Keywords: PjBL, PBL, problem-solving ability, learning motivation.

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INTRODUCTION

Education in Indonesia faces major challenges in developing 21st century skills, especially in improving students' problem-solving abilities. Problem- solving abilities are competencies that are very much needed to face various problems in everyday life, especially in the context of rapid technological change and social development. One approach that is considered effective in developing these skills is project-based learning (PJBL) and problem-based learning (PBL). Both of these methods can encourage students to think critically, collaboratively, and creatively in solving problems.

Project-Based Learning (PJBL) is a learning model that encourages students to learn through involvement in real projects that require

problem solving, exploration, and collaboration. On the other hand, Problem-Based Learning (PBL) focuses on solving problems that are relevant to the real world, where students are faced with problem situations that require them to find solutions independently or in groups.

In addition to these two approaches, students' learning motivation also plays an important role in the development of problem-solving abilities. High learning motivation can encourage students to be more active in participating in learning, completing the challenges given, and developing their problem- solving abilities. Therefore, it is important to examine the interaction between Project-Based Learning, Problem-Based Learning, and students' learning motivation in developing their problem- solving abilities.

Developing problem- solving abilities is an essential skill that students need to have, especially in an era that demands creativity, critical thinking, and the ability to adapt quickly to change. Therefore, it is important to explore learning methods that can improve these skills effectively. Project-Based Learning (PjBL) and Problem-Based Learning (PBL) are two learning approaches that place students in real-world situations and challenge them to solve complex problems, which can improve their problem-solving abilities. In addition, learning motivation is a key factor in the success of implementing this method, because motivated students are more likely to actively participate and persist in facing challenges in the learning process.

Conventional methods that have focused more on theoretical approaches and teacher-based teaching often do not sufficiently encourage students to think critically or actively in solving problems. Traditional learning tends to rely on memorization and routines, which risk inhibiting the development of practical skills that are relevant to the real world. This can make students feel less challenged or engaged in learning, so they are less able to connect what is learned with situations or problems faced outside the classroom. Therefore, there is an urgent need to replace this approach with more interactive and contextual learning methods, such as PjBL and PBL, which can develop problem- solving abilities more effectively.

Project-Based Learning (PjBL) emphasizes project-based learning that engages students in tasks that require creativity, teamwork, and direct application of knowledge. This approach provides a more practical and realistic learning experience, which can motivate students to think deeper and find creative solutions. On the other hand, Problem-Based Learning (PBL) emphasizes the use of real cases to stimulate discussion, analysis, and problem solving, which greatly supports the development of students' critical and analytical thinking skills. Both of these methods, which encourage students to actively interact with the material, not only facilitate the development of knowledge but also strengthen problem-solving abilities.

However, the implementation of these methods is not always easy without the support of learning motivation. Low motivation can hinder the success of both methods, because students may feel less interested or involved in the tasks given. Therefore, this study is important to explore how learning motivation can be a reinforcing element that improves the implementation of PjBL and PBL, so as to maximize the development of students' problem-solving abilities.

This research is important to answer the urgent need for innovation in education that can overcome the limitations of conventional learning methods, as well as provide insight into how the integration of PjBL, PBL, and learning motivation can create more meaningful and beneficial learning experiences for students.

Previous research on Project-Based Learning (PjBL), Problem-Based Learning (PBL), and learning motivation on the development of students' problem- solving abilities has provided important insights into the

influence of learning methods on these skills. Several studies have shown that PjBL and PBL can improve students' problem-solving abilities by providing real contexts for solving problems, as well as increasing student engagement and creativity. For example, research by Thomas (2000) showed that PjBL helps students to be more active in solving problems creatively through collaboration and application of knowledge in real projects. Likewise, research by Savery (2006) found that PBL improves students' analytical skills in solving problems with a case-based approach and group discussions.

However, despite evidence that both methods have positive effects, most previous studies have focused on one learning method (PjBL or PBL) without directly comparing the effects of both on problem-solving abilities. In addition, few studies have examined in depth how learning motivation plays a role in strengthening or weakening the effectiveness of both methods in improving students' problem-solving abilities.

Research also tends not to explore the interaction between PjBL, PBL, and learning motivation comprehensively. Some studies (e.g., Krajcik et al., 1998) focus on specific aspects such as collaboration in PjBL or problem solving in PBL, but do not provide a comprehensive picture of how the three interact to influence the development of students' problem-solving abilities. In addition, few discuss motivational factors as a key element that can optimize both methods, even though motivation is known to be an important factor in learning success.

Previous research that supports this is by Hake (1998) in his research showing that the project-based approach (Project-Based Learning) can improve students' problem-solving abilities through practical experience and reflection on problems faced during the project. Hake also emphasized that PJBL can help students develop critical and creative thinking skills. Based on other research by Barrows (1986) in a study on Problem-Based Learning (PBL) found that PBL can develop students' problem-solving abilities because this approach encourages students to work in groups to find solutions to problems given, thereby improving their analytical and applicative thinking skills. And finally, this research is supported by Ryan & Deci (2000) who stated that intrinsic learning motivation has a positive impact on student learning outcomes, including improving problem-solving abilities. Students who have high learning motivation tend to be more active in participating in learning, more resilient to challenges, and better able to overcome problems given.

This study fills the gap in the existing literature by combining three important factors in learning, namely Project-Based Learning (PJBL), Problem-Based Learning (PBL), and learning motivation, to be analyzed using Structural Equation Modeling (SEM). Most previous studies focus on one or two factors separately, while this study examines a more complex causal relationship between the three variables. In addition, another novelty brought by this study is its application in one of the junior high schools in Surabaya, which has different student characteristics and educational challenges. This study is expected to provide a more comprehensive picture of how the three approaches work together in the context of junior high school education in Indonesia, providing new contributions for education practitioners in designing effective and problem-based learning. By using SEM, this study also offers a more sophisticated and comprehensive approach in measuring the relationship between variables, both directly and indirectly, which can help policy makers and educators in formulating more effective learning strategies in the future.

Thus, the purpose of this study is to simultaneously test the influence of PjBL, PBL, and learning motivation on students' problem-solving abilities and to see the interactive relationship between the three. This study is also designed to answer several key questions, namely

(1) is there a significant influence between students' problem-solving abilities on learning motivation? (2) is there a significant influence between PBL on problem-solving abilities? (3) is there a significant influence between PjBL on problem-solving abilities?

METHOD

This study uses a quantitative method with a Structural Equation Modeling (SEM) approach to analyze the direct and indirect effects between Project-Based Learning (PJBL), Problem-Based Learning (PBL), and learning motivation on students' problem-solving abilities. The SEM approach was chosen because of its ability to test complex relationships between variables at once, as well as its ability to identify direct, indirect, and total effects between the variables studied.

Participant

Population: Students enrolled in one of the junior high schools in Surabaya city in the 2024/2025 academic year. This population consists of students in grade VIII and who have participated in learning with the Project-Based Learning (PJBL) and Problem-Based Learning (PBL) approaches. Sample: The sampling technique used is the quota sampling technique, Selection of quota sampling techniques Sampling to select 200 participants in this study was carried out with several strategic considerations related to the research objectives, population characteristics, and the limitations of time and resources available. The following are the main reasons why this technique was chosen, because by using the quota sampling technique, researchers can select participants systematically based on predetermined categories, without the need for a more complicated random drawing or selection process. This simplifies and speeds up data collection. The number of samples taken was around 200 students, taking into account the ideal SEM sample size rules, which are between 100 and 300 respondents. Criteria: Students who have participated in PJBL and PBL learning for at least one semester.

Research Design and Procedures

This study uses an explanatory design that aims to explain the relationship between variables and test the proposed causality model. This study is non-experimental, where researchers do not manipulate the independent variables, but only observe and analyze the relationship between variables in the educational environment. This study was conducted for one semester, from June to December 2024.

The procedure includes the following steps: (1) Preparation: (a) Preparation of research instruments that include PJBL, PBL, learning motivation, and problem-solving ability tests, and (b) Trial of the instruments on a small sample to ensure validity and reliability, (2) Data Collection: (a) Distribution of questionnaires to students who are the research sample. Respondents are asked to fill out questionnaires related to PJBL, PBL, and learning motivation, and (b) Administration of problem-solving ability tests carried out after students have participated in learning using the PJBL and PBL methods, (3) Data Processing: The collected data will be analyzed using SEM to test the relationship between these variables. SEM is used to identify and model the direct, indirect, and total influences between variables in the model, (4) Data Analysis: (a) Descriptive: Descriptive analysis is used to describe the characteristics of respondents and an overview of the implementation of PJBL, PBL, learning motivation, and students' problem-solving abilities, and (b) SEM (Structural Equation Modeling): SEM techniques are used to test the proposed hypotheses and identify the influences between variables. SEM allows researchers to test complex relationships between latent (hidden) variables and measured variables, and to determine how much influence each variable has on students' problem-solving abilities, (5) Validity and Reliability Tests: (a) Validity: Validity tests are conducted to ensure that the instruments used actually measure

the intended variables. Content and construct validity will be tested using the expert judgment approach and exploratory factor analysis (EFA), and (b) Reliability: Reliability tests use Cronbach's Alpha to ensure the internal consistency of the instrument.

A sample distribution is considered representative if the sample taken reflects the characteristics of the population as a whole, both in terms of demographics, socio-economic background, academic achievement, or other relevant factors that may affect the results of the study. In this case, for SMP Negeri 48 Surabaya, the sample distribution must include a variety of classes, gender, age, and perhaps also academic achievement, so that the results can be generalized to the entire student population at the school.

Cluster random sampling is a sampling technique in which the population is divided into groups or "clusters", and then the clusters are randomly selected to be included in the study. This technique is suitable for large, widely distributed populations and helps in saving costs and time in data collection.

Steps for implementing cluster random sampling at SMP Negeri 48 Surabaya: (1) Cluster Division: SMP Negeri 48 Surabaya can be divided into several clusters based on class (for example, class VII, VIII, and IX) or local area (if there are several class locations or facilities in the school), (2) Random Cluster Selection: From the clusters that have been formed, several clusters are randomly selected to be included in the study. For example, if the school has 10 classes, then 5 classes are randomly selected to be included in the study, (3) Sampling from Selected Clusters: After the clusters are selected, all students from the clusters are used as samples in the study. In this case, this technique allows researchers to obtain representative samples from all classes without having to select individuals directly, and (4) Sample Size: To ensure that the sample includes 200 students, researchers can calculate the number of students per cluster needed to achieve the total number of samples. For example, if 5 classes are randomly selected, then each class can be taken with about 40 students to reach a total of 200 students.

In SMP Negeri 48 Surabaya there are 10 classes, which are divided into classes VII, VIII, and IX, with 3 classes in each level. To select a sample of 200 students using the cluster random sampling technique: (1) The first step is to divide students by class (for example, 3 classes in level VII, 3 classes in level VIII, and 3 classes in level IX), (2) The second step, randomly select several classes from each level. For example, select 2 classes from class VII, 2 classes from class VIII, and 1 class from class IX, (3) The third step, take all students from the selected classes as samples, so that the total is 200 students.

Research Instruments

To collect data, several research instruments were used that had been tested for validity and reliability: (1) Project-Based Learning (PJBL) Questionnaire: Measuring students' perceptions of the application of PJBL in learning, with indicators such as involvement in projects, collaboration, and problem solving adapted from (Amaral, 2021; Larmer & Mergendoller, 2010) , (2) Problem-Based Learning (PBL) Questionnaire: Measuring students' perceptions of the application of PBL, with indicators such as problem relevance, problem analysis, and solution search adapted from (Hmelo, 1998) , (3) Learning Motivation Scale: Measuring the level of students' learning motivation, which includes intrinsic and extrinsic motivation. which measures factors such as autonomy, competence, and student involvement adapted from (Reynolds et al., 2013; Schutz & Muis, 2023) , (4) Problem-Solving Ability Test: Measuring students' ability to solve problems that require critical and analytical thinking skills. This test includes a variety of question types involving mathematical problem solving, science, and social case studies adapted from (Jonassen, 2000) .

Data Analysis

In this study, data analysis was conducted using SmartPLS 4.0, which is one of the software used for statistical analysis based on Partial Least Squares Structural Equation Modeling (PLS-SEM). SmartPLS 4.0 is a very useful tool for testing the relationship between complex variables in structural and measurement models involving various types of variables, both reflective and formative. Before conducting analysis using SmartPLS 4.0, the first stage is data collection and cleaning. The data that has been collected from participants is then checked to ensure that the data is clean, valid, and there are no missing values. After that, the data will be input into SmartPLS 4.0 for further analysis. In this study, the variables measured include Project-Based Learning (PjBL), Problem-Based Learning (PBL), and learning motivation which are expected to affect students' problem-solving abilities. Each variable is measured using relevant items, and all of these variables will be modeled using PLS-SEM to see the relationship between variables. Measurement models are used to test the validity and reliability of the constructs measured in research.

At this stage, the construct validity and reliability of each indicator used to measure the main variables are examined through two main things: Convergent Validity: Measuring how well the existing indicators are related to the construct being measured. Usually measured using the Average Variance Extracted (AVE) value, where an AVE value greater than 0.5 indicates good convergent validity. Discriminant Validity: Measuring the extent to which different constructs can be distinguished from each other. One method used to test discriminant validity is the Fornell-Larcker Criterion, which compares the root value of the AVE with the correlation between constructs. In addition, the reliability of the indicator is also tested through Composite Reliability (CR) and Cronbach's Alpha. A CR value greater than 0.7 indicates good reliability.

The next step is to analyze the structural model to see the relationship between variables in the research hypothesis. In this study, the main objective is to test the effect of PjBL, PBL, and learning motivation on students' problem-solving abilities. SmartPLS 4.0 will estimate the relationship between the independent variables (PjBL, PBL, learning motivation) and the dependent variable (problem-solving ability). In this stage, a path coefficient test is carried out, which measures the strength of the relationship between these variables. The greater the path coefficient value, the stronger the influence of a variable on another variable. The results of this test will then be tested for significance using bootstrapping to see if the influence found is statistically significant. SmartPLS 4.0 also allows for path significance tests using bootstrapping. Bootstrapping is a resampling technique used to test the stability of parameter estimates in a model. In this study, bootstrapping will be used to obtain t-statistic and p-value values to test the proposed hypothesis. A t-statistic value greater than 1.96 (with a significance level of 5%) indicates that the relationship between the variables is significant. A P-value less than 0.05 indicates that the relationship between variables in the structural model is also significant.

As a final step in model analysis, SmartPLS 4.0 also measures Goodness of Fit (GoF) which assesses the overall quality of the model. GoF measures how well the generated model fits the available data. GoF is calculated based on the average of AVE and R-squared. A model with a high GoF indicates that the model built can explain the data well.

■ RESULT AND DISCUSSION

Assessment of Measurement Model

Constructing a path diagram for all variables measured reflectively and formatively is useful for creating a model that will be produced and can identify latent variables that influence each other. The following is a path diagram between the latent variables of student problem solving ability (KPS)

(Y), PJBL (X1), PBL (X2), Learning Motivation (MB) (X3). The model that has been designed can be seen in image below:

Figure 1. shows that the variables measured reflectively are students' problem-solving ability (KPS) (Y), PJBL (X1), PBL (X2), Learning Motivation (MB) (X3). After converting the path diagram, it will be easier to process data using SmartPLS 4 software.

Measurement model testing will be carried out to shows the results of the validity and reliability tests. In this study, the validity test was carried out to to find out whether the construct has met the requirements to be continued as

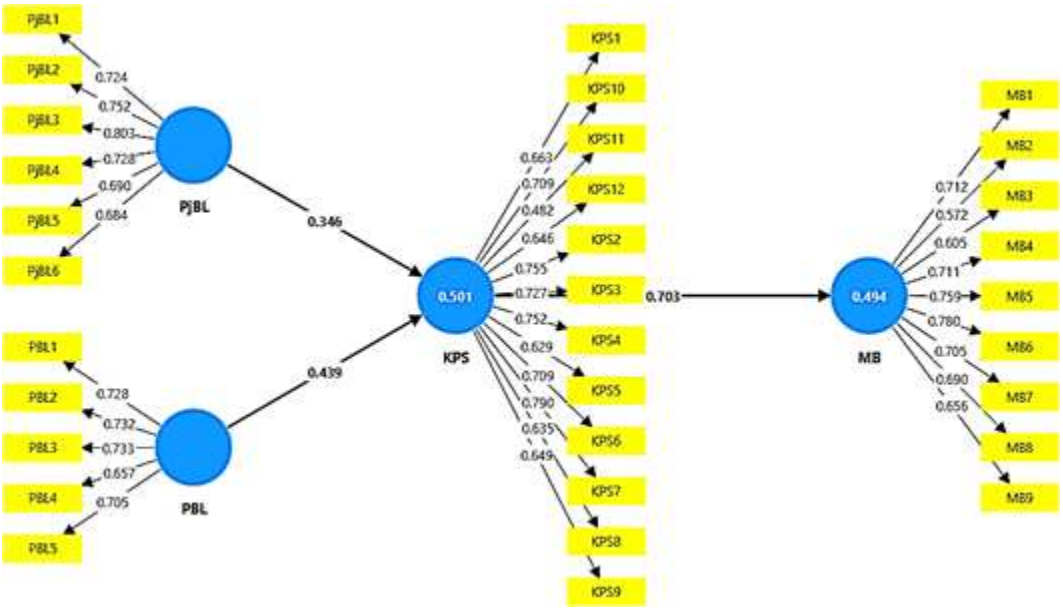

Figure 1. Designed model

research or not. In this validity test, there are two types of evaluations that will be carried out, namely:

Convergent Validity and Composite Reliability

Convergent Validity is a measurement model with items that have values based on the correlation between item scores and construct values. Convergent Index Validity is measured by outer loading, AVE factor, Cronbach's alpha, composite reliability, R square. Results outer loading, AVE factor, Cronbach's alpha, composite reliability, R square. can seen in table 8 below.

Validity and reliability criteria can also be seen from the reliability value of a variable and

Table 1. Convergent validity and internal consistency reliability

Construction	Item Code	Outer Loading	AVE	Cronbach's Alpha	Ro A	Ro C
KPS	**KPS1**	0.663	0.467	0.894	0.900	0.912
	KPS10	0.709				
	KPS11	0.482				
	KPS12	0.646				
	KPS2	0.755				
	KPS3	0.727				
	KPS4	0.752				

	KPS5	0.629				
	KPS6	0.709				
	KPS7	0.790				
	KPS8	0.635				
	KPS9	0.649				
MB	**MB1**	0.712	0.477	0.861	0.866	0.891
	MB2	0.572				
	MB3	0.605				
	MB4	0.711				
	MB5	0.759				
	MB6	0.780				
	MB7	0.705				
	MB8	0.690				
	MB9	0.656				
PBL	**PBL1**	0.728	0.506	0.757	0.760	0.837
	PBL2	0.732				
	PBL3	0.733				
	PBL4	0.657				
	PBL5	0.705				
PjBL	**PjBL1**	0.724	0.535	0.826	0.835	0.873
	PjBL2	0.752				
	PjBL3	0.803				
	PjBL4	0.728				
	PjBL5	0.690				
	PjBL6	0.684				

the Average Variance Extracted (AVE) value of each variable. A variable is said to have reliability. high if the composite reliability value is above 0.7 and AVE is above 0.5. Based on table 8, it is stated that all variables meet the composite reliability because their values are above the recommended number, which is above 0.7 which meets the reliable criteria.

Discriminant Validity

Discriminant Validity is measured by comparing the square root of average variance extracted (AVE) value of each construct with the correlation between the construct and construct other in model. If mark root square AVE every construct is greater than the correlation value between constructs with other constructs in the model, then choose a good discriminant validity value.

The discriminant validity data above, the diagonal value is the square root value of AVE and the value below is the correlation between constructs. The square root value of AVE in the table above is higher than the correlation value,

Table 2. Discriminant validity-cross loading

Construction	Item Code	KPS	MB	PBL	PJBL
KPS	**KPS1**	**0.663**	0.548	0.467	0.594
	KPS10	**0.709**	0.494	0.509	0.465
	KPS11	**0.482**	0.395	0.367	0.289
	KPS12	**0.646**	0.436	0.394	0.394
	KPS2	**0.755**	0.455	0.442	0.402

	KPS3	**0.727**	0.549	0.433	0.507
	KPS4	**0.752**	0.529	0.457	0.526
	KPS5	**0.629**	0.401	0.413	0.322
	KPS6	**0.709**	0.507	0.505	0.391
	KPS7	**0.790**	0.542	0.524	0.416
	KPS8	**0.635**	0.416	0.260	0.297
	KPS9	**0.649**	0.426	0.523	0.358
MB	**MB1**	0.451	**0.712**	0.500	0.565
	MB2	0.418	**0.572**	0.413	0.377
	MB3	0.445	**0.605**	0.392	0.440
	MB4	0.449	**0.711**	0.372	0.466
	MB5	0.517	**0.759**	0.465	0.491
	MB6	0.570	**0.780**	0.513	0.452
	MB7	0.519	**0.705**	0.420	0.361
	MB8	0.482	**0.690**	0.347	0.434
	MB9	0.489	**0.656**	0.384	0.301
PBL	**PBL1**	0.528	0.471	**0.728**	0.508
	PBL2	0.483	0.396	**0.732**	0.500
	PBL3	0.428	0.418	**0.733**	0.431
	PBL4	0.409	0.465	**0.657**	0.492
	PBL5	0.463	0.438	**0.705**	0.278
PJBL	**PjBL1**	0.426	0.489	0.408	**0.724**
	PjBL2	0.463	0.533	0.443	**0.752**
	PjBL3	0.519	0.495	0.537	**0.803**
	PjBL4	0.518	0.417	0.447	**0.728**
	PjBL5	0.415	0.466	0.492	**0.690**
	PjBL6	0.324	0.307	0.386	**0.684**

so it can be concluded that the model is valid because it has met discriminant validity. Another way to measure discriminant validity is to look at the square root of average variance extracted (AVE) value, the recommended value is above 0.50.

Structural Model Assessment

Testing Hypothesis

Testing of the proposed hypothesis is carried out by testing the structural model. (inner model) with see mark R Square that is test goodness-fit model. In addition, by looking at the Total effects which show the parameter coefficient and the significant value of the t-statistic of 1.96. In SmartPLS, statistical testing of each hypothesized relationship is carried out using simulation. In this case, the bootstrap ping method is used also intended to minimize problem abnormality data study. Parameter significant Which in the estimation provides very useful information regarding the relationship between the research variables.

To find out whether a hypothesis is accepted or rejected, this can be done by paying attention to the significance value between... construct, t-statistics and p-values. In this way, the estimation of measurement and standard error are no longer calculated with statistical assumptions, but are based on empirical

observations. In This study, the hypothesis is accepted if the significance value of t-values is greater than 1.96 and or the value of p-values is less than 0.05, then Ha is accepted and Ho is rejected and vice versa. The test results with bootstrapping from SmartPLS analysis can be seen in the output result for inner weight presented in the following table.

Table 3. Summary hypotheses

Hypothesis	Path	St. Beta	Std Error	T Values	P-Values	Confident Interval		Adjusted R2	Effect Size (F2)	Decision
						5.00%	95.00%			
H1	KPS -> MB	0.703	0.037	18.949	0.000	0.646	0.768	0.491	0.975	Supported
H2	PBL -> KPS	0.439	0.070	6.295	0.000	0.325	0.555	0.496	0.236	Supported
H3	PjBL -> KPS	0.346	0.075	4.615	0.000	0.222	0.469		0.147	Supported

Based on table 3, the adjusted R Square of the variable of students' problem solving ability towards learning motivation is 0.491. This means that the latent variable of learning motivation is able to explain or predict 49.1 % of students' problem solving ability while the remaining 50.9 % is explained by other variables not used in this study. While the adjusted R Square of the PBL and PjBL variables on students' problem-solving abilities is 0.496. This means that the latent variables PBL and PjBL are able to explain or predict 49.6 % of students' problem-solving abilities, while the remaining 50.4 % is explained by other variables not used in this study.

Based on table 3, the effect size or F Square (f2) of the variable in Effect Size is grouped into three categories, namely small, medium, and large, with values of 0.975, 0.236, and 0.147 respectively. students' problem-solving ability on Learning Motivation shows a large effect size with a value of 0.975. Meanwhile, PBL on students' problem solving ability has a small effect size of 0.236, which indicates a moderate influence. Meanwhile, students' problem solving ability on PjBL has a very small effect size of 0.147, indicating almost no influence.

Based on Table 3, the determination of the hypothesis is accepted. or rejected is explained as follows:

Hypothesis First Which state that there is a significant influence between students' problem solving abilities on learning motivation can be seen in table 3, the T Values value shows a large number of 18,949 which is >1.96 and can also be proven by the P Value of 0.000 or is said to be smaller than 0.05. This proves that students' problem-solving abilities have a positive effect on the learning motivation of students.

Hypothesis second Which state that there is a significant influence between PBL on students' problem solving abilities can be seen in table 3, the T Values value shows a large number of 6.295 which is >1.96 and can also be proven by the P Value of 0.000 or is said to be smaller than 0.05. This proves that PBL has a positive effect on the problem-solving abilities of students.

Hypothesis the third one state that there is a significant influence between PjBL on students' problem solving abilities can be seen in table 3, the T Values value shows a large number of 4.615 which is >1.96 and can also be proven by the P Value of 0.000 or is said to be smaller than 0.05. This proves that PjBL has a positive effect on the problem-solving abilities of students.

Hypothesis First Which state that there is a significant influence between students' problem solving abilities and learning motivation

The results of this study successfully prove that there is a significant influence between students' problem-solving abilities and students' learning motivation. Based on the data presented in Table 3, the T value (T Value) obtained is 18.949, which is greater than the critical number of 1.96. This figure shows that the influence between the two variables can be confirmed to

be statistically significant, meaning that the first hypothesis stating that there is a significant influence between problem solving abilities and learning motivation can be accepted. In addition, the P Value obtained is 0.000, which is smaller than 0.05, further strengthening the evidence that problem solving abilities have a positive influence on learning motivation. A P value smaller than 0.05 indicates that the results obtained are not coincidental, but rather a relationship that can be scientifically accounted for.

The main finding of this study is that students' problem-solving abilities have a positive effect on their learning motivation. Students who have good problem-solving abilities tend to be more confident in facing academic tasks and challenges, which in turn increases their motivation to learn. The ability to solve problems gives students a sense of achievement and control over the learning process, which can encourage them to continue trying and finding solutions to the problems they face.

Problem-solving abilities can also help students formulate and achieve clearer learning goals. This contributes to increased motivation, as students feel more competent and more able to organize their learning strategies. When students can solve problems independently, they feel more confident, which is a driving factor in increasing their learning motivation.

Previous studies also support the results found in this study. According to (Eldy et al., 2023; Safarati & Zuhra, 2023), problem-solving abilities are closely related to increased learning motivation, because problem solving gives students the opportunity to feel achievement and competence. In the study, students who were trained to develop problem-solving abilities showed higher motivation to participate in learning activities and improved their academic performance.

Studies by (Ezeddine et al., 2023; Tsai et al., 2023) also show that problem-solving abilities play an important role in increasing student motivation. They found that students who are better able to solve complex problems have greater self-confidence, which increases their intention to engage in learning tasks. This study emphasizes that learning motivation will increase along with the increase in students' abilities to face challenges and problems in learning.

Research (de la Fuente et al., 2023; Liu et al., 2024) also supports similar results, where problem-solving abilities are associated with increased student learning independence. Students who are able to solve problems independently will feel more confident in undergoing their learning process, which directly affects increased motivation to continue developing in education.

Based on the results of the data analysis obtained, it can be concluded that there is a significant influence between students' problem-solving abilities and their learning motivation. The better the students' problem-solving abilities, the higher their learning motivation. This study is supported by various previous studies that show that the development of problem-solving abilities plays an important role in increasing students' learning motivation. Therefore, teaching strategies that focus on improving problem solving abilities can be an effective solution to increase students' learning motivation in schools.

Hypothesis second Which state that there is a significant influence between PBL and students' problem solving abilities

The results of this study indicate that the Second Hypothesis, which states that there is a significant influence between the Problem-Based Learning (PBL) method on students' problem-solving abilities, can be accepted. Based on the data presented in Table 3, the T value (T Value) obtained is 6.295, which is greater than the critical number of 1.96. A T value greater than 1.96 indicates that the relationship between the PBL method and students' problem-solving abilities is statistically significant. In addition, the P Value

obtained is 0.000, which is smaller than the significance level of 0.05. This further strengthens the evidence that PBL has a positive effect on students' problem-solving abilities. This very low P value indicates that the results obtained are reliable and the relationship found between the two variables did not occur by chance, but rather as a result of the implementation of the PBL method in the learning process.

The main finding of this study is that the implementation of the PBL method has a positive effect on improving students' problem-solving abilities. The PBL method allows students to be actively involved in the learning process by solving relevant and contextual problems. Through the implementation of PBL, students not only develop an understanding of the subject matter, but also learn to think critically, analytically, and creatively in facing various challenges.

PBL provides an opportunity for students to work collaboratively in groups, find solutions to given problems, and sharpen their communication and self-evaluation skills. This process stimulates the development of their problem-solving abilities, as they are trained to recognize problems, analyze available information, identify potential solutions, and evaluate the effectiveness of the solutions implemented. Thus, students who engage in problem-based learning tend to have better problem-solving abilities.

Research conducted by (Afifah & Faiziyah, 2024; Istiana et al., 2024) revealed that the application of the PBL method contributed significantly to improving students' problem-solving abilities. In the study, students who participated in problem-based learning showed increased ability in solving problems, both individually and in groups. They were able to identify and analyze problems in more depth, and formulate more effective solutions.

Other studies by (Asri et al., 2024; Low et al., 2024) also support this finding, where they found that PBL can improve students' critical thinking skills and problem solving abilities. In their study, students who were taught using the PBL approach were able to develop skills to solve more complex and challenging problems compared to students who followed conventional learning. Students involved in PBL tend to be more motivated to try to find creative and effective solutions.

Amanda et al., (2024); Raman et al., (2024) in their research also stated that PBL has a positive influence on students' problem-solving abilities, especially in the context of learning based on real-world scenarios. By presenting problems that are relevant to everyday life, PBL encourages students to think more critically and creatively in solving problems, which leads to an increase in their problem-solving abilities.

Based on the results of the analysis that has been done, it can be concluded that the application of the Problem-Based Learning (PBL) method has a significant and positive influence on students' problem-solving abilities. Through this method, students are trained to face and solve problems systematically and creatively, which ultimately improves their problem-solving abilities. This study is supported by various previous studies that show that PBL is an effective method in developing students' critical thinking and problem-solving abilities. Therefore, the application of the PBL method in the classroom can be an effective strategy to improve the quality of learning and students' problem-solving abilities.

Hypothesis the third one state that there is a significant influence between PjBL and students' problem solving abilities

This study proves that the Third Hypothesis stating that there is a significant influence between Project-based Learning (PjBL) on students' problem-solving abilities can be accepted. Based on the results of the analysis in Table 3, the T value (T Value) obtained is 4.615 which is greater than the critical number of 1.96, which indicates that the relationship between PjBL and students'

problem-solving abilities is statistically significant. This means that the influence found is not a coincidence, but reflects a strong relationship between the two variables. The P Value obtained is 0.000, which is smaller than 0.05, further strengthening that PjBL has a positive effect on students' problem-solving abilities. The very low P value indicates that these results are very reliable and that the application of the PjBL method does have a significant impact on improving students' problem-solving abilities.

The main finding of this study is that the implementation of the Project-based Learning (PjBL) method has a significant positive effect on students' problem-solving abilities. PjBL is a learning method that focuses on developing students' skills through real projects that challenge them to solve problems, develop creative ideas, and work together in teams.

Through this method, students are given the opportunity to engage in project-based learning that requires them to think critically, analytically, and creatively in dealing with existing problems. In this way, PjBL encourages students to apply various problem-solving abilities, such as identifying problems, finding solutions, planning steps, and evaluating the results.

The implementation of PjBL provides an in-depth and contextual learning experience, where students not only gain theoretical knowledge, but also practice it in real situations. This process motivates students to be more involved in learning, increases their sense of responsibility, and develops their ability to solve more complex problems. This explains why students' problem-solving abilities applied in the context of PjBL can increase significantly.

Research conducted by (Gestira et al., 2021; Rabbani et al., 2023) supports this finding, where they found that PjBL plays an important role in developing students' problem-solving abilities. In their study, students involved in active learning-based projects showed better problem-solving abilities compared to students who followed conventional methods. (Gestira et al., 2021; Rabbani et al., 2023) noted that students who used the PjBL approach had more opportunities to think critically, work in teams, and face real-world challenges that require problem solving.

Similar studies by (Parno et al., 2023; Purwaningsih et al., 2020) also showed that PjBL has a positive influence on improving students' problem-solving abilities. In the study, the application of PjBL provided opportunities for students to develop skills in designing, implementing, and evaluating solutions to the problems they face. Students trained through PjBL showed increased ability to solve more complex problems and apply their knowledge practically.

In addition, research by (Nurmaliah et al., 2021; Rizki M et al., 2021) confirmed that PjBL is an effective method in equipping students with the problem-solving abilities needed to face academic and daily life challenges. By focusing on real projects, students can learn to identify problems, design solutions, and implement those solutions better.

Based on the findings and analysis of the data obtained, it can be concluded that Project-based Learning (PjBL) has a positive and significant effect on students' problem-solving abilities. PjBL provides an opportunity for students to be directly involved in the real problem-solving process, which improves their critical thinking skills and analytical skills. This study is also supported by various previous studies that show that PjBL is an effective learning approach in developing students' problem-solving abilities. Therefore, the application of the PjBL method in the classroom can be an effective strategy to improve the quality of learning and develop students' problem-solving abilities.

■ CONCLUSION

Based on the results of data analysis and discussion that have been done, it can be concluded that the three hypotheses in this study

are proven to be true and provide significant contributions to improving learning motivation and students' problem-solving abilities. *First,* the first hypothesis stating that there is a significant influence between students' problem-solving abilities and learning motivation is proven through the results of statistical analysis showing a T value of 18.949, which is greater than the critical number of 1.96, and a very small P Value, which is 0.000, which is less than 0.05. This indicates that students' problem-solving abilities have a positive influence on their learning motivation, which shows that the better the students' ability to solve problems, the higher their motivation to learn. *Second,* the second hypothesis stating that the application of the Problem-Based Learning (PBL) method has a significant effect on students' problem-solving abilities is also proven by the results of the analysis showing a T value of 6.295, which is greater than 1.96, and a very small P Value, which is 0.000. This shows that PBL has a positive influence on improving students' problem-solving abilities. PBL provides students with the opportunity to engage in learning based on real-world problem solving, which directly improves their critical and creative thinking skills. *Third,* the third hypothesis that tests the effect of Project-based Learning (PjBL) on students' problem-solving abilities also shows significant results, with a T value of 4.615, which is greater than 1.96, and a P Value of 0.000. This proves that PjBL also has a positive effect on improving students' problem-solving abilities. With PjBL, students not only learn theory, but also involve themselves in projects that challenge them to solve complex problems, which directly improve their problem-solving abilities. The results of this study have important implications for the development of learning strategies in schools. The use of Project-Based Learning and Problem-Based Learning methods can be an effective alternative in improving students' problem-solving abilities. In addition, it is important for teachers to create a learning environment that motivates students to be more active and participate in the learning process. By combining these approaches, it is hoped that students can develop critical and creative thinking skills, which are very much needed in facing challenges in the real world. Further research is also needed to dig deeper into other factors that may influence students' problem-solving abilities, such as social and emotional factors.

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