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The effect of using the problem-based learning model on the cognitive learning outcomes and motivation of students at junior high school

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Abstract
Problem Based Learning (PBL) is a learning approach that emphasizes active student involvement in solving real-world problems, and is expected to enhance conceptual understanding and learning enthusiasm. The research method used is quantitative with a quasi-experimental design. The research subjects were eighth-grade students at a junior high school in Junior high school, divided into an experimental class and a control class. The instruments used included a cognitive learning outcomes test and a learning motivation questionnaire. The data analysis technique employed was the t-test to compare learning outcomes and motivation between the two groups. The results showed a significant difference between students who learned using the PBL model and those who learned through conventional methods. Students taught using the PBL model had higher cognitive learning outcomes and learning motivation. These findings demonstrate that the PBL model has a positive effect on the cognitive learning outcomes and motivation of junior high school students.

1. Introduction

Modern developments demand renewal in various aspects of life. The demands of modern progress refer to the various transformations and evolutions taking place in society and the world as a whole, and how these impacts the needs, aspirations, and demands faced by individuals and groups in their daily activities. One aspect of life that is evolving is education. Education must continue to evolve as the needs and demands of society, the workplace, and the environment constantly change with the times. Education plays a crucial role in national development in Indonesia. Therefore, education needs to be refined to create competent individuals who can positively impact national development in Indonesia. According to Taseman et al (2020), education is a crucial element in the implementation of education to achieve the desired national education goals, as the quality of education has a significant impact on the development of a country and its citizens. In the 21st century, developments in science and technology are occurring rapidly, particularly in the information technology sector. Various aspects of life, including the education sector, are significantly impacted by these changes. Curricula, methods, strategies, and learning tools are adapting to the rapid pace of technological and information advancements. It is hoped that these improvements in education will result in higher quality in the education system.

The results of the 7th grade daily assessment for the 2021/2022 academic year in science subjects show that many students still scored below the Minimum Completion (KKM). The minimum competency criterion for Junior High School is 70. And across all classes, with a total of 256 students, almost all classes had low percentages of students scoring above the KKM. Class VII F had a passing percentage of 34.48%; and class VII F 45.75%, respectively.

Learning motivation is a fundamental element in the learning process. Learning motivation is a general force that drives students to have a desire to learn and directs their learning activities to achieve desired goals. This shows that motivation not only drives but also directs learning behavior (Datu et al., 2022). Recent research shows that the level of learning motivation of junior high school students in science subjects is still relatively low. Yuliana and Fitria (2024) found that at SMP Negeri

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10 Padang, students' motivation in science subjects is still relatively low. Student motivation for PA learning is low, with motivation contributing only 0.0441% to learning outcomes (r = 0.21). Similar research by Syamsuddin and Astuti (2021) at junior high schools in Konawe Regency also revealed that the average scores for motivation and science learning achievement were in the low category, although there was a significant relationship between the two. This low motivation can be caused by various factors, such as a lack of variety in learning methods, minimal student involvement in learning activities, and a lack of relevance of the material to students' daily lives.

Most science teachers still use lectures or conventional methods. Science instruction should provide students with practical experiences that enhance their ability to construct, understand, and apply the concepts they have learned (Pratama & Fitriyah, 2023). This can be triggered by several reasons. One is the traditional educational method, where the teacher simply delivers information in front of students, and the students simply listen. Another reason is the suboptimal use of learning aids, which prevents students from actively participating in the classroom learning process. As a result, many students still do not understand the material presented by the teacher directly. Through improvements in the teaching process, academic achievement and student motivation can be enhanced. The learning process itself is a collection of activities and experiences planned and provided by teachers to students. Competent and experienced teachers will respond to their students' abilities. Professional teachers always know how to convey learning material to their students. Problem-Based Learning (PBL) plays a role in explaining the cognitive processes involved. The PBL model is part of active and progressive learning that uses problems as a starting point for the learning process. The problems used are from everyday life and are not as difficult as even elementary school students imagine. In fact, teachers do not always need to utilize real-life problems in students' lives. Teachers can use simulations (Mardiyanto, 2024). Previous research on problem-solving-focused learning found that student learning outcomes were influenced by the application of this learning method.

In the educational context, learning outcomes have important implications for curriculum development, instructional design, and assessment. Learning outcomes serve as the basis for formulating learning objectives, selecting appropriate teaching strategies and methods, and designing valid and reliable assessments. In efforts to improve learning outcomes, the role of teachers is crucial (Mulyadi et al., 2022). Teachers need a deep understanding of the learning process and the ability to design effective learning experiences. Furthermore, teachers must be able to provide constructive feedback, provide support and guidance, and facilitate the development of expected skills and attitudes (Andayani & Madani, 2023).

This research is important and needs to be investigated because the problems involved are real and require appropriate solutions to improve student learning outcomes and motivation. The researcher wants to conduct a study to determine the influence of the PBL model on Substance and its changes on students' cognitive learning outcomes and motivation levels. Based on the background compiled, the author conducted a study with the title "The effect of the problem-based learning model on cognitive learning outcomes and motivation levels of students at junior high school".

2. Method

The research design used is quasi-experimental. The design is in the form of a Pretest-Posttest Control Design, which takes samples randomly (R) and treatment is only given to one group (X) while the other group is not given treatment (Y), but the group is still given the same Pretest-Posttest to get the effect of the treatment (O) (Sugiyono, 2019). The experimental class applies a problem-based learning model, while the control class uses a conventional learning model. This study involved grade VII students at a junior high school in Karanganyar, Central Java, Indonesia in the 2024/2025 academic year. Seventh grade students were selected based on the assumption that they would study the topic of substances and their changes. The sampling technique used in this study was cluster random sampling. The selection of experimental and control groups was determined through normality and homogeneity tests of students' daily test scores. Normality test was conducted using Shapiro-Wilk ($\propto$= 0.05). Data collection techniques include test and non-test methods. Data analysis techniques involve prerequisite tests, normality and homogeneity tests, improvement tests using t-tests, and hypothesis tests. Hypothesis testing was conducted using two sides, Two-sided hypothesis testing was applied by researchers who did not have a specific directional hypothesis and attempted to determine significant differences. The hypotheses in this study are (A): There is an influence of the

Problem Based Learning (PBL) Model on students' cognitive learning outcomes at Junior high school. (B): There is an influence of the PBL Model on students' motivation levels at junior high school.

3. Results and Discussion

3.1. Data Description

Data on students' cognitive abilities were obtained through the results of a pretest conducted before the application of the problem-based learning model, as well as a posttest given after the model was applied. Both the pretest and posttest consisted of 40 short answer questions that tested material on Substances and their changes. The data on students' cognitive ability scores are presented in Table 1.

Table 1. Data Description of Students' Cognitive Abilities

Data description	Control class		Eksperimental class	
	Pretest	Postest	Pretest	Posttest
Average	44.8485	53.485	52.7803	71.212
Minimum value	27.50	25.0	15.00	42.5
Maximum value	62.50	75.0	95.00	100.0
Standard deviation	8.70388	13.7775	17.04850	14.4714

In this study, each group consisted of 33 participants as research objects. Table 1 shows that the pretest and posttest scores of students' creative thinking skills in the experimental group were higher than those in the control group. The average pretest and posttest scores in the experimental group were 52.7803 and 71.212, while for the control group they were recorded at 44.8485 and 53.485 respectively. The highest scores on the pretest and posttest in the experimental group were 95.00 and 100.00, while in the control group they reached 62.50 and 75.00 while in the control class they reached 62.50 and 75.00 respectively.

The standard deviation on the pretest and posttest in both classes, both experimental and control, was smaller than the average value, which proves that the data distribution is relatively narrow or has small variations. Description of students' cognitive learning outcomes data was obtained from the results of the summative test on the material of substances and their changes. The data from the comparison of pretest and posttest scores for cognitive learning outcomes of students in the control class and experimental class on the material on substances and their changes are presented in Figure 1.

Figure 1. Cognitive Learning Outcome Aspect Diagram of Experimental and Control Class Students

The use of the Problem Based Learning (PBL) model in learning shows a significant influence on the cognitive learning outcomes of students. The posttest score of the experimental class was 71.21, higher than the control class which was only 53.48. The summative test results showed better results in the experimental class. The following graph shows a comparison of the average scores between the experimental and control classes.

In this study, the PBL model was applied to the experimental class while the control class used a conventional learning model. The questionnaire results were used to obtain data related to the level of student motivation. The questionnaire questions consisted of 20 questions using a Likert scale. The description of the data on the value of the Motivation Level is presented in Table 2.

Table 2. Description of Student Motivation Level Data

Category	Number of students	Presentation (%)
Very low	0	0%
Low	0	0%
Currently	5	15.63%
High	23	71.88%
Very high	4	12.50%
Total	32	100%

Table 3 shows the results of measurements using a Likert scale in the experimental class which displays the results of the level of student motivation in the following categories: very low totaling 0 (0%), low 0 (0%), moderate totaling 5 (15.63%), high totaling 23 (71.88%), very high totaling 4 (12.50%).

Table 3. Results of Motivation Level Measurement

Category	Number of students	Presentation (%)
Very low	0	0%
Low	0	0%
Currently	11	33.33%
High	22	66.67%
Very high	0	0.00%
Total	32	100%

Table 3 shows the results of measurements using a Likert scale in the control class showing the results of the level of student motivation in the categories, including: very low totaling 0 (0%), low 0 (0%), moderate totaling 11 (33.33%), high totaling 22 (66.67%), very high totaling 0 (0%).

The data from the comparison of the motivation levels of students in the control class and the experimental class on the material on substances and their changes are presented in Figure 2.

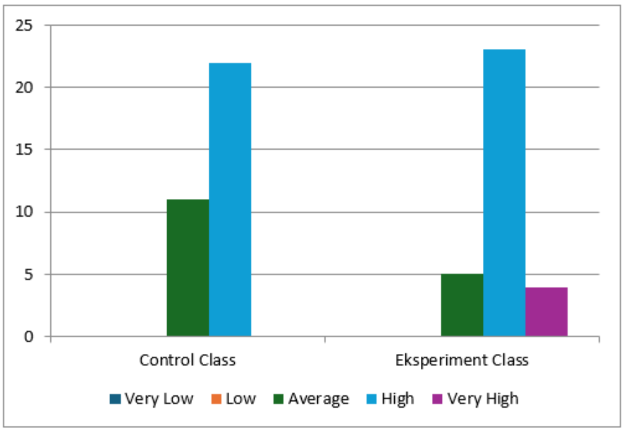

Figure 2. Motivation Level Aspect Diagram of Experimental and Control Class Students

Most students in the experimental class showed a high level of motivation. This is reflected in the percentage of students who were in the 'High' and 'Very High' categories. In contrast, in the control class, no students reached the 'Very High' category. The following graph illustrates the distribution of motivation levels between the two classes.

3.2. Prerequisite Test Results

Before conducting the ANCOVA test, the initial step taken is to conduct a normality test to ensure whether the data has a normal distribution. The normality test is carried out by applying the Shapiro-Wilk method at a significance level (α) of 0.05. In accordance with the Shapiro-Wilk criteria, data is declared normally distributed if the significance value exceeds 0.05. The results of this normality test can be found in Table 4 and Table 5.

Table 4. Results of the Normality Test of Students' Pretest and Posttest Cognitive Abilities

Class	Significance	Comparison of Sig. with α	Test Results
Pretest control class	0.587	0.587 > 0.05	Normal Data
Postest control class	0.063	0.063 > 0.05	Normal Data
Pretest eksperimen class	0.901	0.901 > 0.05	Normal Data
Postest eksperimen class	0.689	0.0689 > 0.05	Normal Data

The p-value is 0.200, which is greater than 0.05, as seen in the research results in Table 4. Therefore, it can be concluded that the data on students' creative thinking abilities, both in the experimental and control classes, show a normal distribution.

Table 5. Results of the Normality Test of Student Motivation Levels

Number of Samples (N)	Significance value	Test Results
0,20	0.20 > 0.05	Normal Data

The study results in Table 5 show that the students' cognitive learning outcomes were normally distributed. The pretest and posttest for both classes showed significance values greater than 0.05. A homogeneity test is necessary before conducting an ANOVA test. The homogeneity test aims to determine the extent of variation in the sample data. Comparable or equivalent groups have similar levels of variation. To evaluate whether the data are homogeneous, a Levene's test was conducted with a significance level of α = 0.05 using SPSS software. The criteria for the Levene's test indicate that if the significance value exceeds 0.05, there is no difference in variation between the groups. The results of the homogeneity test can be seen in Table 6 and Table 7.

Table 6. Results of Homogeneity Test of Students' Cognitive Abilities Posttest

Number of Samples (N)	Significance value	Comparison of Sig. with α	Test Results
66	0.890	0.890 > 0.05	Data Homogen

The creative thinking ability of students in the experimental group and the control group is comparable as can be seen from the results of the study Table 6 with a significance level of more than 0.05. This indicates that there is no significant difference between the pretest and posttest results of students' creative thinking abilities in the two groups.

Table 7. Results of Homogeneity Test of Students' Cognitive Summative Abilities

Number of Samples (N)	Significance value	Comparison of Sig. with α	Test Results
66	0.010	0.010 < 0.05	Non-Homogeneous Data

The results of the study Table 7 show that the pretest and posttest values in cognitive learning of students in the experimental and control classes are similar. This is because the results of the homogeneity test show a significance figure that exceeds 0.05. Results of homogeneity test of student motivation levels can be seen in Table 8.

Table 8. Results of Homogeneity Test of Student Motivation Levels

Number of Samples (N)	Significance value	Comparison of Sig. with α	Test Results
66	0.289	0.289 < 0.05	Data Homogen

The results of the study Table 8 indicate that the pretest and posttest values of students' cognitive learning in the experimental and control classes are homogeneous. This is because the homogeneity test has a significance value of >0.05.

3.3. Hypothesis Test Results

Based on the data contained in Table 9 and Table 10, the implementation of the Problem Based Learning (PBL) model in the trial class indicates that there is no significant variation in students' academic achievement related to content regarding the human movement system or in their creative thinking skills, in line with the null hypothesis.

Table 9. Results of Students' Pretest-Posttest Cognitive Abilities

Group Statistic					
	Class	N	Mean	Std. Deviasi	Std. Error Mean
Score	Posttest control class	33	53.485	13.7775	2.3984
	Experimental class posttest	33	71.212	14.4714	2.5192

The t-test presented in the table above explains that 33 students in the experimental class have an average of 71.212, and 33 students in the control class have an average of 53.485, with t count = 5.097. First, the degrees of freedom (db) of the sample as a whole must be determined using the formula db = N-2.

Table 10. Results of the T-Test (Independent Test) of Students' Pretest-Posttest Cognitive Abilities

Independet Sample T-test										
	Lavene Test for Equality of Variances			T-test for Equality of Means						
		F	Sig.	t	df	Sig(2-tailed)	Means Difference	Std. Error Differences	95% Confidence Interval of The Differences	
									Lower	Upper
Score	Equal variances assumed	.019	.890	-5.097	64	<.001	-17.7273	3.4783	-24.6759	-10.7787
	Equal variances of assumed	-	-	-5.097	63.846	<.001	-17.7273	3.4783	-24.6759	-10.7787

Based on the fact that db = 64, ttable = 1.998 at a significance level of 5%, and based on these t values, it can be concluded that t_{table} = (5%) = 1.998 < tcount (-5.097) is above or more than t_{table} at a significance level of 0.05. Hypothesis Testing (Independent t-test): t-statistic: -5.10, p-value: 0.00000329 (very small) Table 4.8 shows the results. Because the p-value is less than 0.05, then: H0 (no significant difference) is rejected and H1 (there is a significant difference) is accepted. This shows that there is a significant difference in the problem-based learning model that affects cognitive learning outcomes at junior high school between the control group and the experimental group. The experimental group showed a higher average value, indicating that the treatment given in the experimental group had a positive effect on learning achievement. Independent T-Test result can be seen in Table 11 and independent sample T-test of student motivation level can be seen in Table 12.

Table 11. Independent T-Test

Group Statistic					
	Class	N	Mean	Std. Deviasi	Std. Error Mean
Score	Control Class Questionnaire	33	69,58	4.221	.735
	Experimental Class Questionnaire	33	78,70	7.740	1.347

Table 12. Independent Sample T-test of Student Motivation Level

Independet Sample T-test										
	Lavene Test for Equality of Variances			T-test for Equality of Means						
		F	Sig.	t	df	Sig(2-tailed)	Means Difference	Std. Error Differences	95% Confidence Interval of The Differences	
									Lower	Upper
Score	Equal variances assumed	6.575	.013	-5.944	64	<.001	-9.121	1.535	-12.187	-6.055
	Equal variances of assumed	-	-	-5.944	49.486	<.001	-9.121	1.535	-12.204	-6.038

In the experimental group, 33 participants showed an average score of 78.70, while in the control group, 33 participants had an average score of 69.58, with tcount = 5.944. Determine the degrees of freedom (db) of each sample first using the formula db = N-2. Since the total sample is 66, the degrees of freedom db are calculated as 66-2 which is equal to 64. Thus, the t_{table} value at a significance level of 5% is 1.998 and tcount (-5.944) is greater than t_{table} at alpha 0.05. The results of the independent t-test show: t-statistic = 5.94, p-value = 1.27×10^{-7}. Since the p-value is less than 0.05, there is a significant difference between the results in the Experimental Class and the Control Class. This means that the treatment or method applied to the Experimental Class is likely to have a significant impact on the questionnaire results compared to the Control Class.

3.4. Big Influence

The magnitude of the influence of the Problem Based Learning (PBL) model on students' cognitive learning outcomes. The results of the effect size test using Cohen's d explain the value of 1.62. Based on the calculation, it can be interpreted that the magnitude of the influence of the PBL model on the cognitive learning outcomes of class VII students of Junior high school is 1.624334. Thus, the value of 1.62 is included in the very large effect category, which means that the effect of the treatment on cognitive learning outcomes is very significant in practice.

The magnitude of the influence of the PBL model on the level of student motivation. Based on the results of the calculation using Cohen's d, the effect size value of the influence of the PBL model on student motivation is 0.13. This shows that the impact of the PBL on the level of motivation of class VII students at Junior high school is 0.134096973. Based on Cohen's general interpretation, this value describes the magnitude of the influence that occurs. This means that the PBL model has a small influence in increasing student motivation compared to the method used in the control class.

3.5. Discussion

The Problem-Based Learning (PBL) model presents a real-life problem for investigation and resolution (Septiyowati & Prasetyo, 2021). Analysis using the ANCOVA test showed a significance value of <0.05 (Table 9) for the creative thinking ability variable, and a significance value of <0.05 for the student cognitive learning outcomes variable (Table 8). These results indicate a significant effect of the PBL model on student cognitive learning outcomes and motivation. The PBL model was implemented with a time allocation of four meetings. The learning process consisted of the following steps: (1) problem orientation, (2) organizing students for learning, (3) guiding students in investigation, (4) developing and presenting work, and (5) analyzing and evaluating learning.

PBL is a learning approach in which students work with real-world problems to develop their own knowledge, higher-order thinking skills, inquiry skills, and independence and self-confidence (Putri et al., 2021). PBL can be defined as a series of learning activities that emphasize the scientific process of problem-solving. This model uses real-life problems as a foundation to enhance student interest and learning outcomes, as well as to acquire important conceptual knowledge. In this approach, teachers play a role in helping students develop self-direction skills. In this context, students need to have the ability to increase their enthusiasm and interest in selecting accurate and relevant information, both for themselves, their community, their nation, and their country (Kurniawan et al., 2020). Syntax of problem-based learning can be seen in Table 13.

Table 13. Syntax of Problem-Based Learning

Stage	Teacher Activities	Student Activities
Stage 1. Student orientation to problems and formulating problems	The teacher informs the learning objectives, describes the logistical needs, and motivates students to participate in problem-solving activities they choose themselves	Understand the problem conditions by knowing the problem, things that are known and asked Formulate the problem by using concepts and writing down the information provided to solve the problem
Stage 2 Organize students to learn and plan solutions	The teacher helps students determine and organize learning tasks related to the problem	Choose a solution strategy that suits the problem Find other information that can help solve the problem
Stage 3 Assist independent and group investigations that have been planned to find solutions	The teacher guides students in collecting appropriate information, conducting experiments, seeking explanations, and finding solutions.	Try to find solutions using the information already known and applying previous problem-solving strategies
Stage 4 Develop and present the work as well as showcase it	The teacher helps students plan and prepare appropriate works such as reports, video recordings, and models, and assists them in presenting their work	Prepare products as solutions to problems. Present the results of group discussions in front of the class and relate them to knowledge and experiences in everyday life.
Stage 5 Analyze and evaluate the problem-solving process and the solutions produced	The teacher helps students reflect on the investigations and processes they used.	Evaluate the obtained solutions to determine whether they can solve the given problem or address more general issues.

(Source: Suyatman & Chusni, 2023)

The problem-orientation stage determines learning objectives, needs, and the motivation required to engage students in problem-solving activities. In the first meeting in this stage the teacher shows a video showing someone having difficulty walking upright in a swimming pool with water up to their neck, then students try to connect it with the learning objectives and are given motivation related to the learning that will be carried out. Next, students are given LKPD which contains a demonstration of the various states of matter using syringes filled with solids, liquids, and gases. In the second meeting, students are presented with a visual video about a lighter about water condensing on ice, then students try to connect it with the learning objectives and the teacher provides motivation to better understand changes in the state of matter in everyday life. Students are then given LKPD which contains an article about drinking ice water as an illustration for carrying out simple practices that will be carried out after the students form groups. In the third meeting, students are given a demonstration then observe a candle being burned through a demonstration by other students, then students try to connect it with the learning objectives and the teacher provides motivation to better understand physical changes and chemical changes in everyday life. Then students are given LKPD to carry out simple experiments based on the demonstrations carried out previously. At the fourth meeting, students were presented with objects that were put into water, then they observed illustrations of objects that could sink and float, then students tried to connect them with learning objectives and the teacher provided motivation to become more familiar with physical changes and chemical changes in everyday life.

The organizational stage involves interpreting and organizing learning tasks relevant to the problem. Students gather in their respective groups, which have been previously divided into five heterogeneous groups. Then, they formulate the problem based on the articles and worksheets provided through group discussions. The investigation stage involves conducting experiments, seeking information, and finding literature sources to solve the problem. In the first meeting, students explain the particle forms and characteristics of solids, liquids, and gases. Students will then be able to accurately explain examples of diffusion that occurs in liquids and gases in everyday life through discussion activities. In the second meeting, students are expected to explain the process of changes in state of matter through experiments and determine the state of matter at various temperatures based on melting and boiling point data through discussion activities. In the third meeting, students will be able to identify, differentiate, and explain physical and chemical changes through experiments. In the fourth meeting, students will be able to determine and compare the densities of substances through experiments. The product development and presentation stage include planning and preparing work in the form of reports, models, or videos. In the first meeting, students present the results of their discussions with their respective groups. In these two stages, students prepared the results of their discussions for presentation to the class. In the third meeting, students created posters about substances and changes, and each group presented their posters to the class. In the fourth meeting, students presented the results of their experiments, followed by group discussions. The analysis and evaluation stage of learning is a reflection stage on the results of the investigation. Students who did not present analyzed the results of their discussions to identify differences or similarities. Then, each group received an evaluation question to assess the knowledge gained during the meeting.

The research was conducted according to scientific procedures, but it was not without limitations. During the learning process, some students experienced difficulties contributing to group discussions, such as playing alone and disrupting other groups. In addition, it appears that students are not accustomed to being given daily problems so that there are difficulties when identifying problems presented in LKPD. At the time of the research, the lesson hours began after the students had a break, then when the bell rang for science class, the students did not immediately enter the classroom so that it took more time to make the students conducive and first of all made the implementation of learning not meet the planned JP. The quality of a study can be known and the existence of instruments. This study measures cognitive abilities only using cognitive test instruments that are arranged based on cognitive aspects. The question instrument is in the form of short answer questions, short answers to measure the level of motivation are carried out after students have carried out learning activities. To measure the motivational aspect, students fill out a form in the form of a questionnaire that has been given a scale of 1-5 totaling 20 questions.

Based on the pretest, the average score of the experimental class was 52.78, while the control class was only 44.85. This difference indicates that before the treatment, the initial abilities of students in the experimental class were slightly higher, but not significantly different. After the treatment, the posttest score of the experimental class increased significantly to 71.21, while the control class only reached 53.48. This increase indicates a much larger difference in improvement in the experimental class compared to the control class. The improvement in learning outcomes in the experimental class was caused by the implementation of PBL which: Provides real problems relevant to students' lives, Encourages students to think critically, analyze, and find their own solutions, Involves group discussions so that a rich exchange of ideas occurs (Koçoğlu, 2025) also found that PBL significantly improved learning outcomes in a wide range of educational contexts, confirming its strong effect compared to traditional methods. In contrast, in the control class that uses conventional learning, the learning process is more teacher-centered (the teacher delivers, students listen), so that students' opportunities to explore material and discover new knowledge independently are limited. As a result, the improvement in learning outcomes is not as high as in the experimental class. Seeing the real difference between the two groups, it can be concluded that the learning techniques applied in the experimental class play a very important role in improving cognitive learning outcomes.

It is known that the PBL model significantly increases student learning motivation. The results of questionnaire data analysis indicate that this occurs in both the experimental and control classes. The implementation of PBL also has a positive impact on student learning motivation. Based on the results of the motivation questionnaire administered after the treatment, it was found that 71.88% of students in the experimental class had high motivation, and 12.5% had very high motivation. In contrast, the control class had only 66.67% of students with high motivation, and 33.33% in the moderate category, with no students in the very high category. These data indicate that the implementation of PBL is able to increase learning motivation better than conventional learning. This is supported by studies by (Fitri et al., 2024), who found that PBL improved students' motivation in science learning from 66.07% to 82.85%, and Hartatik (2022), who reported that student motivation rose from 73.57% in the first cycle to 91.43% in the second cycle through PBL implementation. Similarly, Rofingah (2023) and Lestari et al (2025) emphasized that PBL not only improves learning outcomes but also significantly strengthens students' motivation, responsibility, and active participation in the learning process. Factors influencing this include: Active involvement: Students are directly involved in the process of finding solutions; Relevance of the material: The problems presented are relevant to students' daily lives; Group collaboration: Creates a more enjoyable learning atmosphere and fosters a sense of ownership in the learning process.

This is supported by the results of the effect size analysis using Cohen's d, which showed a value of 1.46. According to Cohen's (1988) interpretation, an effect size value of 0.2 is categorized as small, 0.5 as medium, and 0.8 or higher as large. Therefore, a value of 1.46 falls into the category of a large effect, indicating that the PBL learning model significantly increased student motivation compared to the conventional learning model used in the control class. Similar findings were reported in a meta-analysis by Wijnia et al (2024) which found that PBL, PjBL, and CBL consistently have a positive effect on student motivation (d = 0.498). Quantitative data also supports this statement. Tables 1.9 and 1.10 in the thesis document show clear differences in the distribution of motivation levels between the two groups. Students in the experimental class predominantly demonstrated high and very high motivation levels, while students in the control class predominantly demonstrated moderate to high motivation levels, with none in the very high category. Thus, it can be concluded that the implementation of the Problem-Based Learning model can provide a greater motivational boost for students. High learning motivation plays an important role in achieving optimal learning outcomes because students are encouraged to be more active, independent, and confident in participating in the learning process.

4. Conclusion

Based on the results of this study, the following conclusions can be drawn; the Problem-Based Learning (PBL) Model has an effect on students' cognitive learning outcomes. The PBL model increases students' desire to learn. The effect size calculation results show Cohen's d is 1.62, while the independent sample t-test shows a significance of 0.001>0.05. This is evidenced by the significant difference between the posttest scores of students in the experimental class compared to the control class. Through contextual problem solving, the PBL model encourages students to think critically, collaborate, and understand concepts comprehensively.

The PBL Model has an effect on students' motivation levels. Student motivation levels have been increased by the implementation of the PBL model. The calculated value using Cohen's d is 0.13, while the independent sample t-test shows a significance of 0.001>0.05. This means that compared to students who participated in conventional learning, students who learned with the PBL model showed a significantly higher level of motivation.

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