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Exploring the Impact of Problem-Based Learning and Curiosity on Enhancing Higher-Order Thinking Skills in Elementary Science

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ABSTRAK

Kemampuan berpikir tingkat tinggi (HOTS) merupakan keterampilan penting yang perlu dikembangkan sejak dini. Model Problem Based Learning *(PBL) sebagai pendekatan pembelajaran aktif memiliki potensi untuk meningkatkan HOTS siswa dengan melibatkan mereka dalam pemecahan masalah dunia nyata. Penelitian ini bertujuan untuk mengevaluasi efektivitas model* Problem Based Learning *(PBL) dan rasa ingin tahu dalam meningkatkan kemampuan berpikir tingkat tinggi (HOTS) siswa kelas V sekolah dasar, serta menganalisis interaksi kedua variabel dalam mendukung pengembangan keterampilan kognitif siswa. Metode penelitian yang diterapkan adalah penelitian eksperimen dengan desain faktorial 2 x 2, yang melibatkan dua variabel bebas yaitu model* Problem Based Learning *(PBL) dan rasa ingin tahu, serta satu variabel terikat yaitu kemampuan berpikir tingkat tinggi (HOTS). Sampel yang digunakan dalam penelitian ini adalah 68 siswa kelas V dari dua sekolah dasar di Jakarta yang dipilih secara acak dengan teknik* cluster random sampling*. Teknik pengumpulan data yang dilakukan yaitu melalui tes kemampuan HOTS, angket rasa ingin tahu, dan observasi proses pembelajaran. Analisis data dilakukan menggunakan uji ANOVA dua jalur untuk mengidentifikasi pengaruh dan interaksi antar variabel. Kesimpulannya, model* Problem Based Learning *(PBL) efektif untuk diterapkan dalam pembelajaran guna meningkatkan HOTS siswa, terutama jika didukung oleh rasa ingin tahu yang tinggi. Pendekatan ini dapat menciptakan lingkungan belajar yang lebih bermakna dan relevan, serta menjadi salah satu strategi inovatif dalam upaya meningkatkan kualitas pembelajaran di tingkat sekolah dasar.*

ABSTRACT

High-order thinking skills (HOTS) are important skills that need to be developed early on. The Problem Based Learning (PBL) model as an active learning approach has the potential to improve students' HOTS by involving them in solving real-world problems. This study aims to evaluate the effectiveness of the Problem Based Learning (PBL) model and curiosity in improving high-order thinking skills (HOTS) of fifth-grade elementary school students, as well as to analyze the interaction of the two variables in supporting the development of students' cognitive skills. The research method applied is an experimental study with a 2 x 2 factorial design, involving two independent variables, namely the Problem Based Learning (PBL) model and curiosity, and one dependent variable, namely high-order thinking skills (HOTS). The sample used in this study was 68 fifth-grade students from two elementary schools in Jakarta who were randomly selected using the cluster random sampling technique. The data collection techniques used were through HOTS ability tests, curiosity questionnaires, and observations of the learning process. Data analysis was carried out using a two-way ANOVA test to identify the influence and interaction between variables. In conclusion, the Problem Based Learning (PBL) model is effective to be applied in learning to improve students' HOTS, especially if supported by a high sense of curiosity. This approach can create a more meaningful and relevant learning environment, and become one of the innovative strategies in efforts to improve the quality of learning at the elementary school.

1. INTRODUCTION

Higher-order thinking skills (HOTS) play a crucial role in students' academic development, as they foster intellectual competitiveness necessary to achieve higher cognitive outcomes and prepare learners to face future challenges in a knowledge-driven society (Farhan, M., & Arisona, 2022; Subramaniam et al., 2020). These skills—such as critical thinking, problem-solving, analysis, and evaluation—go beyond rote memorization and enable students to apply their knowledge in complex, real-world contexts. The emphasis on HOTS is becoming increasingly relevant in today's education systems, where adaptability, innovation, and analytical reasoning are key components of global competence. However, despite its recognized importance, the development of HOTS among Indonesian students remains a critical issue. According to

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surveys conducted by the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), the average science achievement score of Indonesian students in 2012 was only 383, far below the global average of 485. This gap is alarming, especially considering that since Indonesia began participating in the PISA test in 2000, there has been little to no significant improvement in student performance (Martinez, 2022; Suseelan et al., 2022). These findings underscore the urgent need for educational reforms and teaching strategies that prioritize the development of higher-order thinking skills to elevate students' academic readiness and global competitiveness.

The lack of higher-order thinking skills among Indonesian students can be attributed to several factors: insufficient understanding of HOTS by teachers, unclear concepts of HOTS leading to a lack of mastery of the material, students being unaccustomed to solving HOTS questions, which results in them not understanding the information presented in the questions, and a lack of attention to detail (Sun et al., 2022; Tobing et al., 2021). Many schools still implement a teacher-centered learning system, where students only receive information provided by educators without being trained to solve problems, thus hindering the development of their curiosity. The low level of thinking skills in teaching and learning activities may be caused by: 1) the teaching process being dominated by educators, 2) learning being less oriented toward higher-order thinking skills, and 3) questions posed by educators being focused on cognitive levels C1 to C3 (Irdalisa et al., 2022; Sukatiman et al., 2020). In line with observations made at a public elementary school in Jakarta on October 2, 2023, data revealed that fifth-grade teachers still use conventional teaching models, and students continue to work on cognitive questions at levels C1-C3 (LOTS). The education report for 2023, based on the Computer-Based National Assessment (ANBK), indicates that students' higher-order thinking skills (HOTS) are low, with a score of 40.85.

The PBL model has been widely researched by previous scholars, including studies showing that the PBL learning model can enhance elementary students' knowledge about environmental education for children and communities by examining urban lifestyles and waste management (Rachman et al., 2020), PBL's impact on students' creative thinking (Ersoy & Başer, 2014), PBL's effectiveness in improving high school students' higher-order thinking (Liu & Pásztor, 2022), PBL's influence on critical thinking among high school students regarding reaction rates (Dakabesi & Luoise, 2019), and PBL-based worksheets on the human digestive system for high school students (Nasution & Rasyidah, 2022). However, previous studies have only shown the effectiveness of PBL in improving various aspects of critical and creative thinking, and generally use limited research designs, such as quasi-experimental and R&D, and have not integrated other variables that play an important role, such as curiosity. In fact, curiosity is an important factor in the science learning process, because it can encourage students to be more active in exploring, reading, and thinking deeply (Csapó, 2022; Muthmainnah et al., 2021). In addition, PBL research often focuses on junior high and high school students, while at the elementary school level, research is still limited, especially in the context of specific learning topics such as heat. In this study, in addition to applying the PBL model, the Curiosity aspect was also studied using a factorial design method (2x2), which has two independent variables PBL and Curiosity and one dependent variable, HOTS. This approach offers a new contribution by exploring the interaction between innovative learning models and students' curiosity aspects in improving HOTS. Curiosity is a fundamental aspect of the science learning process, acting as the driving force behind students' engagement and intellectual exploration (Jayanti & Pertiwi, 2023; Lestari & Projosantoso, 2016). It serves as the foundation for the development of three levels of student thinking: basic understanding, analytical reasoning, and evaluative judgment. In the classroom setting, curiosity motivates students to actively participate in learning experiences that enhance essential academic skills such as reading, listening, thinking, and communicating. Through these processes, students are not only absorbing information but also learning how to question, reflect, and form connections between concepts. Curiosity pushes learners to engage more deeply with content, especially through reading and listening activities, which become tools for satisfying their desire to know more (Irdalisa et al., 2021; Muthmainnah et al., 2021).

This dynamic is supported by research findings who emphasize that reading and listening activities play a significant role in helping students gather information and deepen their understanding (Samerkhanova & Imzharova, 2018). As students comprehend more of what they read and hear, their curiosity tends to increase, creating a positive feedback loop that reinforces learning motivation (Kryshko et al., 2022). In this context, curiosity is not just a passive trait but an active component that can shape how students engage with complex problems and ideas (Irdalisa et al., 2023; Mahama et al., 2023). Consequently, the focus of research has shifted toward exploring how teaching models such as the Problem-Based Learning (PBL) approach can nurture curiosity and, in turn, enhance higher-order thinking skills. This study specifically aims to examine the relationship between the PBL model and students' curiosity in fostering higher-order thinking among fifth-grade elementary students.

2. METHOD

This research was conducted in schools located in the Rawa Barat sub-district. The population selected was based on the researcher's interest in applying Problem Based Learning in the workplace area. The population for this study consists of fifth-grade students from Rawa Barat 05 Elementary School and Rawa Barat 09 Elementary School for the 2023-2024 academic year. The data is show in Table 1.

Table 1. The Data on Class V Elementary School Student in Rawa Barat Subdistrict

No.	School Name	Class	Number of Students
1.	SD Negeri Rawa Barat 05	VA	26
2.	SD Negeri Rawa Barat 05	VB	26
3.	SD Negeri Rawa Barat 05	VC	26
4.	SD Negeri Rawa Barat 09	VA	26
5.	SD Negeri Rawa Barat 09	VB	26

The reason for choosing fifth grade as the population is that it is considered to represent the characteristics of children's age who are capable of concrete and higher-order thinking, which will be studied. At the elementary school level, students aged 9-11 are deemed capable of solving complex problems. Additionally, fifth-grade students are participants in the Computer-Based National Assessment (ANBK), which affects their educational report cards (Timor et al., 2021). This study uses an experimental method with a quantitative approach. The research design employs a '2x2 Factorial Design.' The selection of this research design is based on the consideration of potential mitigating variables that may influence the treatment (independent variables) and the outcomes (dependent variables) (Simbolon & Koeswanti, 2020). The factorial design paradigm can be described as show in Table 2.

Table 2. The Research Design (Factorial Design 2x2)

Curiosity	Problem Based Learning (PBL)(A1)	Derict Instruction (A2)	Amount
High (B1)	(A1B1)	(A2B1)	
Low (B2)	(A1B2)	(A2B2)	
Total			Total

From Table 2, it can be explained that there are two groups in the learning process: one group learns using Problem Based Learning (A1), and the other learns through Direct Instruction. Within each group, there are two subgroups of students: those with high curiosity (B1) and those with low curiosity (B2). Curiosity is measured using a non-test instrument, a questionnaire, while higher-order thinking is assessed using a test instrument consisting of 25 multiple-choice questions on the topic of heat and its changes. The subjects of the study are fifth-grade students from two public schools in Jakarta, with a total sample of 60 students. In this design, both the experimental and control groups are first given the Curiosity questionnaire before treatment, and the results are used to classify students based on high and low curiosity (Safitri et al., 2023). In this study, the experimental group consists of class VA at Rawa Barat 05 Elementary School, which has 26 students, and class VB at Rawa Barat 09 Elementary School, also with 26 students, both receiving treatments using the Problem Based Learning (PBL) model. Meanwhile, the control group comprises class VC at Rawa Barat 05 Elementary School with 26 students, and class VA at Rawa Barat 09 Elementary School, also with 26 students, both receiving treatments using the Direct Instruction model in this study, curiosity is categorized into three levels: low curiosity, moderate curiosity, and high curiosity. The analyzed data only includes high curiosity and low curiosity, while moderate curiosity data is not analyzed as it serves as a significant gap between high and low curiosity data. Therefore, the sample data used can be seen in Table 3.

Table 3. The Sample Data Class V

No.	Action		Student	Number of Student
1.	Experiment Class	Curiosity high	17	34
		Curiosity low	17	
2.	Control Class	Curiosity high	17	34
		Curiosity low	17	

3. RESULT AND DISCUSSION

Result

The research data were obtained from a post-test on higher-order thinking skills administered to students after the science learning process using the Problem Based Learning (PBL) model. The post-test consisted of 25 multiple-choice questions. From the analysis of the respondents' answers, it was found that the highest score for higher-order thinking skills in group A1 was 96, while the lowest was 54. After analysis, the average ($\bar{x}$) of the data was 77.53 with a standard deviation (SD) of 10.92. The test results for class A1 are presented in Table 4.

Table 4. Data on Post-Test Results for High-Level Thinking Skills in Group A1

N	Results Posttest			
	Xmax	Xmin	$\bar{\chi}$	Standard Deviation
34	96	54	77.53	10.92

Base on Table 4, the results of the analysis above show that the average score of students using Problem Based Learning (PBL) is quite good. Likewise, the most frequent scores among the respondents are above the average score. The research data were obtained from a post-test on higher-order thinking skills administered to students after the science learning process using the Direct Instruction model. The post-test consisted of 25 multiple-choice questions. From the analysis of the respondents' answers, it was found that the highest score for higher-order thinking skills in group A2 was 90, while the lowest was 46. After analysis, the average ($\bar{x}$) of the data was 70.03, with a standard deviation (SD) of 11.49. The test results for class A2 are presented in Table 5.

Table 5. Data on Post-Test Results for High-Level Thinking Skills in Group A2

N	Results Posttest			
	Xmax	Xmin	$\bar{\chi}$	Standard Deviation
34	90	46	70.03	11.49

Base on Table 5, the results of the analysis above show that the average score of students using Direct Instruction is quite good. Likewise, the most frequent scores among the respondents are above the average score. The research data were obtained from the posttest of high-level thinking skills given to students before carrying out the science learning process using the Problem Based Learning and Direct Instruction learning models , where the number of students with high Curiosity using the PBL model was 17 students and in the Direct Instruction class was 17 students. The posttest consisted of 25 multiple-choice questions. From the processed results of the respondents' answers, it was obtained that the highest high-level thinking skill score for students in group B1 was 92 and the lowest was 52. After the analysis, it turned out that the average (x^{-}) of the data was 77.32 with a standard deviation (SD) of 9.78. The following are the test results for class B1 presented in Table **6**.

Table 6. Post-test Result Data Skills Think High Level Thinking in Group B1

N	Results Posttest			
	Xmax	Xmin	$\bar{\chi}$	Standard Deviation
34	92	52	77.32	9.78

Base on Table 6, the results of the analysis above show that the average score that has high curiosity is quite good in classes that use the Problem Based Learning and Direct Interaction learning models. Likewise, the frequency of the highest scores owned by respondents is above the average score. The research data were obtained from the posttest of high-level thinking skills given to students before carrying out the science learning process using the Problem Based Learning and Direct Instruction learning models , where the number of students with low Curiosity using the PBL model was 17 students and in the Direct Instruction class was 17 students. The posttest consisted of 25 multiple-choice questions. From the processed results of the respondents' answers, it was obtained that the highest high-level thinking skill score for students in group B2 was 96 and the lowest was 46. After the analysis, it turned out that the average (x^{-}) of the data was 70.24 with a standard deviation (SD) of 12.60. The following are the test results for class B2 presented in Table 7.

Table 7. Post-test Results on Higher-Order Thinking Skills in Group B2

N	Results Posttest			
	Xmax	**Xmin**	$\bar{\chi}$	**Standard Deviation**
34	96	46	70.24	12.60

Base on Table 7**,** The results of the analysis above show that the average score with low curiosity is quite good. Likewise, the frequency of the most scores owned by respondents is above the average score. Data results study obtained from posttest skills high level thinking Which given on students after do learning process Science with use model Problem Based Learning (PBL) learning. Posttest totaling 25 grains question in multiple choice form. From the processed results of the respondents' answers, it was obtained that the highest high-level thinking skill score for students in group A1B1 was 92 and the lowest was 60. After the analysis, it turned out that the average (x^{-}) of the data was 78.06 with a standard deviation (SD) of 10.59. The following are the test results for class A1B1 presented in Table 8.

Table 8. Data on Posttest Results for Higher-Order Thinking Skills in Group A1B1

N	Results Posttest			
	Xmax	**Xmin**	$\bar{\chi}$	**Standard Deviation**
17	92	60	78.06	10.59

Base on Table 8, the results of the analysis above show that the average score of those who often use Problem Based Learning (PBL) is quite good. Likewise, the frequency of the highest scores owned by respondents is above the average score. The research data were obtained from the posttest of high-level thinking skills given to students after carrying out the science learning process using the Problem Based Learning (PBL) learning model. The posttest consisted of 25 multiple-choice questions. From the processed results of the respondents' answers, it was obtained that the highest high-level thinking skills score for students in group A1B2 was 96 and the lowest was 54. After the analysis, it turned out that the average (x^{-}) of the data was 77.00 with a standard deviation (SD) of 11.55. The following are the test results in class A1B2 presented in Table 9**.**

Table 9. Posttest Results Data on Thinking Skills High level thinking in Group A1B2

N	Posttest Results			
	Xmax	**Xmin**	$\bar{\chi}$	**Standard Deviation**
17	96	54	77.00	11.55

Base on Table 9, the results of the analysis above show that the average score of those who often use Problem Based Learning (PBL) is quite good. Likewise, the frequency of the highest scores owned by respondents is above the average score. Data the results of the study were obtained from the posttest of high-level thinking skills given to students after carrying out the science learning process using the Direct Learning model. The posttest consisted of 25 multiple-choice questions. From the processed results of the respondents' answers, it was obtained that the highest high-level thinking skill score for students in group A1B2 was 90 and the lowest was 52. After the analysis, it turned out that the average (x^{-}) of the data was 76.59 with a standard deviation (SD) of 9.17. The following are the test results in class A2B1 presented in Table 10.

Table 10. Post-test Results Data for High-level Thinking Skills in Group A2B1

N	Posttest Results			
	Xmax	**Xmin**	$\bar{\chi}$	**Standard Deviation**
17	90	52	76.59	9.17

Base on Table 10, the results of the analysis above show the average score for those who frequently use Direct Instruction*.* quite good. Likewise, the frequency of the highest scores owned by respondents is above the average score. The research data were obtained from the posttest of high-level thinking skills given to students after carrying out the science learning process using the Direct Instruction learning model. The posttest consisted of 25 multiple-choice questions. From the processed results of the respondents' answers, it was obtained that the highest high-level thinking skill score for students in group A1B2 was 84 and the lowest was 46. After the analysis, it turned out that the average (x^{-}) of the data was 63.47 with a standard deviation (SD) of 9.84. The following is the test result data for class A2B2 presented in Table 11.

Table 11. Post-test Results Data for High-level Thinking Skills in Group A2B2

N	Posttest Results			
	Xmax	Xmin	$\bar{\chi}$	Standard Deviation
17	84	46	63.47	9.84

The results of the analysis above show the average score for those who frequently use Direct Instruction. quite good. Likewise, the frequency of the highest scores owned by respondents is above the average score.

Data Analysis Prerequisite Test

The posttest data obtained from the experimental classes (A1B1 and A1B2) and the control classes (A2B1 and A2B2) were used as research data for hypothesis testing. Before conducting the hypothesis test, the data must meet the assumptions of normal distribution and homogeneity of variance. Therefore, a prerequisite test was carried out, consisting of a normality test and a homogeneity test. Normality testing was conducted to determine whether the study data were normally distributed. The normality test for the experimental classes (A1B1 and A1B2) and the control classes (A2B1 and A2B2) was carried out using the Liliefors test (X^2) at a 5% significance level (α = 0.05). The results of the normality test for each class are presented in Table 12.

Table 12. Results Calculation Test Normality

Class	N	L_{count}	L_{table}	Criteria	Information
A1B1	17	0.123	0.2060	$L_{count} < L_{table}$	Normal
A1B2	17	0.1816	0.2060	$L_{count} < L_{table}$	Normal
A2B1	17	0.167	0.2060	$L_{count} < L_{table}$	Normal
A2B2	17	0.126	0.2060	$L_{count} < L_{table}$	Normal

Based on the normality test, the data from all four groups were found to be normally distributed. Therefore, the prerequisite analysis continued with a homogeneity test on the experimental classes (A1B1 and A1B2) and the control classes (A2B1 and A2B2) to determine whether the data variances were homogeneous. The homogeneity test was conducted using Bartlett's test at a 5% significance level (α = 0.05). The results of the homogeneity test for both groups are presented in Table 13.

Table 13. Results Calculation Test Homogeneity

Class	SD	V	χ^2count	χ^2 0.01(3)	Criteria	Information
A1B1	10.59	112.18	0.942	11.34	χ^2 count < χ^2 table	Variance Homogeneous
A1B2	11.55	133.38				
A2B1	9.17	84.13				
A2B2	9.84	96.76				

Hypothesis Testing

In the results of the data analysis prerequisite test, the data obtained was class experiments (A1B1 and A1B2) And class control (A2B1 and A2 B2) are normally distributed and have homogeneous variance so that the hypothesis test is continued using the t-test with a significance level of 1% (α = 0.01) to test the null hypothesis (H0) which states "There is no effect of the Problem Based Learning (PBL) and Curiosity learning models on high-level thinking skills (HOTS)". A summary of the t-test results can be seen in Table 14.

Table 14. Results Test Calculation Hypothesis (Summary Table ANOVA)

S. Variance	JK	db	RJK	Fh	Ft α=0.05	Ft α=0.01	Decision
Inter A (PBL)	956.25	1	956.25	8.97	3.991	7.048	Reject H_0, Accept H_1
Antar B (Curiosity)	854.13	1	854.13	8.01	3.991	7.048	Reject H_0, Accept H_1

S. Variance	JK	db	RJK	Fh	Ft α=0.05	Ft α=0.01	Decision
Intera AxB (PBL and Curiosity Interaction)	618.01	1	618.01	5.80	3.991	7.048	Reject H_0, Accept H_1
In	6823.29	64	106.61				
Total	**9251.69**	**67**					

Based on Table 14, the proposed research hypothesis can be answered. There is an influence Problem Based Learning (PBL) learning model on high-level thinking skills of grade V elementary schools. Moreover, there is an influence *c*uriosity towards High-level thinking skills in grade V elementary schools. The ANOVA results were obtained with a value of 8.01 > 3.991, so can concluded that H_0 rejected and H_1 accepted which means that there is an influence of student curiosity on high-level thinking skills in grade V elementary schools in science subjects. There is an interaction between the Problem Based Learning (PBL) and Direct Interaction (DI) learning models and curiosity towards students' high-level thinking skills.

It was concluded that there was an interaction between the influence of the application of the Problem Based Learning (PBL) model. And Curiosity towards High-Order Thinking Skills of Grade V Students in Elementary School Science Subjects. Based on the results of data analysis for the 3rd hypothesis test regarding the interaction between the Problem Based Learning (PBL) and Direct Interaction (DI) learning models with high and low curiosity in influencing students' high-level thinking skills, it can be further described in Figure 1.

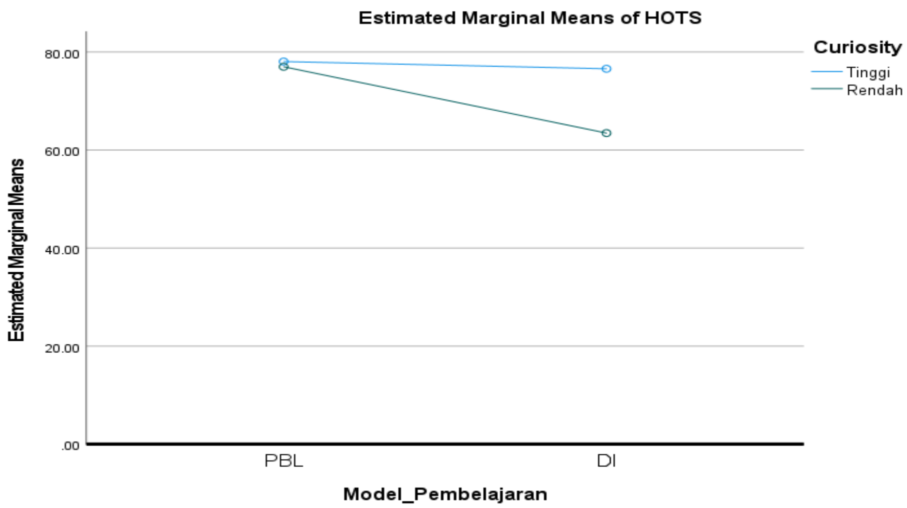

Figure 1. Plot Graph between Learning Models (Problem-Based Learning (PBL) and Direct Instruction (DI)) and Students' Curiosity

Tukey's Test

The calculation of advanced variance analysis with the Tukey Test is to compare groups that have significant differences in the use of learning models (Problem-Based Learning (PBL) and Direct Instruction (DI)) and student curiosity. A summary of the results of the Tukey Advanced Test calculations can be seen in Table 15.

Table 15. Results Test Calculation Tukey

Multiple Comparisons						
Dependent Variable: HOTS						
Tukey HSD						
(I) Interaction	**(J) Interaction**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
A1B1	A1B2	1.06	3.542	0.991	-8.28	10.40
	A2B1	1.47	3.5.42	0.976	-7.87	10.81
	A2B2	14.59*	3.542	0.001	5.25	23.93
A1B2	A1B2	-1.06	3.5.42	0.991	-10.40	8.28
	A2B1	0.41	3.542	0.999	-8.93	9.75
	A2B2	13.53*	3.5.42	0.002	4.19	22.87
A2B1	A1B2	-1.47	3.542	0.976	-10.81	7.87

Multiple Comparisons						
Dependent Variable: HOTS						
Tukey HSD						
(I) Interaction	**(J) Interaction**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
A2B2	A2B1	-0.41	3.5.42	0.999	-9.75	8.93
	A2B2	13.12*	3.542	0.002	3.78	22.46
	A1B2	-14.59	3.5.42	0.001	-23.93	-5.25
	A2B1	-13.53	3.542	0.002	-22.87	-4.19
	A2B2	-13.12	3.542	0.002	-22.46	-3.78

Based on observed means; The error term is Mean Square (Error) = 106.614; *. The mean difference is significant at the end

Based on Table 15, it shows that the Tukey Test calculation can be concluded that the results of the study indicate differences in students' higher-order thinking skills across various treatment groups. Students in the Problem Based Learning (PBL) group with a high level of curiosity scored 1.06 points higher than those with low curiosity, and 1.47 and 14.59 points higher than students in the Direct Instruction group with high and low curiosity levels, respectively. Meanwhile, students in the PBL group with low curiosity scored 0.41 points higher than those in the Direct Instruction group with high curiosity, and 13.53 points higher than those with low curiosity. Additionally, within the Direct Instruction model, students with high curiosity outperformed those with low curiosity by 13.12 points. These findings suggest that both the learning model and students' level of curiosity significantly influence their higher-order thinking skills.

Discussion

Based on hypothesis testing, the results obtained meet the criteria. $t_{count} > t_{table}$ namely with a value of 8.97 > 3.991 then it can be said that Ho is rejected and H_1 accepted which means there is influence Which significant from use model learning Problem Based Learning (PBL) on skills high level thinking (HOTS) students on the Heat material. Based on the research data, the average value obtained posttest class experiment taller than class control. This proves that the use of learning models Problem Based Learning (PBL) in class experiment Better than model learning with the Direct Instruction model in class control. Previous study state that learning by applying problem-based learning can improve high-level thinking skills. Elementary school students on the material of the motor system (Nurochman & Diniya, 2022; Ramadhani & Sukenti, 2023). Learning using problem-based learning can improve high-level thinking skills of elementary school students. The improvement of high-level thinking skills occurs because of the opportunities given to students to solve problems according to the correct problem-solving procedures. Although high-level thinking skills have improved, some students still experience difficulties, especially in planning solutions. This is because students are used to filling in answers directly without planning them first, creating means demonstrating the ability to create your own ideas/concepts, including the ability to construct, design, create, develop, write and formulate the things that are needed.

Thus, students should plan first before solving the problem. Therefore, in order for students to be able to produce these indicators, habituation is needed. This is in line with Pavlov's theory, namely habituation (conditioning) habituation has a relationship with teaching and learning activities (Aningsih et al., 2022; Ilyas & Syahid, 2018). Based on this statement, in the implementation of learning, students should continue to be given habituation through practice in planning problem solving, so that students can carry out problem solving according to their planning. The learning that has been done in this experimental class contains steps of problem-based learning approach, namely the first is the orientation of students to the problem. This step is where students are given an explanation of the learning objectives and motivate students as encouragement in problem-solving activities. The teacher here provides stimulus to students through a problem by connecting it to everyday life. In line with Piaget's theory state that every student at any age is actively involved in the process of obtaining information and constructing their own knowledge (Huang, 2021; Trianingsih, 2016). The connection between problems and students' daily lives can make students construct their own knowledge. The connection between problems and everyday life is also one of the characteristics of science learning in elementary schools, namely gradual science learning. These characteristics provide concepts from simple to more difficult concepts, so that with the problems related to everyday life, this becomes students' initial knowledge. The next step is to organize students to learn. In this step there are stages, namely teams, identification, and planning. The existence of this activity is to help students solve problems, where students are more directed to their activities systematically. Then, identification here students identify the problems they face to then go to the planning stage. At the planning stage, students are required to plan their learning procedures, for example students can divide tasks with their members (Raharjo et al., 2018; Wijnen et al., 2018).

After that, the next step in problem-based learning is to guide individual and group investigations. In this step, there are stages, namely investigation, namely students conduct investigations to obtain/collect, analyze, and evaluate information that they have obtained with the group, and carry out problem solving based on the investigation that has been carried out. The next step is to develop and present the results of the work. This step includes the final project stage, namely students can check the results of their investigations and prepare reports to be presented later. The next is the presentation stage, namely students present the results of their discussions in front of the class. The last step is to analyze and evaluate the problem-solving process with the group investigation strategy stage, namely evaluation. At this stage, students and teachers can evaluate things that happen in group activities (Chen et al., 2021; Solichah & Jailani, 2022).

Based on the explanation above, it can be seen that the science learning carried out in this experimental class went well. The learning carried out in this experimental class is a combination of problem-based learning models. Duch stated that the problem-based learning model is a learning approach in which students are presented with a problem as a challenge that must be solved (Anazifa & Djukri, 2017; Ardianti et al., 2021). So that students can learn in real terms and can work in finding solutions with their groups. The Problem Based Learning model is suitable for use in learning that requires analysis, synthesis, and information acquisition as an effort to solve a problem. Thus, learning using this problem-based learning approach can make it easier for students to understand the material on heat and its changes, where heat and its changes are part of the same whole. This can make it easier for students, because as previous study state that science is a science that studies abstract and relationship patterns (Perdana et al., 2022). The obstacles that occur when learning takes place can be overcome and do not provide obstacles to achieving learning objectives, so that the results of the study state that the problem-based learning approach with a group investigation strategy can significantly improve high-level thinking skills of fifth-grade students on heat and its changes.

The Influence of Curiosity on Students' High-Level Thinking Skills

In this study, curiosity is categorized into 3, namely low curiosity, medium curiosity, and high curiosity . In this study, the data analyzed were only high curiosity data and low curiosity data, medium curiosity data was not analyzed because it was considered neutral by the researcher. The curiosity of students who learned using the Problem Based Learning (PBL) Learning Model, there were 17 students who had low curiosity in learning science, 18 students who had medium curiosity in learning science, and 17 students who had high curiosity in learning science. While the curiosity of students who learned using the Direct Instruction learning model , there were 17 students who had low curiosity in learning science, 18 students who had medium curiosity in learning science, and 17 students who had high curiosity in learning science.

For students with high curiosity , the tasks given can be done correctly and precisely. For students with moderate curiosity, the tasks are done correctly but there are still some that need deeper understanding. Meanwhile, students with low curiosity work on questions less carefully. Patience is needed to deal with students who are slow in doing assignments, because science subjects require students to work on assignments with high curiosity in order to know the material more deeply. Teachers must try to arouse the curiosity of students who have difficulty in learning. Student curiosity is greatly influenced by the environment and so on. Based on hypothesis testing, the results obtained meet the criteria. $t_{count} > t_{table}$ namely with a value of 8.01 > 3.991 then it can be said that Ho is rejected and H_1 accepted which means there is influence The Influence of Student Curiosity on High-Order Thinking Skills of Grade V Elementary Schools in the Science Subject of Heat and Its Changes.

Lots factor Which influence success participant educate in achieving optimal high-level thinking skills, one of which is Curiosity or the curiosity possessed by the students. The existence of differences in students' curiosity can produce different high-level thinking skill scores. A student who has a high curiosity will continue to try to explore new things in order to improve high-level thinking skills in various fields. The high-level thinking skills of the group of participants who have high Curiosity (B1) show a difference with the high-level thinking skills of science students who have low Curiosity (B2). This difference can be seen from existence difference average (mean), score results high-level thinking skills acquired by each group. This is in line with research which states that curiosity and learning styles together can affect student learning outcomes. In addition, other research stated that curiosity and self-confidence can influence student learning outcomes (Hanifah Ameliah & Munawaroh, 2016; Hutagalung, 2022). Curiosity as part of a scientific attitude is an attitude that always wants to get the right answer from the object being observed. Someone will be motivated to learn because of the curiosity that arises from the feeling of curiosity. When the reading process has been able to satisfy the curiosity instinct , what happens is a feeling of pleasure, and there is a strong desire to repeat it again, so that interest begins to form. The curiosity that is possessed can make students aware of the importance of new learning continuously and collaborate with the parents of students (Abdurrozak & Jayadinata, 2016; Mahama et al., 2023; Nirwana et al., 2018).

Problem Based Learning Model and Curiosity in Science Learning

In this study, to find out the relationship between Problem Based Learning and Curiosity of students, it can be done through the Spearman correlation test. Curiosity has a correlation with high-level thinking skills of students. Curiosity can influence individuals in doing something, keep doing something, and help in completing tasks (Bayuningrum, 2021; Hidayat, 2020). The existence of motivation will be the driving force for students in carrying out learning activities, thus directing students in achieving learning goals. The existence of motivation can achieve the goals of science learning, namely solving problems in everyday life in heat material (Perdana et al., 2022; Yuliana et al., 2020). This is in line with the results of the 2-way ANOVA test on there is an interaction between problem-based learning and student curiosity . This can be seen from the results of Fo (AB) 5.80> F_{tab} , so H_0 is rejected and H_1 is accepted.

The results of high-level thinking skills in the group of students taught with the Problem Based Learning model and having high curiosity (A1B1) showed a difference with the results of high-level thinking skills of students in the group taught with the Direct Instruction learning model and having high curiosity (A2B1). The high-level thinking skills of the group of students taught with the Problem Based Learning (PBL) learning model and having low curiosity (A1B2) showed a difference with the high-level thinking skills of students taught with the Direct Instruction learning model and having low curiosity (A2B2).

Learning activities in the Problem Based Learning (PBL) technique allow students to be more relaxed in learning in addition to fostering a sense of cooperation, competition, and responsibility, without abandoning the objectives of existing learning (Mardhani et al., 2022; Sulo et al., 2012). Science teaching with the Problem Based Learning (PBL) learning model challenges students to think about the events that have made our world like this, lessons must be so interesting and interactive that no child finds them boring. So that teachers set high standards for high-level thinking skills and expect students to achieve those standards. By setting such standards, students who have low curiosity will try to achieve these standards optimally which will ultimately provide higher results than students who are taught with the Direct Instruction learning model (Schlegel et al., 2021; Sulo et al., 2012). The purpose of science learning is not only for students to be able to understand science concepts but also to have awareness and concern for society (Festiawan et al., 2021; Rahayu, 2020). With the science knowledge they have, students can improve their high-level thinking skills in supporting knowledge in other sciences. In addition, by training students to be active and creative in science learning, students become accustomed to being active and creative in their daily lives, both in the school environment and outside of school.

4. CONCLUSION

Based on the results of the study, it was found that the Problem Based Learning (PBL) model had a significant effect on students' high-order thinking skills (HOTS) with a significance value of 0.000 ($p < 0.005$). Likewise, curiosity had a significant effect on students' HOTS with a significance value of 0.001 ($p < 0.005$). In addition, there was a significant interaction between PBL and curiosity on students' high-order thinking skills with a significance value of 0.008 ($p < 0.005$). These findings indicate that the PBL model and curiosity contribute to the development of students' high-order thinking skills. This study emphasizes that curiosity can improve thinking skills, which indicates that increasing curiosity will have an impact on increasing students' HOTS. Therefore, educators are expected to be able to create a classroom environment that can stimulate students' curiosity and implement the PBL model effectively, for example by presenting real-world problems and encouraging collaborative work. Further research can explore the long-term effects of the combination of PBL with strategies to increase curiosity on students' cognitive development and their learning outcomes.

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