Application of Problem Based Learning (PBL) Learning Model to Improve Students' Learning Outcomes and Interest in Thermochemistry Material at SMA Muhammadiyah 2 Medan

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Abstract: Application of Problem Based Learning (PBL) Learning Model to Improve Students' Learning Outcomes and Interest in Thermochemistry Material at SMA Muhammadiyah 2 Medan. This study aims to determine whether there is an influence on learning outcomes by applying the PBL learning model to thermochemistry material at SMAS Muhammadiyah 2 Medan. To find out how the interest in applying the PBL learning model to thermochemistry material at SMAS Muhammadiyah 2 Medan. This research was conducted at SMAS Muhammadiyah 2 Medan in September - February of the 2024/2025 academic year. The research method used was a quasi-experimental design with a non-equivalent control group design. The research sample consisted of class XI-R1 as the control class and XI-R2 as the experimental class selected by purposive sampling. Hypothesis I testing was carried out using the Independent Sample T-Test, with the results of the study showing a sig value of $0.007 < 0.05$ which means that the hypothesis (Ha) is accepted and (H0) is rejected. Hypothesis II testing was conducted using the Independent Sample T-Test, with the results showing a sig value of $0.012 < 0.05$, which indicates that there is a positive student response to the (PBL) learning model on thermochemistry material on student learning interest, which means that the Hypothesis (Ha) is accepted.

Keywords: PBL Learning Model, Student Interest, Thermochemistry

Abstrak: Penerapan Model Pembelajaran Problem Based Learning (PBL) untuk Meningkatkan Hasil Belajar dan Minat Belajar Siswa pada Materi Termokimia di SMA Muhammadiyah 2 Medan. Penelitian ini bertujuan untuk mengetahui apakah ada pengaruh terhadap hasil dengan menerapkan model pembelajaran PBL pada materi termokimia di SMAS Muhhammadiyah 2 Medan. Dan untuk mengetahui bagaimana minat terhadap penerapkan model PBL pada materi termokimia di SMAS Muhhammadiyah 2 Medan. Penelitian ini dilaksanakan di SMAS Muhammadiyah 2 Medan pada bulan September – Febuari tahun ajaran 2024/2025. Metode yang digunakan adalah quasi eksperimen dengan desain kelompok kontrol non-ekuivalen. Sampel penelitian terdiri dari kelas XI-R1 sebagai kelas kontrol dan XI-R2 sebagai kelas eksperimen yang dipilih secara purposive sampling. Pengujian hipotesis I dilakukan dengan menggunakan Uji Independent Sample T-Test, dengan hasil penelitian menunjukan nilai sig 0.007 < 0.05 yang berarti hipotesis (Ha) diterima dan (H0) ditolak. Pengujian hipotesis II dilakukan dengan uji Independent Sample T-Test, dengan hasil menunjukkan nilai sig 0.012 < 0.05, yang menandakan bahwa ada respon positif siswa terhadap model pembelajaran model PBL pada materi termokimia terhadap minat belajar siswa, yang berarti Hipotesis (Ha) diterima.

▪ **INTRODUCTION**

The development of science and technology affects all aspects, including the aspect of education. Such rapid development has given rise to new effects and changes in the digitalization era, moving from traditional manuals to the era of information transmission through sophisticated electronic means (Aryani et al., 2022). The quality of the learning model must be seen from two aspects, namely process and product. The process aspect refers to learning that is able to create a fun learning situation. The product aspect refers to learning to achieve goals, namely improving students' abilities according to the specified ability and competency standards, in this case reflected in student learning outcomes (dos Santos et al., 2021).

One of the learning models that can make learning activities more active in the classroom so that it has a very positive effect on learning motivation and understanding of student concepts is the Problem Based Learning learning model. The PBL model is a learning model that introduces problems at the beginning of learning (Nurbaity et al., 2017). These problems can then be used as a form of motivation and at the same time conveying concepts to students. The PBL model is an approach that provides new knowledge to students to solve a problem, so this learning model helps teachers to create a fun learning environment (Alamsari et al., 2011).

Problem Based Learning is an innovative learning model that has optimized students' thinking skills through teamwork processes, so that students can empower, validate, test and develop thinking skills together with team members. This will also have a positive impact on students' active participation in learning activities (Asvifah & Wahjudi, 2019).

The application of the Problem Based Learning model in thermochemistry learning is intended to encourage active student involvement in learning. With this model, students in the class are guided to be more active and directly involved in learning activities and building the learning activities themselves (Dalimunthe et al. 2021). Problem Based Learning is carried out by providing stimulation in the form of problems which are then solved by students which are expected to increase students' skills in achieving learning materials (Ghita, 2017).

Learning outcomes are the results obtained through efforts in learning activities and provide a change in the form of mastery of a number of knowledge, changes in attitudes and skills. The results obtained by students can be shown through evaluations given by teachers after each lesson material is completed, as proof of the level of student ability in achieving learning objectives (Andrian & Rusman, 2019).

The main material of thermochemistry is one of the chemical materials that is calculated and requires a strong understanding of concepts so that it is often considered difficult for students. Mastery of thermochemistry material related to solving problems requires students' skills in calculating mathematically (Kurniyawan & Tanshzil, 2024). So far, teachers have not fully considered the factors that cause low student learning achievement. Internal factors in student behavior consist of seven memory factors, verbal factors, number factors, word fluency factors, reasoning factors, perception factors, and space factors. One of the number factors that needs to be considered is the ability to

calculate or do mathematics. Students who have high mathematical abilities are more likely to be successful in the learning process compared to students with low mathematical abilities. Therefore, it is hoped that with a learning model that is oriented towards solving problems that uses a scientific approach which has systematic and scientific steps. One of the learning models that has a scientific approach is PBL (Khairunisa et al.,2024).

SMAS Muhammadiyah 2 Medan is one of the Senior High Schools in Medan City. Based on the results of interviews with the chemistry subject teachers concerned, many factors influence the high and low learning achievement obtained by a student, both factors from themselves (internal) and from outside themselves (external), including internal factors of students in the form of learning interest. Learning interest has been proven to have a major influence on student learning achievement, because if the learning material studied does not match the student's interests, students will not learn as well as possible, which results in students not being interested in learning and not getting satisfaction from the lesson. Based on an interview with one of the chemistry subject teachers at SMAS Muhammadiyah 2 Medan, information was obtained that the average student learning outcomes in chemistry learning are still low, the students' scores have not reached the predetermined completeness, namely 76. Based on the problems that occur, it is necessary to choose an innovative learning model that can attract students' interest in learning, create an interactive learning atmosphere, and be able to motivate students to learn either independently or in groups, so that they can understand the material presented by the teacher and learning objectives can be achieved. One of the appropriate learning models to use is the Problem Based Learning model.

Based on this background, the researcher is motivated to conduct this research as an effort to find out whether there is an influence of learning outcomes by applying the PBL learning model to thermochemistry material and to find out how the interest in applying the PBL learning model to thermochemistry material.

▪ **METHOD**

This research was conducted at SMAS Muhammadiyah 2 Medan Jalan Abdul Hakim No.2 Tj. Sari. This research was conducted in September - February of the 2024/2025 academic year. The population in this study were all students of class XI SMAS Muhammadiyah 2 Medan in the Even Semester of the 2024/2025 academic year consisting of 5 classes from class XI-R1 to xi-R5. The sampling technique used in this study was Purposive Sampling with samples taken in the study to be conducted consisting of two classes, namely class XI R1 and R2 totaling 62 students, as a sample of the experimental class using the Problem Based Learning learning model as a sample of the control class using a direct learning model using conventional methods. The type of research used is a quasi-experimental type. The purpose of this quasi-experimental research is to determine the improvement in student learning outcomes in thermochemistry material taught using the PBL learning model (Putra et al., 2024). In this study, data collection techniques were carried out by giving test questions to students. The test is used to measure the learning outcomes of the experimental class and the control class. The test used in this study was a pretest and posttest in the form of objective questions (multiple choices) totaling 30 questions. Then in the experimental class a questionnaire was given to determine students' interest in the learning model used. Data analysis in this study used normality tests, homogeneity tests, hypothesis tests and

percentages of student responses using SPSS 26.0 for windows with a significance level of 0.05 and Microsoft Excel.

Research Design

The type of research used is quasi-experimental. The design chosen is two group pretest-posttest design.

Table 1. Research Design is Two Group Pretest-Posttest Design

Class	Pretest	Treatment	Posttest
Experiment	T_1	X_1	Y_1
Control	T_2	X_2	Y_2

(Saraswati et al., 2020)

Research Procedures

The stages carried out in this study are: This study consists of three stages. The preparation stage includes school observation, proposal preparation, validation of test instruments, and processing of research permits. The implementation stage includes pre-test, application of discussion methods and Problem Based Learning models, observation of student learning activities, and post-test. The final stage includes data analysis, calculation of mean and standard deviation, normality and homogeneity tests, and drawing conclusions based on the research results.

▪ **RESULT AND DISCUSSION**

Research Instrument Data Analysis

This research was conducted at SMAS Muhammadiyah 2 Medan located at Jalan Abdul Hakim No.2 Tj. Sari which was conducted in September - February of the 2024/2025 academic year. This research was conducted by first being validated by an expert validator and the validator was a Lecturer in Chemistry, FMIPA UNIMED. Then 30 test instrument questions were tested on 30 students of class XII R.1 in the form of multiple choices consisting of five choices, namely A, B, C, D, and E. The test instrument trial was conducted at SMAS Muhammadiyah 2 Medan. After the questions were tested, calculations were carried out with the aim of determining the feasibility of the questions, and what was calculated included the level of difficulty of the questions, the discrimination power of the questions, item validity, distractors and question reliability.

1) Level of Difficulty of Questions

Analysis of the level of difficulty of questions is carried out to determine the feasibility of questions used in the test in the difficult, medium, or easy categories (Sianturi, 2021). Based on the results of the calculation of the level of difficulty of questions from 30 questions, there are 3 questions in the easy category, 22 questions in the medium category, and 5 questions in the difficult category. The following table shows the results of the level of difficulty of questions:

Table 2. Test Results of Question Difficulty Level

No.	Criteria	Question Item Number												Total
1.	Easy	1	3	4										3 Questions
2.	Currently	2	5	6	7	8	9	10	11	12	13	15		22 Questions
		16	17	19	20	21	22	23	26	28	29	30		

3.	Difficult	14	18	24	25	27	5 Questions

2) Different Power

The discriminating power of questions is the ability of the question items to provide a difference between students who have high-level abilities and those who have low-level abilities (Muliani et al., 2021). Based on the results of the excel calculation test, it was found that there were 24 questions in the qualifying category, 6 in the not qualifying category.

3) Validity of Questions

The formula used in determining or calculating the validity of the test instrument is the product moment formula to find the r count for each question item with N = 30. Questions that are declared valid are questions that have r count > r Table (Mufida et al., 2022). Based on the validity test, it was obtained that out of 30 test items, 20 questions were declared valid, while 10 questions were declared invalid.

4) Distractor

Based on the trial of the question instrument on students, the distractors or distractor answers that meet the requirements are questions number 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30. Meanwhile, the one that does not meet the requirements is question number 27.

5) Test Reliability

To calculate the reliability of the test instrument in this study, the KR-20 formula was used so that the rcount value = 0.496 was obtained where rcount > rTable (0.362) so that the test instrument was declared reliable and was in the moderate category (Lastri, 2023). Based on all prerequisite tests, the test instrument had met the requirements, so the test instrument used as a data collection tool to see the results in this study was with a total of 20 questions, namely with question numbers 2, 3, 5, 6, 8, 10, 12, 13, 14, 18, 19, 20, 21, 23, 27, 31, 32, 34, 36, and 40.

Research Data Analysis

1) Normality Test

A normality test is conducted to determine whether the research data is normally distributed or not. Processing of the normality test using IBM SPSS Statistics 26 for Windows Data normality test using the Kolmogorov-Smirnov test. The research data can be said to be distributed with the criteria of normal distribution if Sig> 0.05 and not normally distributed if Sig <0.05 (Magdalena et al., 2020). The following is a table of data tests for the normality of the pretest and posttest as well as the questionnaire in the control and experimental classes :

Table 3. Normality Test

Class	Data	Sig (2-tailed)	Information
Learning outcomes	Pretest Control	0.200	Data is normally distributed

Pretest Control	0.139	Data is normally distributed
Pretest Experiment	0.087	Data is normally distributed
Postest Experiment	0.091	Data is normally distributed

Based on the data from the table, it shows that each sample has a significant value > 0.05, namely in the pretest learning results of the control class, the sig value is 0.200 > 0.5, and the posttest of students is 0.139 > 0.05, which indicates that the data is normally distributed. While the learning outcomes of students in the experimental class obtained a pretest sig value of 0.087 > 0.05, and the posttest of students in the experimental class was 0.091 > 0.05, which means that the data is normally distributed

2) Homogeneity Test

The homogeneity test aims to see whether two or more groups of data samples are taken from populations that have the same variance or are homogeneous (Ginting et all, 2022). This test is carried out with the help of IBM SPSS Statistics 26 for windows The basis of decision making in this homogeneity test is:

1. If the Significance value (sig) on the based on mean> 0.05, then the data is homogeneous
2. If the Significance value (sig) on the based on mean <0.05, then the research data is not homogeneous, as presented in table 4.5 summary of homogeneity test data (Sianturi, 2021).

Table 4. Homogeneity Test

Data	Nilai Sig.	Information
Learning Outcomes	0.061	0.061 > 0.05 = Homogen
Student Questionnaire	0.157	0.157 > 0.05 = Homogen

Based on table 4, the results of the homogeneity test of learning outcome data and student response questionnaires in the experimental class and control class are data that have a sig value greater than 0.05, which indicates that the learning outcome data and student response questionnaires obtained are homogeneous.

4) Hypothesis Test I

Based on the results of the normality and homogeneity tests that have been carried out, then continued with the first hypothesis test with the help of IBM SPSS Statistics 25 for Windows, namely the Independent Sample T-Test (Hamid, 2022). The Independent Sample T-Test aims to determine whether there is an effect of using the Problem Based Learning (PBL) learning model on student learning outcomes. The following is a table of the results of the Independent Sample T-Test calculation:

Table 5. Hypothesis Test I

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil Belajar Siswa	Equal variances assumed	7.747	0.007	3.954	60	0.000	-43.000	1.909	-46.810	-39.190
	Equal variances not assumed			3.954	43.831	0.000	-43.000	1.909	-46.810	-39.189

Based on the hypothesis test that has been carried out using the IBM SPSS Statistics 26 for Windows program, it was found that there is an effect of using the Problem Based Learning (PBL) learning model on thermochemistry material on student learning outcomes, as seen from the sig value of 0.007 <0.05 which means the hypothesis (Ha) is accepted.

5) Hypothesis Test II

To find out the second hypothesis test, namely to find out how students respond to the Problem Based Learning (PBL) learning model on thermochemistry material, using the Independent Sample T-Test (Jahro, 2023). The following is a table of the results of the Independent Sample T-Test calculation:

Table 6. Hypotesis II

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil Belajar Siswa	Equal variances assumed	1.128	0.012	3.229	60	0.000	4.871	1.434	1.853	7.889
	Equal variances not assumed			3.229	52.092	0.000	4.871	1.434	1.837	7.905

Based on the student response table above, a sig value of 0.012<0.05 was obtained, which indicates that there is a positive response to the application of the PBL learning model on thermochemistry material on students' learning interest, which means that the Hypothesis (Ha) is accepted. This finding is in line with the results of previous

research by (Imelda & Huwaida, 2016) which stated that the PBL model is able to stimulate students to be more active in finding solutions, thinking critically, and being more involved in the learning process. This model places students as active learning subjects who face real problems as a stimulus for learning. In the context of Thermochemistry material that contains abstract concepts and calculations, a problem-based approach can make learning more contextual and meaningful.

▪ **CONCLUSION**

The conclusions that can be drawn from the results of the research and discussion are as follows: (1) Through the results of the hypothesis test analysis carried out using the t-test. After the calculated t is known, the significance level (2 tailed) is 0.007. Based on the calculations that have been carried out, it can be seen that the sig result (2 tailed) is 0.007 <0.05, so it can be concluded that Ho is rejected and Ha is accepted due to a significant difference, which means that there is a visible influence in the use of Problem Based Learning (PBL) learning media. (2) Student interest in the learning model obtained the result of sig (2 tailed) 0.012 < 0.05, this is also supported based on the value of the student questionnaire in the control and experimental classes where the average value of the questionnaire in the experimental class> control class is 81.74> 64.77, then it can be concluded that there is an influence of the use of the Problem Based Learning (PBL) learning model for thermochemistry material on student learning interest

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