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The Effect of the Problem Based Learning Model on Students' Problem-Solving Ability and Scientific Attitude

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Abstract: This study aims to analyze significant differences in problem-solving skills and scientific attitudes between students who learn using the Problem Based Learning model and students who learn using the Discovery Learning model and determine the effective contribution of learning using the PBL model developed to students' problem-solving skills and scientific attitudes simultaneously. This research approach uses a quantitative research approach with a quasi-experimental method. The research population is 5 classes of students in grade XI MIPA Malinau for the 2023/2024 academic year. The sample was determined by random sampling technique against the class. Based on the random results, class XI MIPA1 was selected as a group of students using the Problem Based Learning learning model and class XI Mipa 3 using the Discovery Learning learning model. Data on problem-solving ability were collected by tests, while scientific attitudes were collected by questionnaires. The data was analyzed by One way Multivariate. The results of the study showed that: (1) there was a significant difference in problem-solving ability and scientific attitude between students who learned with the Problem Based Learning model and students who learned with the Discovery Learning model; (2) the effective contribution of learning using the PBL model to problem-solving ability and scientific attitude simultaneously was 0.46 or 46.1%.

Keywords: Problem based learning; Problem solving skills; Scientific attitudes

Introduction

State in the 21st century, students are expected to have life skills which involves creative thinking, critical thinking and problem-solving, communication skills, and collaboration (Sugiyarti & Arif, 2018). However, Based on the results Programme for International Student Assessment (PISA) in 2018, Indonesia was ranked in the bottom 10 for all three assessment categories. The ability of Indonesian students in science is ranked 71 out of 81 countries. In 2022, science literacy increased by 6 positions. The low ranking indicates that Indonesian students have not been able to solve problems using science concepts. The low problem-solving ability of students is one of the illustrations that science learning in Indonesia still needs improvement in the learning process (Sari et al., 2021).

Chemical research is expected to be able not only to master concepts, but also to implement the concepts learned to solve chemical problems. However, classroom learning tends to emphasize the acquisition of concepts and paralyze students' problem-solving skills in chemistry (Rohayah, 2022). In abstract concepts such as chemistry lessons, the use of the right learning model and approach should be an important reference so that the goal of learning chemistry can be achieved. One of the appropriate learning models and approaches is the problem based learning (PBL) model with a scientific approach (Jundu et al., 2018; Payadnya et al., 2023; Duygu, 2022).

Success in the learning process does not only depend on external factors, but also pays attention to internal factors, including the scientific attitude possessed by students (Permendikbud RI No.21, 2016).

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Regarding the content standards of primary and secondary education, one of the levels of competence that students must have in order to meet the competency standards of graduates in chemistry lessons is to develop scientific attitudes such as curiosity, discipline, logical and analytical thinking, diligence, tenacity, honesty, discipline, responsibility, and care through chemistry. Based on observations during teaching, students do not dare to ask questions and express opinions when discussing and in presentation activities.

Thermochemistry is one of the chemical materials that contains theories, calculations and experiments. One of the indicators in thermochemistry material that is considered difficult by students is the material for determining enthalpy changes. Based on the results of the preliminary study, in learning thermochemistry material, students are required to be able to apply mathematical concepts and equations in certain calculations such as calculating changes in the enthalpy of a reaction. Therefore, students need to be accustomed to solving problems, finding something useful for them, and struggling with ideas, that is, students must construct knowledge in their own minds (Safitri & Holiwarni, 2023).

The selection of a good learning model is one of the determinants of students' success in learning. One of the learning models suggested by experts and researchers is to apply the model Problem Based Learning *(PBL)* (Astuti et al., 2018). PBL is a learning model that challenges students to think critically in solving existing problems. (Panggabean, Simanjuntak, Hutahean, Purba, 2022). PBL is learning that provides problems to students and requires students to be able to solve and provide solutions to these problems. According to Pramana et al. (2020) and Munawaroh (2020), there are five steps of the PBL learning model, namely student orientation to problems, organizing students to learn, guiding individual and group investigations, developing and presenting works, and analyzing and evaluating the problem-solving process.

Based on a preliminary study in class XI MIPA SMAN 1 Malinau, it shows that the PBL model has never been used in chemistry learning, students' problem-solving skills are still low, and scientific attitudes have not yet developed. One of the efforts that can be made to overcome these problems is to apply the PBL model in chemistry learning to improve the problem-solving ability and scientific attitude of grade XI students. Based on previous theories and research, the purpose of the research conducted is to determine the influence of the Problem Based Learning model on the problem-solving ability and scientific attitude of grade XI students of SMAN 1 Malinau Thermochemistry material.

Method

This research approach uses a quantitative research approach with a quasi-experimental method. The sampling technique uses the random sampling method for the class. The sample in this study consists of an experimental class and a control class. The experimental class is the class that uses the Problem Based Learning (PBL) model and the control class is the class that uses the Discovery Learning (DL) model. The population of the study is students of grade XI Mipa SMAN 1 Malinau for the 2023/2024 academic year. The research sample was 33 students in class XI Mipa 1 (experimental class) and 33 students in class XI Mipa 3 (control class) who were selected using random sampling techniques for classes. The research design used is a quasi-experimental type posttest only control group design. The design of this study can be seen in the following table.

Table 1. Posttest Only Control Design

Class	Treatment	Posttest
Control	-	O1O2
Experiment	X	O1O2

Information:
O1 = Problem-solving ability instrument
O2 = Scientific attitude instrument
X = Application of the Problem Based Learning model (Lestari, 2016)

The data collection techniques used are test and non-test techniques. A test to measure students' problem-solving skills. The test used was in the form of 20 multiple-choice questions on thermochemistry material. Problem-solving skills contain 4 indicators, namely understanding the problem, planning solutions, implementing the plan, and reviewing the results. Non-tests in the form of questionnaires are used to measure students' scientific attitudes. The aspects of scientific attitudes measured are curiosity, critical thinking, open thinking, perseverance, and cooperation. The data analysis techniques used are One way Multivariate Analysis of Variance (One-way MANOVA) through SPSS 26. One-way MANOVA to analyze whether or not there is a significant difference in problem-solving ability and scientific attitude between students who learn using the PBL model and students who learn using the DL model. One-way MANOVA It can be done by fulfilling the assumption test, namely no univariate and multivariate outliers, multivariate normality, linear relationships between each variable pair to each independent variable, multivariate homogeneity, and no multicollinearity. The influence of the PBL model on students' problem-solving ability and scientific attitude simultaneously can be seen from the significance values

in the table Multivariate Test on the test Hotteling's Trace (Githa et al., 2019).

Result and Discussion

The implementation of the research was carried out twice a week in each class with a time allocation of 2 x 45 minutes for one meeting. The research was carried out 4 times in the experimental class, namely class XI MIPA 1 and the control class, namely class XI MIPA 3. The application of the Problem Based Learning model in the phase of guiding students in the investigation can be seen in the following figure.

Figure 1. Teachers guide students in the inquiry stage

In the implementation of learning using the PBL model, there are several stages that are carried out, namely orienting students to problems, organizing students to learn, guiding individual/group investigations, developing and presenting the results of the work, analyzing and evaluating (Tiring, 2020). Data on students' problem-solving skills and scientific attitudes were obtained after learning using the PBL model. Data on students' problem-solving skills and scientific attitudes were obtained from the posttest experimental and control classes. Descriptive statistical analysis was carried out to explain students' problem-solving skills and scientific attitudes obtained from the use of the learning model. Based on the results of descriptive statistics, the following data were obtained.

Based on the data in table 2, it shows that the average problem-solving ability and scientific attitude of students in the PBL class (treatment) showed higher results than the DL class. This shows that the PBL model has a positive influence on the problem-solving ability and scientific attitude of students in grade XI MIPA.

Table 2. Descriptive Statistical Results

Dependent Variables	Learning model	Average
Problem-Solving Capabilities	PBL	73.97
	DL	63.38
Scientific Attitude	PBL	80.85
	DL	75.21

Normality Test

The normality test aims to find out whether the data is normally distributed or not. The test used was Mahalanobis Distance.

Table 3. Correlation between Mahalanobis Distance and Qi (Chi Square)

		Mahalanobis Distance	Qi
Mahalanobis Distance	Pearson Correlation	1	0.983
	Sig. (2-tailed)		< 0.001
Qi	Pearson Correlation	0.983	
	Sig. (2-tailed)	< 0.001	

Because the Pearson Correlation value is 0.983 in the high category, this shows that all data groups in this study come from a normally distributed population.

Homogeneity

The homogeneity test aims to find out whether several population variants are the same or not. This multivariate homogeneity test uses *Box's M*. Because the value of sig. greater than 0.05, this shows that the data group has the same variance (homogeneous).

Multicollinearity

This test aims to see the relationship or correlation between the variables of problem-solving ability and students' scientific attitudes.

Table 4. Correlation between Variables

		Problem-solving skills	Scientific Attitude
Problem-Solving Capabilities	Pearson Correlation	1	0.757
	Sig. (2-tailed)		<0.001
Scientific Attitude	Pearson Correlation	0.757	1
	Sig. (2-tailed)	0.757	

Since the Pearson correlation value is 0.757 belonging to the strong category, it is concluded that there is no multicollinearity.

Manova

The Manova test was carried out to find out the differences in problem-solving skills and scientific attitudes of students who used PBL and DL model learning. The test in the Manova analysis used to make decisions from hypotheses is the Hotelling's Trace test because there are two groups of independent variables. The results can be seen in the Table 5.

Table 5. Results of Multivariate Tests

Test Analysis	F	Significance Value	Conclusion
Hotteling's Trace	7.381	0.001	H0 rejected

Based on table 5, the significance value is less than 0.05 (H0 is rejected) so it can be concluded that there is a difference in problem-solving ability and scientific attitude of students who are taught using the PBL model and students who use the DL model. The influence of the PBL Model on problem-solving ability and scientific attitude simultaneously can be seen from the significance value in the Multivariate test table. The effective contribution of learning using the PBL model to students' problem-solving ability and scientific attitude simultaneously can be seen in the partial eta squared value can be seen in the Multivariate Test table.

The PBL model in chemistry learning, especially in thermochemistry materials, can affect problem-solving skills because in PBL students are given problems to actively think about the given problem. This can encourage students to be better at providing simple explanations, building basic skills, using strategies and solving existing problems. In line with research (Valdez et al., 2019) concluded that problem-based learning can improve the chemistry problem-solving skills of high school students.

The learning activities that started from the first meeting to the fourth meeting have gone well, where many students who are enthusiastic in receiving the lessons seen from the students begin to pay attention to the lessons calmly, the assignments are done carefully and on time, try to do the problems in the book by themselves without being told, actively ask teachers and other friends if there is material that they do not understand and dare to do the questions in front of the class without having to appointed first by the teacher (Rosyidi et al., 2024). Discussion activities in the group went well, even though at the first meeting the students were still passive and had not shown the activeness of group activities. In line with research Murningsih et al. (2016) that the application of the PBL model can improve students' scientific attitudes and learning achievements (Suglo, 2024; Rosyidi et al., 2024).

The scientific attitudes of students that emerged by applying the PBL model in this study were curiosity, open-mindedness, critical thinking, perseverance, and cooperation. Scientific attitude is an act that comes from oneself that is done by a person to be better, in this case it is to support the learning results achieved (Chaidam & Poonputta, 2022; Ernawati et al., 2022).

Indicators of curiosity are students asking questions to the teacher if they do not understand the material being discussed, actively seeking information from various learning sources, enthusiastic in participating in chemistry learning through the application of the PBL model. Indicators of critical thinking are asking questions about the results of other group discussions if there are inconsistencies (Dakabesi & Luoise, 2019; Qondias et al., 2022), responding to the results of other group discussions, and retesting if there are different results of discussions (Treepob et al., 2023; Alfares, 2021; Ridwan et al., 2021; Hariyadi et al., 2023). An open-minded indicator is willing to accept ideas or other opinions submitted by teachers and friends, willing to improve the results of group discussions based on suggestions/inputs from teachers and friends, and respecting the opinions of friends (Zulyusri et al., 2023; Utomo et al., 2023). Indicators of perseverance are showing perseverance in finding the information needed, being diligent in correcting mistakes or shortcomings in completing tasks, completing tasks with full responsibility. Indicators of a cooperative attitude are actively participating in group discussions, collaborating with group friends in solving problems, and not always feeling right (Arifin et al., 2020; Dakabesi & Luoise, 2019).

The importance of scientific attitudes in science education is very important because once formed, attitudes will last for a long time and are difficult to change (Shah et al.,2012). Scientific attitude is the attitude that is the main characteristic of students in science learning, generally students who have a high scientific attitude also have high learning achievement (Rosita, 2017; Purnomo et al., 2024; Zulkifli et al., 2022).

Conclusion

From the results of the study, it can be concluded that: there are significant differences in problem-solving skills and scientific attitudes between students who learn with the Problem Based Learning model and students who learn with the Discovery Learning model and the effective contribution of learning using the PBL model to problem-solving ability and scientific attitude simultaneously was 0.461 or 46.1%. The results show that students who were taught using the PBL model demonstrated a substantial improvement in their problem-solving skills, as well as a more positive and inquisitive scientific attitude. This suggests that the PBL model is an effective instructional strategy for developing students' critical thinking and scientific literacy.

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Author Contributions

The study consists of the first author: Sri Handayani contributed to collecting, analyzing and presenting research

data. Second author: Suyanta corrected the results of the research.

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Conflicts of Interest
The authors declare no conflict of interest.

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