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## THE EFFECT OF PROBLEM-BASED LEARNING AND DISCOVERY LEARNING MODELS ON STUDENTS CRITICAL THINKING SKILLS

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**Abstract:** This study aims to determine the effect of the Problem-Based Learning (PBL) model and the Discovery Learning (DL) model on students' critical thinking skills and to identify which aspects of critical thinking are most developed in the topic of reaction rates. The research employed a quasi-experimental design. The sample consisted of two experimental classes: class XI-1 as the first experimental group and class XI-4 as the second, each comprising 34 students. The research instrument was an essay test consisting of three questions. Hypothesis testing was conducted using an Independent Sample T-Test, which yielded a significance value of 0.001. Since the significance value is less than  $\alpha$  (0.05), the alternative hypothesis ( $H_a$ ) is accepted and the null hypothesis ( $H_o$ ) is rejected, indicating a significant effect of the PBL and DL models on students' critical thinking skills in the topic of reaction rates. The analysis of critical thinking aspects shows that the ability to elementary clarifications was the most developed. This is evidenced by the  $n$ -gain percentage, which reached 94% for students taught using the PBL model and 86% for those taught using the DL model.

**Keywords:** Problem-Based Learning, Discovery Learning, Critical Thinking Skills, Reaction Rate

**Abstrak:** Penelitian ini bertujuan untuk mengetahui pengaruh model *Problem Based Learning* (PBL) model *Discovery Learning* (DL) terhadap kemampuan berpikir kritis siswa dan mengetahui aspek berpikir kritis yang paling berkembang pada materi laju reaksi. Jenis penelitian ini yaitu quasi experiment. Sampel penelitian terdiri dari XI-1 sebagai kelas eksperimen I dan XI-4 sebagai kelas eksperimen II yang masing-masing berjumlah 34 siswa. Instrumen penelitian berupa tes esai sebanyak 3 soal. Uji hipotesis menggunakan uji Independent Sample T-Test dengan hasil penelitian diperoleh harga sig. 0,001. Nilai sig. <  $\alpha$  (0,05) sehingga  $H_a$  diterima dan  $H_o$  ditolak yang artinya terdapat pengaruh yang signifikan kemampuan berpikir kritis siswa yang diberi pembelajaran menggunakan model PBL dan model DL pada materi laju reaksi. Hasil analisis aspek yang diperoleh indikator aspek memberikan penjelasan sederhana adalah aspek kemampuan berpikir kritis yang paling berkembang, terlihat dari persentase  $n$ -gain 94% untuk yang diujikan menggunakan model PBL dan 86% untuk yang diujikan menggunakan model DL.

**Kata kunci:** Problem Based Learning, Discovery Learning, Kemampuan Berpikir Kritis, Laju Reaksi

### INTRODUCTION

Education plays a crucial role in developing human resources, with teachers serving as key pillars in nation-building. In the learning process, teachers must design engaging lessons that keep

pace with educational advancements. They should not rely solely on outdated methods but also focus on equipping students with essential skills (Rifa Hanifa Mardhiyah et al., 2021). However, in practice, many still use the lecture method, causing students to passively

listen and take notes without developing critical thinking. This results in monotonous learning. Students should be encouraged to think deeply and express their opinions about the material (Prasetyo & Kristin, 2020). Reaction rate is one of the chemistry topics taught in Grade XI (Phase F) at SMA/MA.

This material has several challenging characteristics. First, it involves abstract concepts, such as activation energy and collision theory, which cannot be directly observed but can be understood through reaction processes. Second, it requires mathematical understanding, such as calculating reaction rates, reaction orders, and rate laws. Third, it involves multiple representations macroscopic, sub-microscopic, and symbolic which are linked to real-life contexts. Understanding this topic demands critical thinking, proportional reasoning, and data interpretation skills. These characteristics often make the topic difficult, but with regular critical thinking practice, students can better grasp and solve problems related to reaction rates.

Critical thinking is a fundamental skill that students must develop to enhance their understanding of subject matter, solve problems effectively, and make well-informed decisions. By thinking critically, students are encouraged to examine and evaluate various sources of knowledge, such as textbooks, scientific journal articles, and opinions shared by peers during group discussions (Hardika Saputra, 2020).

However, the majority of learning processes still fail to cultivate students' critical thinking skills effectively. According to Setianingsih et al. (2022), 37.14% of the 36 students assessed fell into the low category. The average critical thinking score was only 36.87, indicating a generally low level of proficiency. Several factors contribute to this issue, including the inconsistent implementation of learning models that support critical thinking, the use of assessment instruments that do not adequately

measure critical thinking abilities, and students' limited engagement in independent reasoning and practice.

Based on observations and interviews at SMAN 1 Perbaungan, it was found that the classroom learning process is still dominated by the teacher, who mainly uses the lecture method. As a result, teachers have not applied varied learning models or provided opportunities for students to be actively involved and understand the material in depth. Interviews with chemistry teachers revealed that students tend to memorize rather than understand concepts, leading to weak critical thinking and problem-solving skills. Student engagement is also low only a few students participate by asking questions or sharing opinions, while most remain passive, simply listening without critically evaluating the material. This lack of two-way interaction indicates that students have not developed strong critical thinking habits. Overall, the critical thinking skills of Grade XI students in chemistry remain at a low level.

Understanding reaction rates highlights the need for innovative learning models to improve critical thinking skills, especially in the context of reaction rates. One of the learning model that can be used is Problem Based Learning and Discovery Learning model with the support of educational video media.

Problem-Based Learning (PBL) is an instructional model grounded in real and meaningful problems for students. This approach enables students to solve problems and conduct independent investigations to find solutions. Hermansyah (2020), problem-solving fosters critical thinking, making it highly effective for understanding lesson content, developing and challenging students' abilities, and providing a sense of satisfaction through the discovery of new knowledge. Maqbullah et al. (2018), it is known that the PBL learning model can improve students' critical thinking skills, as obtained from the results of

classroom action research through 3 consecutive cycles of 65%, 75%, and 92%. The Discovery Learning (DL) model is an instructional approach that emphasizes the process of independently exploring and discovering learning materials. As a result, they become more active, independent, and critical in addressing various problems.

According to Yuliati & Susianna (2023), the Discovery Learning (DL) model can enhance students' critical thinking skills. Their study showed that students actively applied critical thinking in interpreting, analyzing, and evaluating information. They also made informed decisions based on observations and discussions. This was reflected in the increase in average critical thinking scores across three cycles: 63.51 in Cycle I, 77.01 in Cycle II, and 85.63 in Cycle III.

## METHOD

This research will be conducted at SMA Negeri 1 Perbaungan, located on Jl. Mayjend H.T. Rizal Nurdin, Perbaungan North Sumatra, Indonesia. The study will take place from October 2024 to January 2025. The population in this study was all grade XI students in the 2024/2025 academic year. The sample was taken using random sampling techniques from two classes, namely experimental class 1 (XI-1) with a total of 35 students who were taught using the Problem-Based Learning model, while experimental class 2 (XI-4) had a total of 35 students who were taught using the Discovery Learning model.

This research employed a quasi-experimental design using a two-group pretest-posttest control group design. In this study, there are two groups, which are given a pretest to determine the initial conditions between experimental group I and experimental group II. The research began with school observations and teacher interviews, followed by the preparation of teaching modules and

research instruments. In the implementation phase, a pretest was given to both experimental classes. Class I was taught using the Problem-Based Learning model, and Class II used the Discovery Learning model, both supported by educational videos. A posttest was then administered to assess students' critical thinking skills, followed by data analysis and conclusion drawing. The test instrument was a structured essay consisting of three main questions, each with five sub-questions, and was validated by experts for content validity, clarity, and alignment with research objectives.

The analysis of students' critical thinking skills was conducted by evaluating their responses to essay-type questions. The interpretation of the scores was carried out by processing the students' results using a predetermined formula to determine their level of critical thinking skills, as outlined below.

$$\text{Skor berpikir kritis} = \frac{\text{skor perolehan}}{\text{skor maksimum}} \times 100$$

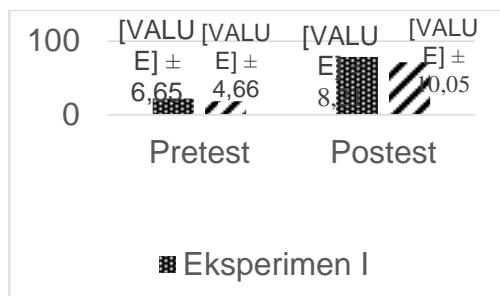
The scores obtained from the calculations were categorized into levels of critical thinking ability, as presented in Table 1.

**Table 1 Range Of Critical Thinking Skills**

Rentang Nilai Hasil Kemampuan Berpikir Kritis	Kategori
81-100	Sangat Tinggi
61-80	Tinggi
41-60	Sedang
20-40	Rendah
0-20	Sangat Rendah

## RESULT AND DISCUSSION

Figure 1 presents the average data on students' critical thinking abilities, obtained from Experimental Class I and Experimental Class II, including both pretest and posttest.



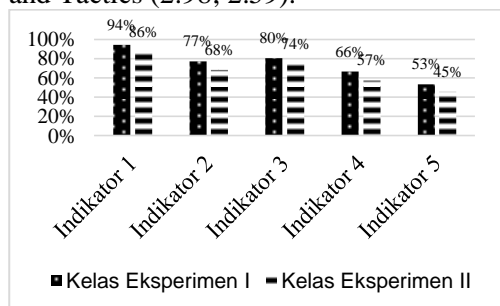
**Figure 1 Average Pretest and Posttest Scores**

Based on Figure 1, the average pretest and posttest scores in experimental class I were  $22,11 \pm 6,65$  and  $18,29 \pm 4,66$  while in experimental class II they were  $78,97 \pm 8,21$  and  $71,52 \pm 10,05$ . The post-test results of students' critical thinking skills in both experimental classes fall into the high category, which is within the range of 61–80. The results of the critical thinking test based on each aspect of the indicators can be seen in the following table.

**Table 2 Average Critical Thinking Ability of Students on Each Indicator**

Indikator	Kelas Ekperimen 1		Kelas Ekperimen 2	
	Pretest	Posttest	Pretest	Posttest
	Memberikan Penjelasan sederhana	1,69	4,81	1,46
Membangun Keterampilan Dasar	1,37	4,16	1,16	3,80
Menyimpulkan	1,03	4,22	0,87	3,91
Memberikan Penjelasan Lebih Lanjut	0,78	3,56	0,50	3,08
Memberikan Stretegi dan Taktik	0,66	2,98	0,58	2,59
<b>Rata-Rata</b>	<b>1,11</b>	<b>3,95</b>	<b>0,91</b>	<b>3,58</b>

Table 2. shows that the critical thinking skills of both experimental classes improved across all indicators. In both classes, the post-test average scores from highest to lowest were as follows: Elementary Clarification (4.81 in Class I; 4.50 in Class II), Inference (4.22; 3.91), The Basis for the Decision (4.16; 3.80), Advanced Clarification (3.56; 3.08), and Supposition and Integration/Strategies and Tactics (2.98; 2.59).



**Figure 2 Percentage of N-Gain in Critical Thinking Skills**

The figure above shows the calculated results for each aspect of critical thinking indicators in Experimental Class I as follows: Aspect 1 (Elementary Clarification) at 94%, Aspect 2 (The Basis for the Decision) at 77%, Aspect 3 (Inference) at 80%, Aspect 4 (Advances Clarification) at 66%, and Aspect 5 (Supposition and Integration/developing strategies and tactics) at 53%. Meanwhile, in Experimental Class II, the results are: Aspect 1 at 86%, Aspect 2 at 68%, Aspect 3 at 74%, Aspect 4 at 57%, and Aspect 5 at 45%.

### Data Analysis

To test the hypothesis, a series of assumption tests, including normality and homogeneity, were conducted at a 0.05 level of significance. The normality test results are shown in Table 3.

**Table 3 Normality Test Results**

	Kelas	<i>Shapiro-Wilk</i>	
		<i>Statistic</i>	<i>Sig.</i>
Kemampuan	Eksperimen 1	0,943	0,076
Berpikir Kritis	Eksperimen 2	0,984	0,880

Table 3. shows that the critical thinking ability data in experimental class I and experimental class II have sig. values of 0.076 and 0.880, respectively, which are greater than the significance level  $\alpha$  (0.05), so it can be concluded that the students' critical thinking ability data are normally distributed. The results of the homogeneity test for students' critical thinking skills are shown in Table 5.

**Table 4 Homogeneity Test Results**

	Rata-Rata	<i>Levene Statistic</i>	
		<i>Statistic</i>	<i>Sig.</i>
Kemampuan Berpikir Kritis	Rata-Rata	0,970	0,202
	Median	1,668	0,216

Based on the data in Table 4.3, the average critical thinking ability has a sig. value of 0.202  $>$   $\alpha$  (0.05), so it can be concluded that the critical thinking ability data is homogeneous.

After the parametric test was conducted, data that were normally distributed and homogeneous were used for statistical analysis to test the hypothesis. The hypothesis testing was carried out using the SPSS Version 31.0 for Windows software, employing an Independent Samples T-Test at a significance level of  $\alpha = 0.05$ . If the significance value (sig.) is less than  $\alpha$  (0.05), then the alternative hypothesis ( $H_a$ ) is accepted and the null hypothesis ( $H_0$ ) is rejected. Conversely, if the significance value is greater than  $\alpha$  (0.05), then the null hypothesis ( $H_0$ ) is accepted and the alternative hypothesis ( $H_a$ ) is rejected. The results of the hypothesis test are presented in the following table 5.

**Table 5 Hypothesis Test Results**

Source	<i>Sig.</i>
Kemampuan berpikir kritis	.001

He results of the hypothesis test showed a significance value of .001, which is lower than the significance level ( $\alpha = 0.05$ ). Therefore, the alternative hypothesis ( $H_a$ ) is accepted, and the null hypothesis ( $H_0$ ) is rejected.

### Discussion

Based on the research results, it was found that the average posttest score for critical thinking skills among students using the PBL model was higher than that of students using the DL model. The posttest scores obtained by the experimental class were in the high category, as they were in the range of 61 to 80 according to the classification criteria for students' critical thinking skills.

Furthermore, the gain test results show that students critical thinking skills in Experimental Class I improved with an N-Gain of 0.74 (74%), while Class II achieved 0.65 (65%). Based on each indicator, the PBL model led to greater improvement than the DL model. For example, the 'providing simple explanations' indicator increased by 94% in Class I and 86% in Class II. These results indicate that the PBL model more effectively enhances students' critical thinking skills compared to the DL model.

To support the validity of the research results, normality and homogeneity tests were conducted on the students' critical thinking skills data. The results indicated that the data were normally distributed and homogeneous at a 95% significance level ( $\alpha = 0.05$ ), as the significance values were greater than 0.05. Subsequently, an independent sample t-test was conducted, yielding a significance value of 0.001. Since this value is less than 0.05 ( $0.001 < 0.05$ ),  $H_0$  is rejected and  $H_a$  is accepted. Therefore, it can be concluded that there is a significant difference in critical thinking

skills between students taught using the PBL model and those taught using the DL model, particularly in the topic of reaction rates. The PBL model has been proven to be more effective in enhancing students' critical thinking skills.

Utami (2020) also stated that there is a significant difference between the implementation of the two learning models in terms of students' critical thinking skills. In her study, the average posttest score of students taught using the PBL model was higher than that of students taught using the DL model. Ariyani and Prasetyo (2021) stated that the PBL model resulted in a greater improvement in students' critical thinking skills compared to the DL model, with average scores of 83.75 and 80.17, respectively.

This success is partly attributed to students' active involvement in each stage of the PBL process from identifying problems, gathering information, and processing data, to testing and evaluating solutions which helps them develop active and systematic thinking skills. This process trains students to analyze, comprehend, and critically evaluate information in a thorough manner.

This finding aligns with various studies indicating that the "Elementary Clarifications" indicator shows the highest level of improvement. Research by Rahmawati et al. (2023) at MAN 2 Pontianak demonstrated that the implementation of PBL significantly enhanced the critical thinking skills of 11th-grade science students, with their average scores increasing from 13.70 (pretest) to 20.75 (posttest). Among the four measured indicators, "Elementary Clarifications" recorded the highest improvement.

This is attributed to the early stages of PBL, such as problem orientation and trigger questions, which require students to identify the core issues and express their initial understanding. Kumullah et al. (2018) also reported that the Elementary Clarifications indicator obtained the highest average score,

ranging from 80 to 82. This achievement was influenced by the PBL syntax, which emphasizes problem orientation, triggering questions, and initial discussions from the outset. Yu & Zin also confirmed that PBL consistently has the greatest impact on the early stages of critical thinking, particularly in *elementary clarification*. Students' ability to articulate initial ideas clearly and coherently outperformed other aspects such as inference, strategy, or advanced clarification.

Overall, these studies affirm that "providing simple explanations" is the most significantly developed aspect of critical thinking. This is primarily due to the PBL syntax especially the problem orientation and initial discussion phases which emphasizes.

## CONCLUSION

Based on the results of research, calculations, and hypothesis testing, it can be concluded that there is a significant difference in the average critical thinking ability of students taught using the Problem-Based Learning (PBL) model compared to those taught using the Discovery Learning (DL) model on the topic of reaction rates. Among the various aspects of critical thinking, the ability to provide simple explanations was found to be the most developed.

This is supported by the percentage of each critical thinking indicator in Experimental Class I, which used the PBL model: Elementary Clarification (94%), The Basis for the Decision (77%), Inference (80%), Advanced Clarification (66%), and Integration/Developing Strategies and Tactics (53%). In comparison, Experimental Class II, which used the DL model, showed the following results: Elementary Clarification (86%), The Basis for the Decision (68%), Inference (74%), Advanced Clarification (57%), and Integration/Developing Strategies and Tactics (45%).

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