



Effect of Discovery Learning on Student's Achievement in Acid-Base Chemistry

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Abstract

This study aimed to determine the effect of the Discovery Learning model on students' learning outcomes in acid-base material at SMAN 1 Sungai Tarab. The research employed a quasi experimental method using a nonequivalent control group design. The sample consisted of 45 students selected through a total sampling technique. Data were collected through observation, documentation, and learning achievement tests. The findings showed that students who learned through the Discovery Learning model achieved higher learning outcomes than those who received conventional instruction. Hypothesis testing indicated that the implementation of the Discovery Learning model had a significant effect on students' learning outcomes in acid-base material. These findings suggest that Discovery Learning can be used as an effective instructional alternative to enhance students' engagement and conceptual understanding in chemistry learning, particularly in acid-base topics.

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INTRODUCTION

Chemistry is a branch of science that studies the properties, structures, and transformations of matter (Mulatsih, 2018). For many senior high school students, chemistry is perceived as difficult due to its abstract and complex concepts. This challenge requires teachers to select appropriate learning models to create effective, enjoyable, and meaningful learning experiences (Abdullah, 2017).

Learning models serve as systematic frameworks to organize learning experiences and achieve specific objectives (Asrini, 2021). One relevant approach is Discovery Learning, which emphasizes active student involvement in discovering concepts through observation, experimentation, and data analysis. Knowledge acquired through this process becomes more meaningful and long-lasting (Lesma Wati, 2022).

The acid-base topic in grade XI is often challenging because of its abstract nature, involving Arrhenius, Bronsted-Lowry, and Lewis

theories, as well as pH and ion concentration calculations (Fitriani, 2021). Observations at SMAN 1 Sungai Tarab revealed that learning was still dominated by conventional lecture-based methods, limiting student engagement and resulting in low achievement. Daily assessment data showed that only 34% of students reached the minimum competency threshold KKTP 80.

Previous studies have demonstrated that discovery learning can improve student achievement and motivation in various subjects (Kasmianti et al., 2021). However, the application of in chemistry, particularly in acid-base material, remains limited. This research gap highlights the need to further examine the effectiveness of discovery learning in secondary school chemistry.

Therefore, this study aims to investigate the effect of Discovery Learning on students' learning outcomes in acid-base material at SMAN 1 Sungai Tarab. The novelty of this research lies in applying Discovery Learning to a challenging

chemistry topic, aiming to bridge the gap between abstract concepts and real-world applications, and to contribute to improving the quality of chemistry education in schools.

METHOD

This study employed a quasi-experimental design with a *pretest posttest control group* to examine the effect of the Discovery Learning model on students' achievement in acid-base chemistry (Sugiyono, 2013). The participants were all 45 grade XI students at SMAN 1 Sungai Tarab, selected using total sampling. The research instrument was a multiple-choice cognitive achievement test, validated through tests of validity, reliability, difficulty level, and discrimination index (Minahasa, 2024). The experimental class was taught using Discovery Learning, while the control class received

conventional instruction. Data were collected through a posttest administered after the treatment and analyzed using normality and homogeneity test, N-Gain and Independent Sample T-Test to determine differences in learning outcomes between the two groups (Yam & Taufik, 2021).

RESULTS AND DISCUSSION

The research began with descriptive statistical analysis of students' pretest and posttest scores. The average score of the experimental class taught using the Discovery Learning model was higher than that of the control class taught using conventional methods. This finding indicates that the application of a student-centered learning model was able to improve learning outcomes in acid-base material. The comparison of scores can be seen in the figure 1.

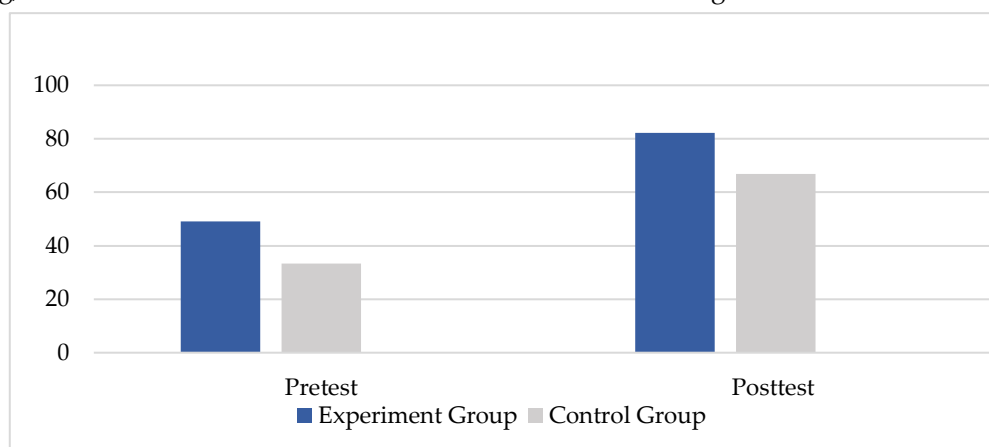


Figure 1. Comparison of The Average Pretest and Posttest Score

Based on the figure, it can be observed that the learning outcomes of students in Moving Class Chemistry 1 were much better compared to the control class, namely Moving Class Chemistry 2. The experimental class obtained a final average score of 82.20, while the control class only reached 66.90. This demonstrates that the treatment using the Discovery Learning model in the experimental class significantly enhanced students' learning outcomes.

Next a normality test was conducted using the Shapiro wilk test through the SPSS application (Haniah, 2013). Based on the SPSS output, the normality test using the shapiro wilk test method showed that the significance values for both the experimental $0.965 > 0.050$ and control classes were $0.520 > 0.050$. Therefore, it can be concluded that the data in both the experimental and control classes were normally distributed, which means the analysis could proceed with the homogeneity

test and hypothesis testing. For further details, the results can be seen in the table 1.

Table 1. Shapiro Wilk Test

	Tests of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Kimia MC 1	,099	24	,200*	,983	24	,965
Kimia MC 2	,464	21	,200	,588	21	,520

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

After obtaining the normality test results, which showed that the data in both the experimental and control classes were normally distributed, the next step was to conduct the homogeneity test. The homogeneity test is a statistical procedure used to determine whether two or more groups of data have equal variances. The test was performed using Levene's test through the SPSS application (Hambali, 2019).

The output indicated that the significance value of $0.198 > 0.05$ (Based on Mean), which means that the variances of the experimental and control

class data were equal or homogeneous. For further details, the results can be seen in the table 2.

Table 2. Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
hasil PH	Based on Mean	1,706	1	43	0,198
	Based on Median	4,188	1	43	0,047
	Based on Median and with adjusted df	4,188	1	36,533	0,048
	Based on trimmed mean	2,660	1	43	0,110

Next, the N-Gain test was conducted to determine whether there was an improvement obtained from the differences between the pretest

and posttest scores. The table of average N-Gain scores for the experimental and control classes is presented below.

Table 3. Table of Average Test N Gain of Experimental Class and Control Class

experiment group					
	N	Minimum	Maximum	Mean	Std. Deviation
NGain_score	24	,45	1,00	,7397	,11861
NGain_persen	24	45,45	100,00	63,9712	11,86090
Valid N (listwise)	24				
control group					
	N	Minimum	Maximum	Mean	Std. Deviation
ngain_score	21	,00	,75	,4993	,26820
ngain_persen	21	,00	75,31	49,9290	26,82011
Valid N (listwise)	21				

Based on the table above, it can be concluded that there is a significant difference between the control class and the experimental class. In the control class, the average N-Gain score obtained was 0.4993, which falls into the moderate category. This indicates that the conventional teaching method applied was not fully effective in optimally improving students' learning outcomes. In contrast, the experimental class achieved an average N-Gain score of 0.7397, which is categorized as high. This result shows that the implementation of the Discovery Learning model provided a greater positive impact on enhancing students' learning outcomes. Therefore, it can be concluded that the Discovery Learning model is more effective in improving learning outcomes compared to the conventional model used in the control class.

Hypothesis testing was conducted to strengthen the assumptions of the research hypothesis that had been formulated. The hypothesis test data consisted of pretest and posttest scores. The hypothesis testing of the pretest and posttest data was designed to determine whether there was a difference in the mean effect of the Discovery Learning model on students' learning outcomes. Therefore, the

method used was the t-test. In this study, hypothesis testing was carried out using the independent sample t-test through the SPSS application. The independent sample t-test was applied to examine whether there was a significant difference between the mean scores of the two groups (Yam & Taufik, 2021). Based on the SPSS output, it was found that the hypothesis test produced a significance value of Sig.(2-tailed) $0.001 < 0.005$. This means that the alternative hypothesis was accepted, indicating that the Discovery Learning model had a significant effect on improving the learning outcomes of grade XI students in acid-base material. For further details, the results can be seen in the table 4.

Based on the research findings, the experimental class achieved better learning outcomes than the control class. This result indicates that the Discovery Learning model was more effective in facilitating students' understanding of acid-base concepts than conventional instruction. Although the control class also showed improvement, the increase was lower than that of the experimental class. This finding suggests that the use of student worksheets (LKPD) in conventional learning was still beneficial in supporting students' conceptual

understanding through structured learning activities. However, it did not provide students with the same opportunities to construct knowledge independently as those offered by the

Discovery Learning model. This finding is consistent with Rahmatan (2017), who reported that LKPD contributes to conceptual understanding through guided learning activities.

Table 4. Hypothesis Test Results

		Independent Samples Test								
		Levene's Test for Equality of Variances			t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
hasil_belajar	Equal variances assumed	26,518	,000	3,595	43	,001	15,304	4,257	6,718	23,889
	Equal variances not assumed			3,389	22,598	,003	15,304	4,516	5,953	24,654

The hypothesis testing results confirmed that the Discovery Learning model had a significant effect on students' learning outcomes in acid-base material. This finding supports previous studies conducted by Ulfah et al. (2025) and Syafriyanto et al. (2023), which found that Discovery Learning improves chemistry learning outcomes by actively engaging students in the process of concept discovery. The consistency of these findings suggests that the effectiveness of Discovery Learning extends across different chemistry topics and learning contexts. The improvement in the experimental class can be explained through constructivist learning theory, which emphasizes that knowledge is actively constructed by learners through experience. In this study, students were not merely recipients of information; instead, they actively participated in observing phenomena, identifying problems, collecting data, processing information, verifying findings, and drawing conclusions. Such active involvement enabled students to develop deeper conceptual understanding, making learning more meaningful and long-lasting.

In addition to the learning model, students' prior knowledge also contributed to learning outcomes. The higher average pretest score of the experimental class indicates that students already possessed a stronger conceptual foundation before the treatment was implemented. According to Faujiah et al. (2020), prior knowledge plays a critical role in learning because new information is more easily understood when

connected to existing knowledge structures. Nevertheless, the greater improvement observed in the experimental class suggests that learning success was influenced not only by prior knowledge but also by the effectiveness of the Discovery Learning model.

Each stage of the Discovery Learning model contributed to the improvement of students' learning outcomes. During the **stimulation** stage, images and guiding questions not only attracted students' attention but also activated their prior knowledge related to acid-base concepts. This is consistent with Silaban & Nasution (2025) report, that visual media facilitate concept formation and improve students' understanding.

At the **problem identification** stage, students were encouraged to formulate questions and hypotheses based on observed phenomena. This activity fostered critical and analytical thinking skills, which are essential for understanding abstract chemistry concepts. Similar findings were reported by Djangi et al. (2023), who found that involving students in problem formulation enhances conceptual understanding and critical thinking.

The **data collection and data processing** stages provided opportunities for students to gather, organize, and analyze information from multiple sources. Through these activities, students developed a deeper understanding of concepts by constructing knowledge based on evidence rather than memorizing information. This finding supports Hani et al. (2017), who

concluded that data collection and analysis activities in Discovery Learning promote higher-order thinking skills and problem-solving abilities.

Furthermore, the **verification and generalization** stages played a significant role in strengthening conceptual understanding. Through presentations, discussions, and reflection, students evaluated their findings and compared them with established scientific theories. This process helped reduce misconceptions and enhanced students' ability to transfer knowledge to new situations. These results are in line with (Anugrah et al., 2023), who found that verification and generalization improve students' analytical, evaluative, and conceptual understanding skills.

Therefore, the improvement in learning outcomes observed in the experimental class was not solely attributable to the implementation of the Discovery Learning model itself but also to the contribution of each instructional stage in promoting active knowledge construction, critical thinking, and conceptual understanding. These findings reinforce previous studies highlighting Discovery Learning as an effective instructional model for improving chemistry learning outcomes, particularly in acid-base material.

CONCLUSION

This study confirms that the Discovery Learning model has a significant effect on students' achievement in acid-base chemistry at SMAN 1 Sungai Tarab. The independent sample t-test produced a significance value of $0.0001 < 0.05$, thus accepting H_1 . The experimental class achieved an average posttest score of 82.33 with an N-Gain of 0.739 (high category), while the control class reached 66.95 with an N-Gain of 0.499 (medium category).

These findings demonstrate that discovery learning is more effective than conventional model in improving students' conceptual understanding. Practically, the model engages students actively in discovering, processing, and verifying concepts, making learning experiences more meaningful. The educational implication is that chemistry teachers can adopt Discovery Learning as an alternative instructional strategy to enhance students' mastery of abstract concepts and critical thinking skills, particularly in topics requiring deep conceptual understanding.

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