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The Effect of SATL Strategy Integrated with Problem-Based Learning on Students' Conceptual Understanding of Compound Nomenclature and Chemical Equations

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Abstract

This research aims to determine the effect of applying the Systemic Approach Teaching and Learning (SATL) strategy on the conceptual understanding of grade X students on the material of compound names and reaction equations. The research was conducted in the even semester of the 2023/2024 academic year at SMA Negeri 68 Jakarta. The type of research used is quantitative research with quasi experimental method and with a Pretest Posttest Nonequivalent Control Group Design. The research sample was obtained through purposive sampling technique with class X-2 serving as the experimental class which used the Systemic Approach Teaching and Learning (SATL) strategy using the problem based learning (PBL) model and class X-4 serving as the control class which used problem based learning (PBL) model without using strategy. The results showed that the average posttest of the experimental class (85,71) was higher than control class (76,91). Based on the results of the U Mann Whitney test calculation, the Asymp.Sig.(2-tailed) value is 0,047 so it can be concluded that $0,047 < 0,05$ which means that H_0 is rejected. Based on the results obtained, it can be concluded that the application of Systemic Approach Teaching and Learning (SATL) strategy has a positive effect on the conceptual understanding of class X students on the material of Compound Names and Reaction Equations.

Keywords: Systemic Approach Teaching and Learning (SATL), Conceptual Understanding, Compound Nomenclature, Chemical Equations

Introduction

The current Merdeka curriculum aligns with the ideals of Indonesian education, which focuses on the freedom to learn independently and creatively, thereby expected to impact the formation of independent student character (Ardianti & Amalia, 2022). The learning process in the Merdeka curriculum is more directed toward the needs and active participation of students in learning activities (Indarta et al., 2017).

Therefore, teachers as educators must have a variety of innovative designs in the use of models, strategies, approaches, or teaching methods tailored to the needs of students and the learning material, as this can influence the sustainability of meaningful learning processes. Based on observations thru teaching skills practices (PKM), it was found that learning activities have not yet optimized the use of models and teaching strategies that align with the characteristics of the material being studied. This can result in a lack of student focus during the learning process, causing students to tend to have a poor understanding of the concepts being taught.

One of the subjects with various conceptual characteristics that need to be well understood is chemistry. One of the chemistry topics considered difficult to learn is the nomenclature of compounds and reaction equations. This is evidenced by the results of a preliminary analysis questionnaire given to 30 students at the PKM school who have studied the nomenclature of compounds and reaction equations, where 70% of the students stated that the material was very difficult and 30% stated that the material was difficult.

This can happen due to several factors, one of which is the lack of understanding of the concepts of compound nomenclature and reaction equations, which can be caused by students' learning styles and the use of models, approaches, methods, or teaching strategies employed by teachers in the teaching and learning process. The use of strategies and methods in the learning process must be carefully considered so that the learning objectives can be achieved effectively (Sukmawati, 2017). One strategy that can be used to build student engagement in learning activities is the Systemic Approach Teaching and Learning (SATL) strategy.

Conceptual understanding is the ability to comprehend or grasp something that has been known and remembered (Suryani, 2019). The achievement of students' conceptual understanding can be determined based on indicators of conceptual understanding. Anderson and Krathwohl state that the category of understanding includes seven cognitive processes based on the revised levels of understanding processes found in Bloom's taxonomy, namely interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining (Anderson et al., 2001).

Conceptual understanding in the material of compound nomenclature and reaction equations involves acquiring chemical knowledge such as the properties of matter and the behavior of subatomic particles, as well as their application in daily life, industry, and the environment (Leigh & Metanomski., 1998). Learning strategies differ from teaching methods because learning strategies are activity plans to achieve goals, while teaching methods are the means used to achieve the goals of implementing the strategy (Gulo, 2008). The Systemic Approach Teaching and Learning (SATL) strategy is a teaching and learning approach based on the development and use of cyclic concept mapping procedures, known as system diagrams (Fahmy & Lagowski, 2000). The fundamental difference between the SATL strategy and conventional teaching is the integration of concept mapping techniques into the teaching process and the representation of interrelated concepts as a system diagram (Vachliotis & Tzougraki, 2021). The research aims to determine the effect of implementing the Systemic Approach Teaching and Learning (SATL) strategy on the conceptual understanding of 10th-grade students regarding compound nomenclature and reaction equations.

Method

The method used in this research is the quasi-experimental method with a pretest-posttest nonequivalent control group design. The sampling in this research was conducted using purposive sampling technique, with class X-2 designated as the experimental class and class X-4 designated as the control class. The instrument used to measure students' conceptual understanding is a two-tier multiple-choice test. This test consists of 20 items that align with the indicators of achieving learning objectives on the topic of compound nomenclature and reaction equations.

The results of the pretest and posttest data were followed by the analysis requirement tests thru the normality test with the Kolmogorov Smirnov (K-S) test and the homogeneity test with the Levene test at a significance level of >0.05 .

The hypothesis tests used in this research are the Wilcoxon test to determine the difference between two paired samples, the Independent T-test to determine the difference between two unpaired samples in

the pretest values, and the U Mann Whitney test to determine the difference between two unpaired samples in the posttest values with a significance level of <0.05 .

Results and Discussion

In this research, the average pretest score for the experimental class was 35.29, and the average pretest score for the control class was 35.74. Based on the average pretest scores of both the experimental and control classes, it can be concluded that the initial concept understanding of students in both classes is still low. The pretest results for each class can be seen in Table 1.

Table 1. Mean Pre-test Scores of the Experimental and Control Groups

Group	N	Mean	SD	Maximum Score	Minimum Score
Experiment	35	35.29	9.621	55	20
Control	34	35.74	10.526	60	10

The data obtained were presented as histograms to depict the frequency distribution of pre-test scores. Figure 1 shows the histogram of the control group, whereas figure 2 shows the histogram of the experimental group.

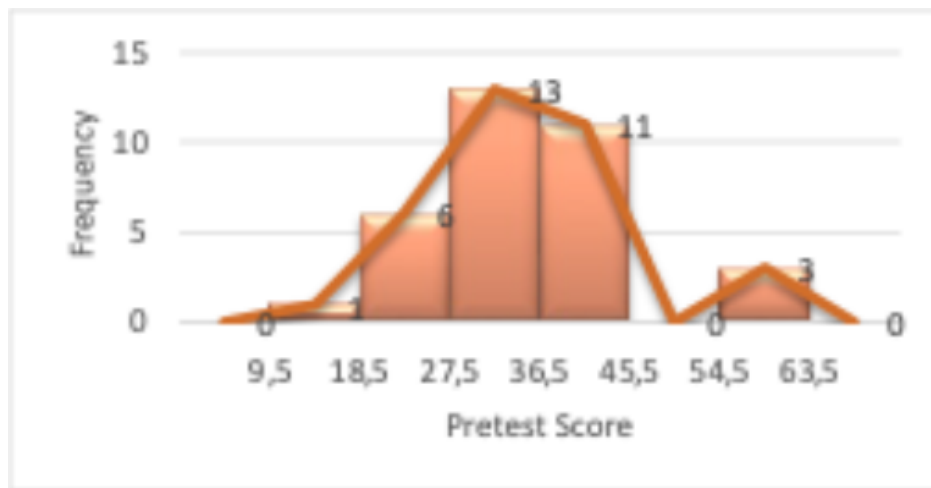


Figure 1. Control Group Pretest Score Distribution

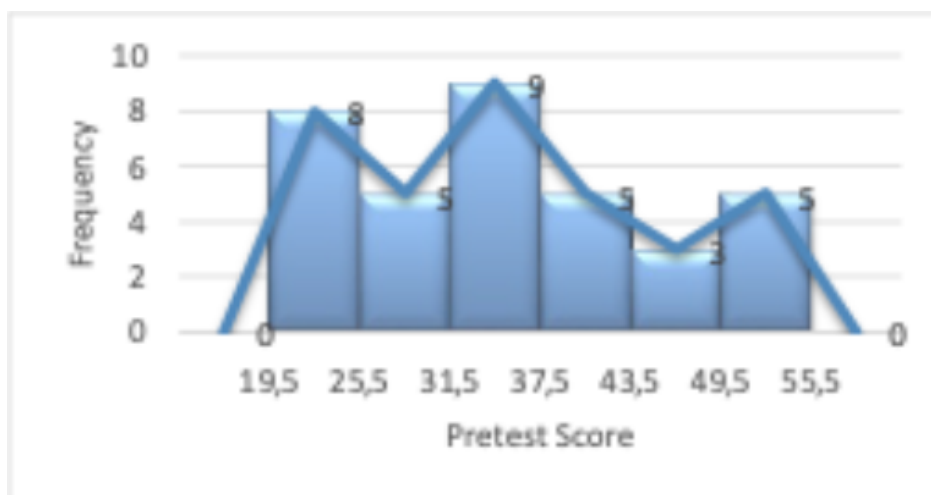


Figure 2. Experiment Group Pre-test Score Distribution

In this research, the average post-test score for the experimental class was 85.71, while the average posttest score for the control class was 76.91. Based on the average posttest scores of both classes, it can be concluded that the initial concept understanding of the experimental class students was higher compared to the concept understanding of the control class students. The posttest results for each class can be seen in Table 2.

Table 2. Mean Post-test Scores of the Experimental and Control Groups

Group	N	Mean	SD	Maximum Score	Minimum Score
Experiment	35	85.71	11.577	100	55
Control	34	76.91	18.505	100	30

The obtained data were presented as histogram to depict the frequency distribution of post-test scores. Figure 3 shows the histogram of the control group, whereas figure 4 shows the histogram of the experimental group.

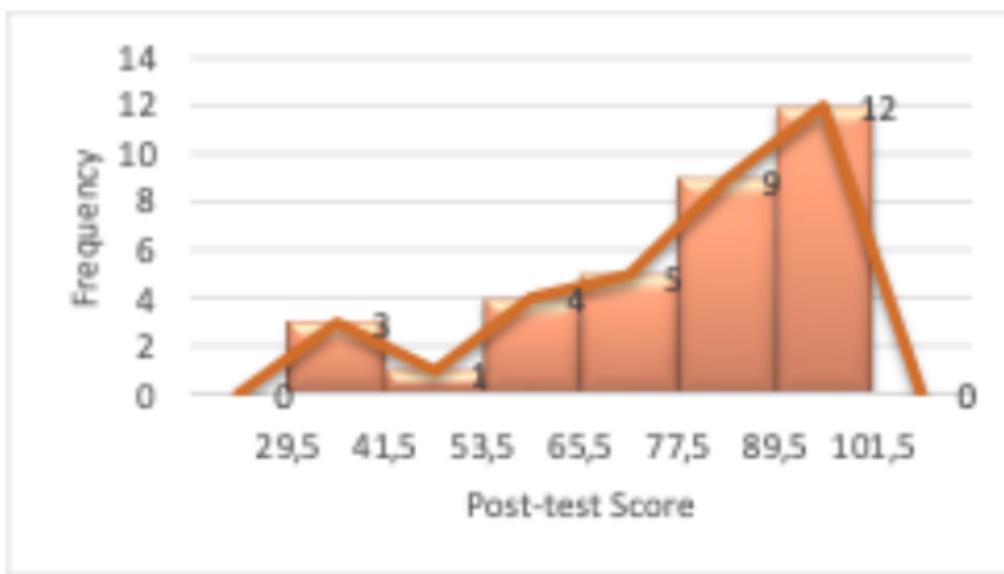


Figure 3. Control Group Post-test Score Distribution

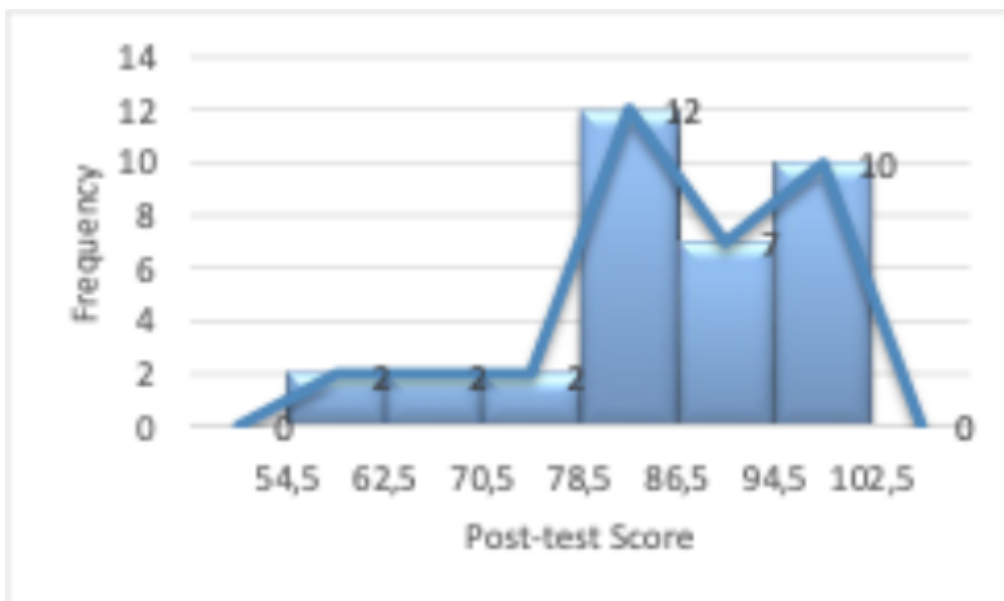


Figure 4. Experimental Group Post-test Score Distribution

The results of the N-Gain value calculations for each concept understanding indicator obtained from the pretest and posttest of the control class and the experimental class are presented in the form of a histogram shown in Figure 5.

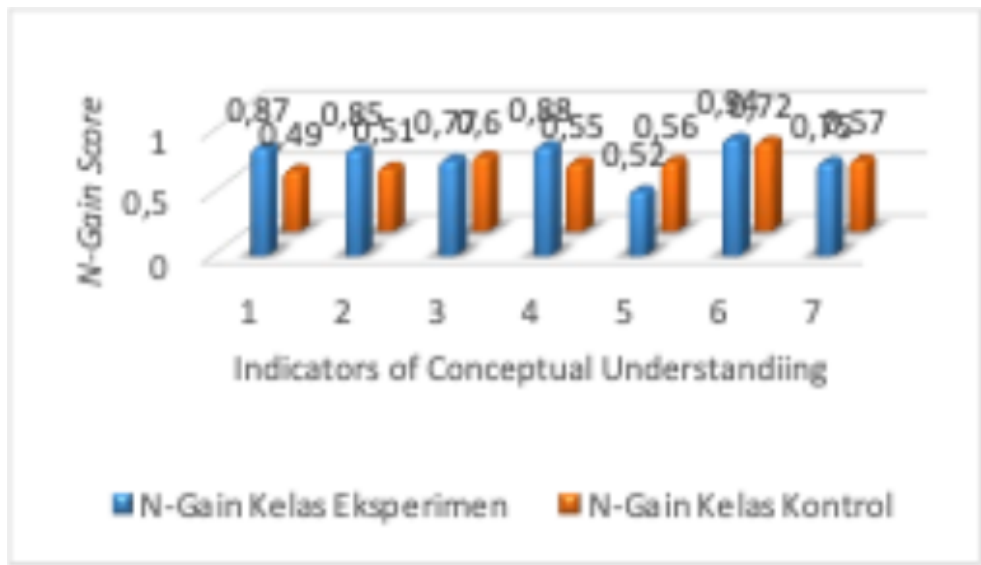


Figure 5. N-Gain Score for Conceptual Understanding Indicators

Note:

- 1 = Interpreting 4 = Summarizing 7 = Explaining
- 2 = Exemplifying 5 = Inferring
- 3 = Classifying 6 = Comparing

Based on the N-Gain results that shows in Figure 5, the highest N-Gain value is found in the experimental class with the comparing indicator, which is 0.94 with a high criterion. Meanwhile, the inferring indicator has the highest N-Gain value in the control class, which is 0.56. Testing the analysis requirements, namely the normality test for pretest and posttest scores, resulted in normal distribution for both the control and experimental class pretest data because the significance value was >0.05 . Meanwhile, the normality test results for the posttest data in both the control and experimental classes were not normally distributed because the significance value obtained was <0.05 . The results of the normality test are presented in Table 3.

Table 3. Result of The Pre-test and Post-test Data Normality Test

Group	Test	Sig.	Category
Experimental	Pre-test	0.078	Normal
	Post-test	0.003	Non-Normal
Control	Pre-Test	0.362	Normal
	Post-Test	0.003	Non-Normal

Testing the analysis requirements, namely the homogeneity test for pretest and posttest values, resulted in homogeneous pretest data for both classes because the significance value was $0.631 > 0.05$, while the posttest data for both classes were not homogeneous because the significance value was $0.010 < 0.05$. The results of the homogeneity test for the pretest and posttest data of the experimental class were not homogeneous because the significance value was $0.001 < 0.05$, while the pretest and posttest data of the control class were homogeneous because the significance value was $0.445 > 0.05$. The results of the homogeneity test are presented in Table 4.

Table 4. Results of the Pre-test and Post-test Data Normality Test

Test	Group	Sig.	Category
Pre-test	Experimental	0.631	Homogeneous
	Control		
Post-test	Experimental	0.010	Not homogenous
	Control		
Group	Test	Sig.	Category
Experimental	Pre-test	0.001	Not homogenous
	Post-test		
Control	Pre-test	0.445	Homogeneous
	Post-test		

Based on the results of the prerequisite analyses, the pretest data of both the control and experimental groups were found to be normally distributed and homogeneous. In contrast, the posttest data of both groups were not normally distributed and were not homogeneous. Therefore, the Wilcoxon test was used to determine differences between two paired samples, while the Independent Samples t-test was employed to examine differences between the pretest scores of two independent groups, and the Mann–Whitney U test was used to analyze differences between the posttest scores of two independent groups.

The results of the Wilcoxon test conducted to compare the pretest and posttest scores in the control group yielded an Asymp. Sig. (2-tailed) value of 0.000. Similarly, the Wilcoxon test conducted in the experimental group also produced an Asymp. Sig. (2-tailed) value of 0.000. The results of the Wilcoxon test for the control group are presented in Table 5, whereas the results for the experimental group are presented in Table 6.

Table 5. Wilcoxon Test Results for The Control Group

	Pretest-posttest
Z	-5.098
Asymp sig. (2-tailed)	0.000

Table 6. Wilcoxon Test Results for The Control Group

	Pretest-posttest
Z	-5.182
Asymp sig. (2-tailed)	0.000

Based on the results of the Wilcoxon test conducted in both the control and experimental groups, the Asymp. Sig. (2-tailed) value was 0.000, which was lower than the significance level of 0.05. Therefore, the alternative hypothesis (H_a) was accepted, indicating a significant difference between the means of the two paired samples.

To determine the difference between the means of two independent samples, the pretest scores of both groups were analyzed using the Independent Samples t-test. The analysis yielded an Asymp. Sig. (1-tailed) value of 0.427. The results of the Independent Samples t-test for the pretest scores are presented in Table 7.

Table 7. Independent t-test pretest score

Group	N	Mean	SD	sig
Experiment	35	35.29	9.621	0.427
Control	34	35.74	10.526	

Based on the results of the Independent Samples t-test, it was found that the implementation of the Systemic Approach Teaching and Learning (SATL) strategy did not have a significant effect on students' conceptual understanding of compound nomenclature and chemical equations, as indicated by the Asymp.

Sig. (1-tailed) value of 0.427, which was greater than the significance level of 0.05. This result can be attributed to the fact that the data analyzed using the Independent Samples t-test were pretest scores, representing students' initial conceptual understanding before the implementation of the SATL strategy.

To determine the difference between the means of two independent samples, namely the posttest scores of the experimental and control groups, the Mann–Whitney U test was employed. The analysis yielded an Asymp. Sig. (2-tailed) value of 0.047. The results of the Mann–Whitney U test for the posttest scores are presented in Table 8.

Table 8. U-mann Whitney posttest score

	posttest
Z	-1.988
Asymp.sig (2-tailed)	0.047

Based on the results of the Mann–Whitney U test, it was found that the implementation of the Systemic Approach Teaching and Learning (SATL) strategy had a positive effect on students' conceptual understanding of compound nomenclature and chemical equations, as indicated by the Asymp. Sig. (2-tailed) value of 0.047, which was lower than the significance level of 0.05. The results of the statistical hypothesis testing were supported by the students' posttest mean scores after the treatment was administered. The posttest results, which were used to assess students' final conceptual understanding of compound nomenclature and chemical equations, showed that students in the experimental group who were taught using the Systemic Approach Teaching and Learning (SATL) strategy integrated with the Problem-Based Learning (PBL) model achieved a mean posttest score of 85.71, with a mastery level of 83%. In contrast, students in the control group who were taught using the Problem-Based Learning (PBL) model without the SATL strategy obtained a mean posttest score of 76.91, with a mastery level of 59%.

These findings indicate that the mean conceptual understanding score of students in the experimental group was higher than that of students in the control group. This suggests that the integration of the Systemic Approach Teaching and Learning (SATL) strategy with the Problem-Based Learning (PBL) model contributed positively to students' conceptual understanding compared with the use of the Problem-Based Learning (PBL) model alone. The findings of this study are consistent with those reported by Vachliotis et al. (2021), who found that the implementation of the Systemic Approach Teaching and Learning (SATL) strategy through a systemic approach produced positive outcomes by improving students' performance in chemistry and enhancing their understanding of relevant scientific concepts compared with conventional teaching approaches (Vachliotis & Tzougraki, 2021).

Conclusion

Based on the research results, the implementation of the Systemic Approach Teaching and Learning (SATL) strategy has a positive impact on the conceptual understanding of 10th-grade students on the topic of compound nomenclature and reaction equations. The results of the Mann-Whitney U test showed a significant difference between the experimental class and the control class (Asymp. Sig. (2-tailed) = 0.047 < 0.05). Additionally, the average posttest score of students in the experimental class (85.71) was higher than that of the control class (76.91). These findings indicate that the SATL strategy is capable of helping students understand the interconnections between concepts more systematically, thereby supporting the enhancement of conceptual understanding. Therefore, the SATL strategy has the potential to become one of the effective alternative learning strategies to be used in chemistry education, especially for topics with complex and interrelated conceptual relationships.

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