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The Effect of the Discovery Learning Model on Student Higher Order Thinking Skills on Buffer Solution Material

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ABSTRACT

Higher order thinking skills are skills needed in studying chemistry. Student higher order thinking skills are currently still relatively low, so appropriate learning models are needed to overcome them. This research aimed at finding out the effect of Discovery Learning (DL) model toward student higher order thinking skills on Buffer Solution lesson. This research was conducted to the eleventh-grade students of Chemistry class at the second semester in the Academic Year of 2023/2024 at State Senior High School 2 Tambang. Quantitative method was used in this research with pretest-posttest non-equivalent control group design. The samples consisted of two classes selected by using cluster random sampling technique. The techniques of analyzing data were t-test to find out whether there was an effect of Discovery Learning model toward student higher order thinking skills and determination coefficient test to find out the effect. Based on the research findings, (1) t-test showed that the significant score 0.002 was lower than 0.05, it meant that there was a significant difference between experiment and control groups, the experiment group higher order thinking skills posttest mean was 80.21, and the control group was 72.64, so H0 was rejected and Ha was accepted; (2) determination coefficient test showed that the score of r2 was 0.130, so it could be concluded that DL learning model affected student higher order thinking skills on Buffer Solution lesson 13%.

INTRODUCTION

The 21st century is frequently described as the century of knowledge. To navigate the globalized world of this era, learners must acquire the knowledge and skills essential for both current and future success. One effective approach to achieving this is through 21st-century learning. The Partnership for 21st Century Skills underscores that such learning should encompass four core competencies: communication, collaboration, critical thinking, and creative thinking. Assessment & Teaching of 21st Century Skills (ATC21S) according to Arifin (2017), which groups 21st century skills into four categories, one of which is how to think critically (Hidayat et al., 2020).

Higher Order Thinking Skills have become an important need as a reliable workforce in the 21st century. So that Indonesian people do not just become "laborers", college graduates must also have thinking skills. All of these expert opinions support the idea that from the beginning, students must be taught high-order thinking skills. However, attention to the development of these high-order thinking skills is still less than optimal among teachers in schools (Rudibyani & Perdana, 2018).

The current state of education in Indonesia remains unsatisfactory, as reflected in the results of the 2022 PISA test. The Programme for International Student Assessment (PISA) evaluates students' abilities to solve complex problems, think critically, and communicate effectively.

According to the PISA 2022 data, average scores in mathematics, reading, and science have declined compared to 2018. The 2022 results are among the lowest ever recorded by PISA for these subjects, matching the levels seen in 2003 for reading and mathematics and in 2006 for science (Avvisati & Ilizaliturri, 2022).

21st century education aims to encourage students to critically select valid and relevant information, make creative innovations, work independently and in groups and solve problems in everyday life. Human resources in the 21st century are required to have important skills known as high order thinking skills or HOTS (Higher Order Thinking Skills*),* Among them are the ability to think critically, think creatively, and solve problems (Muniarti & Pratiwi, 2023). According to Resnick (1987), high order thinking skills are complex thinking processes in explaining material, drawing conclusions, forming representations, conducting analysis, and establishing relationships involving the most basic mental activities (Ariyana et al., 2018). High order thinking skills involve the skills of linking, operating, and transforming existing experiences and knowledge to carry out critical and creative thinking (Oktaviani et al., 2021).

Higher order thinking skills also has a close relationship with the ability to think in the cognitive, affective, and psychomotor fields, which are inseparable elements in a learning process. Students at higher levels such as high school are expected to have achieved high-order thinking (Nisa et al., 2018). However, the use of C1-C4 indicators in learning often results in a lack of development of students' high-order thinking skills (Balqist et al., 2019).

Students are given the chance to actively engage in the learning process, which helps them develop skills in discovering concepts and solving problems (Rudibyani & Perdana, 2018). Learning models are crucial in the educational process, and selecting an appropriate model can boost students' interest and motivation, thereby enhancing their comprehension of the material (Palupi et al., 2018). Constructivist learning is especially effective in science education, including chemistry. The discovery model, which emphasizes exploring concepts and honing problem-solving skills, is one such effective approach (Rudibyani & Perdana, 2018).

Discovery learning is a learning pattern that occurs when learning material is not given to students in its final form, but rather they are expected to be able to organize it themselves (Surya, 2020). Students are encouraged to actively seek knowledge that has not been taught by the teacher. In general, students build concepts and generalizations from the findings they obtain. Although students actively learn on their own, of course they always need teacher supervision (Susriani, 2021). The research focuses on developing high-order thinking skills in students through the use of the discovery learning model. This approach is intended to prepare students to meet the demands of the workforce, adapt to rapid advancements, and address increasingly complex global challenges in the 21st century.

Chemistry is a subject taught at the high school level. As noted by Silaban (2017), chemistry is a branch of natural science that examines the structure and properties of matter and the changes it undergoes. It involves microscopic concepts such as molecular structure, chemical reactions, and complex chemical processes (Siregar & Silaban, 2023). Therefore, the ability to answer a variety of chemical problems including theories, concepts, laws, and facts is necessary. Understanding chemical principles, their linkages, and their applications in technology and daily life is one of the objectives of studying chemistry (Adriani & Septiani Silitonga, 2017).

Buffer solutions are one of the chemical materials that are considered difficult (Sanova et al., 2023). This material is considered difficult because it often involves mathematical calculations and its complex nature. Understanding of the concept of buffer solutions can be obtained well, if the preparation of buffer solution learning is carried out carefully, including in determining strategies and implementing appropriate learning models (Mardiansyah et al., 2022). Students must understand basic materials such as acid-base materials and chemical equilibrium in order to understand buffer solution materials. It is certain that students will have difficulty learning the contents of buffer solutions if they have difficulty understanding both materials (Siregar & Silaban, 2023).

Process discovery learning involves a series of stages, the stages (syntax) in the discovery learning model play a role in building students' high order thinking skills. This learning model trains students to identify problems, formulate hypotheses, and find solutions through exploration. In addition, it encourages students to work together in groups, discuss, and exchange ideas, this is the key to developing high order thinking concepts. The data processing syntax in this model focuses on developing conceptual understanding, especially buffer solution material. Includes understanding the concept of buffer solutions, the concept of acid buffer solutions, base buffer solutions, and the concept of buffer pH where a small amount of acid or base is added. It is hoped that by implementing the discovery learning model, students' understanding of the concepts in buffer solution material can improve so that they are proficient in answering questions in categories C4-C6 (Nurfauzia et al., 2021).

Previous studies have examined the effectiveness of the discovery learning model in improving higher order thinking skills in chemistry learning. However, most of these studies are still limited to measuring the final results without explaining in detail how each syntax in the discovery learning model contributes to improving each indicator of higher order thinking skills. In other words, the relationship between the stages of learning in discovery learning and the achievement of HOTS indicators has not been explained in depth.

This research is here to provide a new contribution by focusing attention on the relationship between syntaxdiscovery learningand the development of HOTS indicators in more detail. This approach is expected to enrich the understanding of the working mechanism of the learning model in encouraging students' high order thinking skills. In addition, it also has differences in terms of the material being studied. If previous studies have raised more topics such as acids and bases or chemical equilibrium, this study chooses to focus on buffer solution material which is considered relevant and contextual. The material is combined with an approach to everyday life issues to increase the relevance and meaning of learning for students.

Based on the results of teacher interviews at SMA Negeri 2 Tambang, it was found that students have begun to have high order thinking skills but not optimally or there are still many students whose thinking skills are at medium or low levels, this can be seen from the skills of students in solving problems that are analytical, evaluating, and creative. When teachers test high order thinking questions to students, children who have medium to high abilities are found to be able to analyze or answer the questions, but some of them who have medium to low abilities have not been able to solve the questions. Currently, schools have implemented the independent curriculum, the independent curriculum is designed to improve students' high order thinking skills. However, there are still obstacles including how teachers implement it effectively. The teacher's ability to understand and apply the independent curriculum greatly influences the success of students in achieving high order thinking skills, for this reason the selection of the right learning model and in accordance with the current learning context must be considered.

Based on the problems that have been explained, teachers play a very large role in achieving learning objectives and in honing students' high-order thinking skills. The researcher formulated the title of this study, namely "The Effect of Discovery Learning Models on Student Higher Order Thinking Skills on Buffer Solution Material". This study is expected to provide answers and solutions to the problems that are the basis of this study, thereby improving students' high-order thinking skills, especially in buffer solution material.

METHODS

Research Design

This research uses a quasi-experimental design and a quantitative methodology. It makes use of a pretest-posttest non-equivalent control group design, namely. Prior to starting treatment, a pretest is part of this research design. The existence of a pretest takes into account the degree of group equality. In this particular context, the pretest serves as a statistical control measure and sheds light on how treatment affects score attainment. The study design is displayed in Table 1 below:

Table 1. Research design *pretest-posttest*

Class	Pre-test	Treatment	Post-test
Experiment	P_1	Q_1	P_2
Control	P_3	Q_2	P_4

Information:
P_1 = Pretest results of the experimental class
P_2 = Post-test results of the experimental class
P_3 = Pretest results of control class
P_4 = Post-test results of control class
Q_1 = Treatment in the experimental class with the discovery learning model
Q_2 = Treatment in the control class with a conventional model (Kurniawati, 2021).

Research Target

This study was carried out in the even semester of the 2023–2024 school year at SMA Negeri 2 Tambang. Every research subject made up the population (Priadana & Sunarsi, 2021). Each of the four classes comprising 143 students in class XI chemistry at SMA Negeri 2 Tambang served as the study's population. The population includes the sample (Priadana & Sunarsi, 2021). Two classes were chosen for the study: XI.1 was the control class and XI.2 was the experimental class. The sampling technique used cluster random sampling by selecting two homogeneous classes based on the homogeneity test using the repeat value of the prerequisite material, namely acid base. This technique is used if the population does not consist of individuals, but based on groups of individuals (clusters) (Kurniawati, 2021).

Research Data

This study included both observational data and the outcomes of tests of higher-order cognitive skills. Thirty-six students in the experimental class and thirty-five students in the control group took the tests. The teacher activity sheets, which recorded the application of chemical instruction on buffer solutions, were the source of observational data. In the experimental class, the researchers used the discovery learning model, while in the control class, they used the conventional approach.

Research Instruments

Higher-order thinking skills were measured using essay-style tests developed by the researcher. The instrument underwent two validation stages: content validation by one expert, a lecturer from the Chemistry Education program, involving a total of 16 questions. After being deemed valid by the validator, the instrument was then subjected to empirical validation, tested on a 12th-grade class at SMA Negeri 2 Tambang consisting of 20 students. The data were analyzed using statistical tests with IBM SPSS Statistics 24 software. The validity test of the questions resulted in 10 valid questions, followed by reliability testing, difficulty level assessment, and discrimination power evaluation of the questions.

The instruments in this study consisted of a high order thinking skills test, an observation sheet for the implementation of teacher activities, and documentation. The high order thinking skills test consisted of 10 essay questions. The observation sheet for the implementation of teacher activities was carried out in both classes, namely control and experiment, this observation sheet was validated by an expert validator by 1 lecturer from the chemistry education study program before being used in the study. Research documentation was obtained from related parties at the school, in the form of students, curriculum, and facts related to high order thinking skills possessed by students obtained from chemistry teachers at SMA Negeri 2 Tambang.

Data Analysis

The data collected from this study are quantitative, including pretest-posttest scores and the percentage of discovery learning model implementation. The pretest and posttest data were analyzed using IBM SPSS Statistics 24 software. A normality test was conducted to determine if the data was normally distributed, a homogeneity test was used to check if the data was homogeneous, and a t-test was employed to assess the impact of the discovery learning model on higher-order thinking skills. The extent of the impact of the discovery learning model on higher-order thinking skills related to buffer solution material can be assessed using the determination coefficient test with the following formula:

$$\boldsymbol{Kp = r^2 \times 100\%}$$

Information:

r^2 : Coefficient of determination

Kp : Influence coefficient

The implementation of learning describes the extent to which the research achieves its objectives in implementing learning strategies in the classroom. Quantitative analysis of the implementation of learning is carried out with the following steps:

1) Identify the frequency of the results of observations of researcher activities for each activity.
2) Calculate the percentage of the frequency of learning implementation by dividing the frequency of each indicator by the total number of frequencies, then multiplying by 100%.

$$Percentage = \frac{Number\ of\ aspects\ implemented}{Total\ number\ of\ aspects\ observed} \times 100\%$$

The categorization of learning implementation is in accordance with the following table.

Table 2. Learning implementation category

No	Percentage (%)	Category
1	$90 < \times \leq 100$	Very good
2	$75 < \times \leq 90$	Good
3	$50 < \times \leq 75$	Currently
4	$25 < \times \leq 50$	Not enough
5	$0 < \times \leq 25$	Very less

(Ramadhana & Hadi, 2022)

RESULTS AND DISCUSSION

This research was conducted with 71 11th-grade chemistry students at SMA Negeri 2 Tambang, divided into two groups: an experimental class and a control class. The objective of the study was to evaluate the effect of the discovery learning model on students' higher-order thinking skills related to buffer solutions at SMAN 2 Tambang.In this study, quantitative data were gathered from higher-order thinking skills tests, which included both pretest and posttest scores, to assess the differences in these skills between the experimental and control classes.

The research also analyzed the impact of the discovery learning model on students' higher-order thinking skills concerning buffer solutions, and measured the implementation percentage of the model in both the experimental and control classes. In this study, the discovery learning model was applied solely in the experimental class to improve students' higher-order thinking skills related to buffer solution lessons, while the control class did not experience this approach. The goal was to evaluate the effect of the discovery learning model on students' higher-order thinking skills, with the assessment conducted after the model had been implemented in the learning process.

Discovery learning is a learning model where students actively discover knowledge that they previously did not know without being told directly, the aim is to help students learn concepts and analytical thinking skills practically (Saturnut, 2022). Through this discovery activity, students' interest in learning chemistry can be increased in a more interesting way than conventional methods (Nurfauzia et al., 2021). According to Bicnell in Asri & Noer (2015), explains three main characteristics of discovery learning such as: 1) investigating and solving problems to create, integrate, and combine knowledge, 2) encouraging students to learn independently, where they determine their own methods and steps, including frequency and sequence, 3) Activities to encourage the integration of principles using existing knowledge as a foundation for developing new knowledge. In this discovery learning model, students are given the opportunity to investigate, draw conclusions, make guesses, use intuition, and experiment (trial and error) freely (Susriani, 2021).

The discovery learning model implemented by the researcher in the experimental class at SMA Negeri 2 Tambang Kampar is detailed in the table that presents the research results on the stages of the model. The model comprises six stages of learning: (1) stimulation, (2) problem statement/identification, (3) data collection, (4) data processing, (5) proof, and (6) conclusions/generalization (Kusumaningtyas et al., 2020).

Table 3. Discussion of the stages of the discovery learning model

Discovery Learning Stage	Student Learning Activities	Teacher assistance	Documentation
Stimulation (stimulation/giving stimulation)	a. Observing pictures of acidic drinks/canned food (narrative related to buffer solutions in acidic drinks in the worksheet) b. Reading reference sources (books) c. Form study groups according to teacher's instructions	a. Seeing a picture of a sour drink as a stimulus b. The teacher gives a brief description of the stimulus displayed. c. Give some questions to students d. Conditioning students to read a number of reference sources e. Conditioning students to focus on the next learning activity, namely working on LKPD in groups.	 
Problem statement (Problem statement/ identification)	a. Identifying the problem that occurred b. Formulate problem questions from the problem focus	a. The teacher gives students the opportunity to identify problems that occur based on the results of their reading. b. The teacher gives students the opportunity to choose and determine	

Discovery Learning Stage	Student Learning Activities	Teacher assistance	Documentation
		hypothetical sentences to answer questions that arise from the focus of the problem. c. Guide the discussion	
Data collection (Data collection)	a. Carry out exploration activities in accordance with the instructions in the LKPD	a. The teacher prepares students to collect relevant and appropriate information to answer questions.	
Data processing (Data processing)	a. Processing data by answering questions on the LKPD	a. The teacher directs students to process data and information to formulate answers to questions (problem focus) at the problem statement stage.	
Verification (Proof)	a. Students come forward to give presentations regarding the results of the discussion.	a. The teacher asks students to present the results of their discussions. b. The teacher gives students the opportunity to exchange ideas with each other.	
Generalization (Draw conclusions/ generalizations)	a. Students conclude the results of the discussion to be used as a concept.	a. The teacher guides students to conclude the results of the discussion to be used as a concept. b. The teacher provides clarification to strengthen the conclusions conveyed by the students.	

The use of the discovery learning model, which is the focus of this research at SMA Negeri 2 Tambang in the 11th-grade chemistry class on buffer solutions, has been evident in the students' learning process. Students have become more engaged by actively asking questions, participating in group discussions, identifying and solving problems collaboratively, and drawing conclusions that serve as concepts. Additionally, they have started to manage their time more effectively during the learning process. The implementation of the learning model showed improvement and increased effectiveness at each meeting, as reflected in the percentage values from the observations of teacher activities in both the experimental and control classes.

Table 4. Percentage of results of experimental class learning implementation

No	Meeting	Percentage (P)	Category
1	1st	88.5%	Good
2	2nd	93%	Very good
3	The 3rd	94%	Very good
Average		91.33%	Very good

Table 4 above shows that, in Meeting 1, the proportion of teacher activity in using the discovery learning model was 88.5%, classified as good; in Meeting 2, it was 93%, classified as very good; and in Meeting 3, it was 94%, classified as very good. With every meeting, the discovery learning model's implementation rate went up.

Table 5. Percentage of learning implementation results in control class

No	Meeting	Percentage (P)	Category
1	1^{st}	89.5%	Good
2	2^{nd}	92.5%	Very good
3	The 3^{rd}	93%	Very good
Average		91.67%	Very good

Based on Table 5 above, it can be seen that the percentage of the teacher's activities in applying the conventional model is as follows: 89.5% in meeting 1, categorized as good; 92.5% in meeting 2, categorized as very good; and 93% in meeting 3, categorized as very good. The percentage of implementation of the conventional learning model also increased in each meeting.

Experimental and control classes received different treatments. However, based on the results of observations of teacher activities in both experimental and control classes, a very good category was obtained. This means that teachers have carried out the learning process as optimally and as well as possible in the classroom based on the steps in each learning model that has been prepared. The data above were obtained from the results of observation sheets assessed by observers regarding the implementation of teacher activities in both classes. This will refer to the results of students' high order thinking skills obtained from the influence of the application of learning models in both classes.

The study began with a pretest. The pretest is an initial assessment given to determine students' higher-order thinking skills and to ensure that both classes have similar levels of these skills before any treatment is applied. The average pretest score for the experimental class was 7.01, while the control class had an average pretest score of 6.93. After confirming that there was no significant difference in pretest scores between the two sample classes, each class was then given different treatments. Students' higher-order thinking skills were measured using essay tests, which included both pretests and posttests. The results of the essay tests can be seen in the following table.

Table 6. Pretest and posttest values of high-order thinking skills

Information	Experimental Class		Control Class	
	pretest	*Posttest*	*pretest*	*Posstest*
Highest Value	22.50	92.50	20.00	92.50
Lowest Value	0	62.50	0	55.00
Average	7.01	80.21	6.93	72.64

Based on the data in Table 6, the average post-test score for higher-order thinking skills in the experimental class was 80.21, whereas the control class had an average score of 72.64. This indicates a difference in average scores between the experimental and control classes. This difference is attributed to the learning models used: the experimental class employed the discovery learning model, while the control class used a conventional model. The application of the discovery learning model involves student participation in group work, discussions, and problem-solving activities. The difference in average higher-order thinking skills scores between the experimental and control classes can be seen in Figure 1 below.

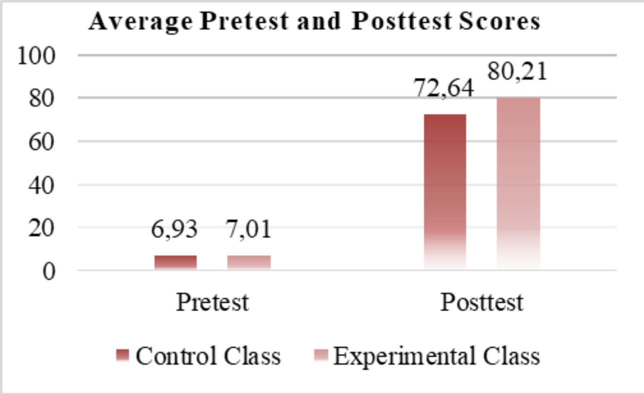

Figure 1. Average Score Diagram of Pretest-Posttest of Experimental and Control Classes

In the experimental group, the average post-test score for higher-order thinking skills was 80.21, while in the control group it was 72.64. Because the experimental class utilized the discovery learning model and the control class used a conventional model, there was a difference in the average scores between the two classes. The two classes differed by 0.08 on the pre-test, however there was a 7.57 difference on the post-test results. This indicates that pupils in the experimental class had higher-order thinking abilities than those in the control group.

The difference in the average post-test scores can also be observed through the independent sample t-test. This t-test was conducted to test the hypothesis regarding the impact of the discovery learning model on higher-order thinking skills by examining the significant difference between the post-test results of the experimental class, which used discovery learning, and the control class, which used conventional teaching methods on the buffer solutions topic. The results of the t-test are presented in the table below.

Table 7. Independent Sample t-Test

	Sig.(2-tailed)
Posttest Results	0.002

When tcount > ttable, the hypothesis must be accepted by rejecting Ho and accepting Ha. However, the significant value (Sig) from the tcount findings is used to determine the hypothesis in the t-test using SPSS software version 24. Ha is approved while Ho is rejected if Sig (2-tailed) < 0.05. In contrast, Ha is rejected while Ho is approved if Sig (2-tailed) ≥ 0.05. Testing was done on both the experimental and control groups in this study. The experimental class's average post-test score was 80.21, while the control class's was 72.64.

Based on the data in Table 7, the t-test analysis of post-test data for the experimental class and the control class yielded a Sig. (2-tailed) value of 0.002. The Sig. (2-tailed) value is smaller than the significance level of 0.05 (0.002 < 0.05). Thus, the t-test results indicate a significant difference between the experimental and control classes. Therefore, it can be concluded that the average higher-order thinking skills of students taught using the discovery learning model are higher than the average higher-order thinking skills of students who were not given the same treatment, proving that the discovery learning model has an effect on students' higher-order thinking skills on the topic of buffer solutions.

The higher-order thinking skills indicators measured in this study are analysis, evaluation, and creation. The percentage of achievement for each higher-order thinking skills indicator can be seen in Figure 2 below.

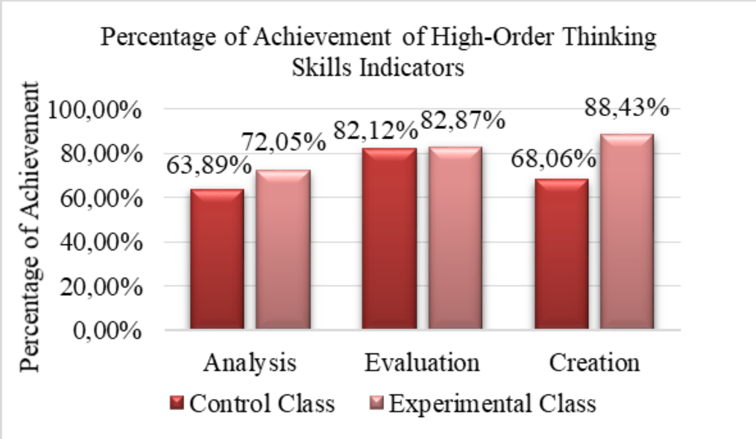

Figure 2. Percentage of Achievement of High-Order Thinking Skills Indicators

The first indicator measured in this study is analysis. Analysis is the process of using data to group, classify, and find relationships between information, including facts, concepts, arguments, and conclusions (Nafiati, 2021). The data above shows the percentage of achievement of analysis indicators in the experimental class is 72.05%, while in the control class it is 63.89%. The high percentage of achievement of analysis indicators in the experimental class is due to the use of the discovery learning model. In chemistry subjects, students will often and even become accustomed to critical thinking and high order thinking activities. This is due to the need for chemistry learning for in-depth analysis in finding answers to each phenomenon studied (Susriani, 2021). This is supported by research showing that the discovery learning model can improve high order thinking skills. This model encourages students to be active in the learning process by finding and investigating their own concepts, so that the new knowledge gained is more durable because it involves the thinking process rather than just memorizing. In addition, students learn to think analytically and solve problems faced, which are then applied in real life (Oktaviani et al., 2021). In the stimulation syntax, students are faced with an issue that demands a critical attitude from students to question and doubt a truth so that high order thinking skills emerge in students (Paputungan et al., 2022).In addition, in the syntax of identifying problems and processing data in the discovery learning model, students are required to analyze the problems themselves and find solutions from the data that has been collected. Therefore, students are trained in working on analytical test questions (C4).

The second indicator of high order thinking skills measured in this study is the evaluation indicator. Evaluation is an activity of making considerations based on criteria or standards (Ariyana et al., 2018). Subcategories for evaluation include proving, validating, projecting, reviewing, testing, reviewing, examining, criticizing, etc.(Nafiati, 2021). Based on the data, it can be seen that the percentage in the experimental class is 82.87% and in the control class is 82.21%. The difference in the evaluation indicator percentages between the two classes was relatively small. This result was influenced by the teacher’s approach in the control class, which provided engaging instruction not only through direct explanation but also by presenting challenging questions that stimulated students' critical thinking and evaluation skills. Although an innovative learning model was not formally implemented, the teacher’s structured questioning strategy contributed to the development of students’ evaluative abilities. Nevertheless, the experimental class still achieved higher scores than the control class. This was due to the implementation of the discovery learning model. One of its key syntax stages, the verification phase, trained students’ evaluative skills through careful examination of previously formulated hypotheses by relating them to known chemical phenomena and data analysis results (Pranoto, 2023). So that students' evaluation skills develop well when they encounter questions that have the cognitive domain C5 (evaluation).

The third indicator of high order thinking skills is creation. Creating is the activity of arranging or connecting parts into a new whole, as well as reformulating existing formulations (Nafiati, 2021). The percentage of achievement of the creative indicator in the experimental class is higher than the control class. Based on the data, it can be seen that the percentage in the experimental class is 88.43% and in the control class is 68.06%. The high percentage of achievement of the creative indicator in the experimental class is due to the use of the discovery learning model. This creative activity requires creativity in it, as this is in line with the definition of creativity. Creativity is the ability to produce new ideas or different ideas, which are reflected in the mindset when looking for solutions to solve problems (Saputra, 2020). This is supported by research (Rudyanto, 2016)which explains that discovery learning requires students to discover new things. This discovery process requires creativity, so that the discovery learning model and its syntax can improve students' creative thinking skills. This creative thinking skill is one type of high order thinking skill (Ahmar, 2016). Based on the percentage data of HOTS indicator achievement, it can be seen that the creation indicator has the highest percentage, this is because the discovery learning syntax greatly supports the improvement of creation skills (creativity). The syntax that contributes the most to improving creation skills (creativity) is stimulation and generalization. The stimulation stage triggers curiosity and encourages students to actively seek information and generate new ideas. Then, the generalization stage allows students to apply the knowledge gained and develop creative solutions to broader problems.

Discovery learning proven to improve each HOTS indicator, seen from the percentage of student achievement results for each indicator. The stages (syntax) in the discovery learning model are what play a role in building students' high order thinking skills. The beginning of learning begins with the stimulation stage. The teacher involves students in providing basic explanations according to what they have understood and obtained previously, either through an incident experienced or reading material that has been read. In this step, the teacher provides students with assistance to be able to explain the initial ideas they have to make them more complete. This is done by identifying and considering possible answers to a problem and problems from stimulation found in everyday life.

The implementation of the discovery learning learning model has proven effective in improving student achievement in each indicator of higher order thinking skills (HOTS). This can be seen from the increase in learning outcomes in each HOTS indicator after the learning process takes place. The syntax or stages in the Discovery Learning model play an important role in building students' critical, analytical, and reflective thinking skills, especially in understanding chemical concepts such as buffer solutions.

Learning begins with a stimulation stage, where the teacher gives trigger questions related to everyday life to arouse students' curiosity. For example, questions such as, "Why does blood pH remain stable even though we consume acidic or basic foods?", or "Why can canned food last a long time without spoiling quickly or changing taste, even though it is not stored in the refrigerator?" These kinds of questions help students connect concrete experiences with the concept of buffer solutions. The teacher also provides direction so that students are able to express initial ideas systematically as a basis for further exploration.

In the data collection and processing stage, students analyze the information presented in learning activities independently or in groups. Through structured guidance, they examine examples of buffer solution systems, compare pH changes under various conditions, and answer guiding questions that encourage them to think logically and objectively. Although it does not involve direct experiments, this activity still allows students to develop the ability to conclude meaning from the data and situations analyzed.

The verification stage is an opportunity for students to review their understanding. They evaluate how buffer solution systems—such as CH_3COOH/CH_3COO^- or NH_4^+/NH_3—can maintain pH stability when strong acids or bases are added. Students convey their reasoning in writing and orally as a form of reinforcement for the concepts they have learned.

Next, in the generalization stage, students draw conclusions from a series of activities that have been carried out. They are able to identify the characteristics of buffer solutions, explain their working principles, and relate them to biological and environmental contexts. This process shows that students have been able to develop conceptual understanding independently and in a structured manner.

Overall, the application of Discovery Learning in learning encourages students to be active, reflective, and involved in the process of building knowledge. Students are trained to identify problems, formulate hypotheses, analyze data, and draw conclusions, so that they are accustomed to high order thinking. Although learning is carried out without laboratory experiments, the exploratory process that is carried out remains effective in fostering high order thinking skills, especially in analyzing (C4), evaluating (C5), and creating (C6) in the context of buffer solution material.

Based on the improvement in higher-order thinking skills, it can be observed that there was an increase in both classes. However, the percentage increase in higher-order thinking skills of students in the experimental class was higher compared to the control class. This proves that teaching chemistry using the discovery learning model can enhance students' higher-order thinking skills better than conventional teaching methods. Furthermore, the extent of the effect of the discovery learning model on students' higher-order thinking skills on the topic of buffer solutions can be seen from the following test results.

Table 8. Test of determination coefficient

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.360[a]	.130	.104	8.282

The analysis of the coefficient of determination test in the experimental class treated with the discovery learning model produced an r2 value of 0.130 so that the Kp value obtained was 13%. The purpose of this coefficient of determination test is to determine how much influence the learning model that has been applied has on the high order skills of students in the experimental class. The achievement of high order thinking skills is not only influenced by the learning model used, but also by various other interrelated factors. Among them is the availability of adequate facilities and learning resources. A learning environment rich in information, both in digital and physical forms, allows students to explore concepts more deeply and independently. In addition, a conducive classroom climate also plays an important role. A classroom atmosphere that supports active participation, provides space for students to express opinions, ask questions, and discuss openly, will trigger a more complex thinking process. Another factor is the involvement of teachers as learning facilitators. Teachers who are able to provide constructive feedback, ask challenging questions, and encourage students to reflect on their understanding, contribute significantly to shaping students' high order thinking skills.

Nevertheless, the use of the discovery learning model still provides a significant contribution. Although in this study, the influence of the discovery learning model on HOTS may not be dominant in percentage, its existence remains relevant and supportive. This shows that a structured learning approach through the stages of discovery learning remains an important component in encouraging the development of students' high order thinking skills, especially if applied in a supportive learning environment. Overall, the discovery learning model can have an influence on students' high order thinking skills on the material of buffer solutions.

CONCLUSION AND RECOMMENDATIONS

The research conducted in the 11th-grade chemistry class at SMA Negeri 2 Tambang showed that the implementation of the discovery learning model has an effect on students' higher-order thinking skills on the topic of buffer solutions. This can be seen from the t-test calculation, which resulted in a significance value of 0.002, which is less than 0.05, indicating that the alternative hypothesis (H_a) is accepted and the null hypothesis (H_0) is rejected. A significant difference in the higher-order thinking skills between the experimental class, which received treatment using the discovery learning method, and the control class, which used a conventional model, can be observed from the average post-test results: 80.21 for the experimental class and 72.64 for the control class. The discovery learning model influences the higher-order thinking skills of 11th-grade students on the topic of buffer solutions at SMA Negeri 2 Tambang by 13%..

Based on the research results, the researcher suggests implementing the discovery learning model in teaching, as it can enhance students' higher-order thinking skills and serve as a variation in classroom instruction. For future researchers, it is recommended to conduct studies on other chemistry topics or in other subjects that have the potential to develop higher-order thinking skills.

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