UPAYA PENINGKATAN HASIL BELAJAR KIMIA SISWA MELALUI MODEL DISCOVERY LEARNING PADA BAHAN TITRASI ASAM BASA

Diyani Wahyu Ningsih¹, Muchlis², Suci Suti’ah³
Jurusan Kimia FMIPA
Universitas Negeri Surabaya
diyaniwahyun@gmail.com¹, muchlis@unesa.ac.id²

Abstrak
Penelitian ini bertujuan untuk mengetahui peningkatan hasil belajar dengan penerapan model Discovery Learning (DL) pada materi titrasi asam basa. Penelitian ini dilakukan pada siswa tahap F khususnya kelas XI kimia 2 yang berjumlah 35 siswa. Metode penelitian ini adalah Penelitian Tindakan Kelas yang terdiri dari 2 siklus yang setiap siklusnya 1 pertemuan. Hasil yang diperoleh dalam penelitian ini adalah hasil belajar siswa. Pada siklus I jumlah siswa yang telah mencapai KKM sebanyak 15 siswa (42,8%). Pada siklus II jumlah siswa yang telah mencapai KKM sebanyak 29 siswa (82,8%). Terjadi peningkatan persentase ketuntasan dari siklus I ke siklus II sebesar 40,0%.

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Abstract
This study aims to determine the improvement of learning outcomes by applying the Discovery Learning (DL) model on acid-base titration material. This research was conducted on phase F students, especially in class XI chemistry 2 totaling 35 students. This research method is Classroom Action Research consisting of 2 cycles of each cycle 1 meeting. The results obtained in this study are the learning outcomes of students. In cycle I, the number of students who have reached the minimum completeness criteria is 15 students (42.8%). In cycle II, the number of students who had reached the minimum completeness criteria was 29 students (82.8%). There was an increase in the percentage of completeness from cycle I to cycle II by 40.0%.

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INTRODUCTION

The learning process is an activity carried out based on the curriculum in an educational institution to influence students to achieve educational goals. In the learning process, teachers can deliver material and provide learning facilities while students understand the material taught [1]. Education in the 21st century emphasizes understanding skills, character education, learner-centered which involves the activeness of students to explore all the potential talents they have. Chemistry learning is one of the branches of natural science that studies the nature of substances from atomic to molecular scales that are abstract and for students who cannot visualize the material. So that in learning chemistry, intermediary media such as images, videos, animations are needed to visualize the material so that students understand [2]. Acid-base titration material is high school class XI material that is difficult for most students because it is abstract. Learners describe the neutralization process between mixing a compound solution that does not produce a product and does not have a written reaction equation. This material is related to the level of retention or the ability to recall the material that has been learned by Windura in [3].

Based on the results of observations and interviews in class XI Chemistry-2 one of the high schools in Sidoarjo district many students still do not understand the concept of acid-base titration well. Difficulty in distinguishing types of titration, calculating pH titration and drawing graphs. The percentage of achievement of student learning outcomes is still less than 50% of the KKM value. This shows the low learning outcomes of students. This is in accordance with research [3] which states that as many as 53.33% of students have difficulty writing equations and equalizing reactions, as many as 70% of students have difficulty determining the concentration of acid bases. As many as 86.66% of students have not been able to determine the type of titration based on the curve that has been presented. This is reinforced by [4] which states that as many as 90% of students at SMA Negeri 5 Padang have difficulty understanding acid-base titration material. Based on the recap of data values, students get scores below the KKM.

Many factors cause low student learning outcomes in acid-base titration material including: The first is the difficulty of students in understanding the correct concepts. Students have low interest and motivation in learning chemistry, especially acid-base titration material. In observations and interviews, there are students who do not understand calculations related to powers and roots, so they have difficulty in completing calculations on acid-base titration problems. This is in accordance with [5] research that concept is abstract so that students have not mastered, do not understand which causes errors in understanding [5]. Learners experience difficult concepts, even experience concept errors [6]. The involvement of students is very low
during classroom learning, less active in asking and answering questions. In reality, the involvement of active learners plays an important role in determining the success of learning [7]. Lack of motivation to learn because students consider chemistry lessons difficult. Learners who are less motivated in participating in chemistry learning activities tend to be passive when compared to students who have high motivation. Lack of learning motivation is in line with the achievement of low learning outcomes [8]. The ability of students in calculations is still weak because acid-base titration material requires understanding of mathematical concepts. Learners are required to be skilled in operating calculations. This is because students do not know the basics of good mathematics, students do not memorize the pH formula to be used and how to calculate [9].

According to [10], one way to improve the learning process and improve student learning outcomes is by applying a learning model that is in accordance with the characteristics of students and the characteristics of the material. One of the learning models applied is Discovery Learning. In this learning model has characteristics centered on students and the teacher is only a facilitator. The teacher guides by providing opportunities for students to find concepts according to their abilities. Meanwhile, students learn independently and find out the answers to develop their ability to solve learning problems that have been given by the teacher.

According to research [11] that the application of the Discovery Learning model can improve the activity and learning achievement of students on buffer solution material in class XI IPA 2 SMA Negeri 1 Ngemplak. In cycle I cognitive aspects amounted to 63% and increased in cycle II by 81%. While the results of research [12] state that the application of the Discovery Learning learning model can increase the learning activity of students in chemistry class XI MIPA 2 SMA Negeri 3 Singaraja odd semester of the 2018/2019 school year. This is evident in the increase in student learning outcomes in cycle I by 13% from 75% to 88% in the cycle II category.

RESEARCH METHODS

Implementation of class action research XI Chemistry 2 located on Jalan Raya Suko Sidoarjo District Sidoarjo Regency East Java. The implementation time was from May to June 2023. This research was conducted in two cycles or two meetings in one week. The subjects of this study were students of class XI Chemistry-2 as many as 35 children consisting of 20 girls and 15 girls. The object in this study is the learning outcomes of students on acid-base titration material in class XI Chemistry-2 even semester of the 2022/2023 academic year.

The purpose of this study was how to improve student learning outcomes by applying the Discovery Learning model of acid-base titration material in class XI Chemistry 2. Because there are 50% of students still score below the KKM. So that researchers use classroom action
research methods that aim to improve the quality of learning practices. This class action research was carried out in two cycles. Each cycle consists of four stages, namely: planning, implementation, evaluation and reflection [13]. This is in accordance with the steps of research implementation proposed by Kemmis and Mc Taggart, namely the spiral model. Kemmis' planning uses design (planning), action (acting), observation (observing) and reflection (reflecting). This activity is called a cycle of problem-solving activities [14]. In order for the research framework is needed. The research framework is the stages carried out in completing the research. The framework can be seen Figure 1:

![Figure 1 Research plan](image)

In cycle I, the planning stage includes the design of the application of Discovery Learning. The second stage is the implementation of learning in accordance with the design in the teaching module of acid-base titration material sub-chapter determination of concentration and determination of pH of acid-base titration results using the Discovery Learning model. The third stage is observation of the implementation of learning independently in groups. The fourth stage is reflection and evaluation of the learning that has been done using problem-based studies, the results of students' discussion work. Reflecting on the learning outcomes obtained from the pretest and posttest.

In cycle II, the first thing to do is to design new actions based on reflections on cycle I. Designing learning tools that are tailored to the characteristics of students, making assessment instruments and assessing student activities during learning. The second stage is to implement the design that has been prepared in the teaching module with the material of acid-base titration sub-chapter drawing and interpreting the acid-base titration curve according to the calculation results and determining the right indicator by applying the Discovery Learning model. The third stage is observation of the implementation of learning independently in groups and student...
activities. The last stage is reflection and evaluation of the learning outcomes obtained by students from the results of the pretest and posttest II.

Researchers used the experimental method with reference to the posttest-only control design. The psychomotor aspect used is the observation of students when discussing working on LKPD based on Discovery Learning syntax, presenting and giving opinions or answering questions. The cognitive aspect of the data used in this study is the pretest and posttest results of students on acid-base titration material. Students work on posttest questions as many as 10 essay questions, the correct score in the process and the answer gets a value of 10, if the work steps are correct but the final answer is wrong, it gets a value of 5 and if it is not answered it gets a value of 0.

The data analysis technique uses qualitative descriptive analysis. Performed by analyzing and describing the average value of posttest cycle I and II and comparing the percentage of students' completeness in cycle I and cycle II. Researchers reviewed the average learning outcomes and the percentage of learning completeness. Classical learning completeness states that it is successful if the percentage of students who have completed learning to get a score ≥ 75 is greater than or equal to 75% of the total number of students. This agrees with the [15] that the ideal learning completeness for each indicator is 0-100% with a minimum ideal criterion of 75%. To calculate the percentage of classical learning completeness, the formula can be used:

\[ T = \frac{\sum \text{Students complete learning}}{\sum \text{Total learners}} \times 100\% \]

Conclusions are drawn based on the results of the calculation of the average learning outcomes and the percentage of completeness of learning outcomes in cycle I and cycle II. Learning outcomes can be used as recommendations and considerations in making decisions.

RESULTS AND DISCUSSION

Description of Action

This class action research was conducted in the specialization class XI Chemistry-2 one of the high schools in Sidoarjo district using 2 cycles in each cycle consisting of one meeting. Based on interviews conducted with chemistry teachers, the lowest learning outcome is acid-base titration which has a percentage of completeness of 57.3%. There has been no innovation made by the teacher to improve the learning outcomes of students on acid-base titration material.

Based on the results of observations made on May 22-23, 2023, it shows that students are too passive and have difficulty in solving problems that have been presented by the teacher.
During the learning process, it was seen that some students were still chatting with their classmates, daydreaming and even playing online games. This shows that students lack interest in taking chemistry lessons. For this reason, it is necessary to improve the learning outcomes of students by applying the Discovery Learning model to acid-base titration learning.

**Description of Cycle I Action Results**

**Action planning**

At the action planning stage, researchers and teachers planned 2 meetings with an allocation of 5 lesson hours, each lesson consisting of 45 minutes. Researchers compiled lesson plans on complete teaching modules consisting of LKPD, Teaching Materials, Assessments and instruments by applying the Discovery Learning model then submitted to the chemistry teacher for approval. Researchers compiled research instruments which included rubrics for observing student activities during acid-base titration learning and assessments in the form of pretest and posttest questions to measure the cognitive aspects of students by knowing learning outcomes.

The lesson plan for acid-base titration material only measured learning outcomes from the cognitive and psychomotor aspects. Researchers did not measure affective aspects (attitude). Cognitive aspect measurement planning using pretest and posttest. The psychomotor aspect of the assessment of students in carrying out LKPD work, presenting results and giving opinions during acid-base titration learning activities. In the planning stage, namely the preparation of learning devices such as Learning Implementation Plans (RPP), learning media, Learner Worksheets (LKPD), teaching modules, Assessment Instruments, pretest and posttest assessments in the form of 10 essay questions and each number is given a score of 10 wrong answers but the correct working steps get a score of 5 if not done gets a score of 0 and research instruments that will be used at the implementation stage in cycle I and cycle II.

**Implementation of action**

Learning activities that have been designed by researchers and have been approved by teachers are applied in class XI-Chemistry 2 2022/2023 academic year. The implementation of cycle I action was carried out on Tuesday, May 23, 2023 which was the first meeting with a time allocation of 3 JP which each JP was 45 minutes. This first meeting discusses calculating the concentration of unknown solutions and calculating the pH of acids and bases consisting of strong acids with strong bases, strong acids and weak bases, weak acids and strong bases and weak acids and weak bases.

Researchers provide pretest assessments at the beginning of learning to determine the initial abilities of students, followed by a posttest at the end of learning to measure the cognitive aspects. 
abilities of students. During learning activities, researchers made direct observations to measure the psychomotor aspects of students. Researchers measure psychomotor aspects by observing the skills of students in answering LKPD questions, accuracy in answering, presenting results and responding or providing opinions for other groups. The division of this group consisting of 6 learners was carried out heterogeneously in cognitive level, gender, ethnicity. The main function of this heterogeneous group is to ensure that each group member can learn well so that members depend on each other to solve the problems that have been provided [16].

In the core activities according to the syntax of the Discovery Learning model, the first stage is stimulation. Students are given the phenomenon of an analyst who will perform a titration to prove the concentration levels listed on the packaging of an everyday product. For example, HCl in floor cleaners, vinegar acid levels and pH, NH3 levels in ammonia fertilizer and Mg(OH)₂ in ulcer medicine. The solution will be titrated with a titrant. The second syntax is problem statement, students are asked to formulate a problem and hypothesis of the phenomenon. The third syntax is data collecting, students analyze the type of titration and write the reaction equation and titrate concentration. The fourth syntax is data processing, students are asked to calculate the pH of the titration before adding the solution and after adding the solution. Then students draw a titration curve from the calculation of pH and determine the appropriate indicator. The fifth syntax is verification, students are asked to rewrite the hypothesis and analyze the curve that has been presented by determining the type of titration and the appropriate indicator. The sixth syntax is generalization, students are asked to conclude the learning outcomes that have been obtained.

**Action Reflection**

The observation results obtained in the implementation of cycle I can be concluded as follows: First, the lack of time management in working on LKPD is too long so that presentation activities tend to be limited. The second observation is that in guiding the group only partially, there are groups that have not received guidance from the teacher in working on LKPD. The number of group members consisting of 6 learners is less effective in discussion activities in solving the problems presented, only a small part of the group conducts problem solving discussions. So that when the discussion forum there are learners who are busy playing games and do not want to participate in doing the task.

Based on the results obtained, to improve the learning process for cycle II as follows: First, the teacher must be more assertive in managing time, especially when working on LKPD so that it runs according to the time allocation. Organize the time of each activity to anticipate the lack of learning hours due to class transfers such as taking attendance while waiting for the number of students to be complete. The second action is that teachers need to organize more effective
strategies in guiding groups of students fairly. Group division should be done by 4-5 students so that the discussion process is more efficient and avoids group members who do not take part in working on the LKPD. This is in accordance with Slavin (1995) in [16] that cooperative learning is a learning group consisting of 2-5 people with the idea of motivating each other among its members to help each other achieve maximum learning goals. Students' learning outcomes are not optimal and are still below the KKM score.

Based on the results of the reflection of cycle I learning, it is known that the non-achievement of students' learning completeness is influenced by internal and external factors: The first internal factor is that students do not have the interest and motivation to learn. From this, it causes most students to be lazy to learn chemistry and have the opinion that chemistry, especially acid-base titration material, is difficult material to understand. This is in line with research [17] which states that in order for students to obtain optimal learning outcomes, students must like the lesson first. Based on the results of interviews with students who have difficulty in chemistry lessons because when choosing the class of choice only follow friends. Learners admit that they do not have the ability in chemistry, they choose chemistry because of family demands and due to confusion factors when choosing elective subjects. Whereas determining majors that just follow friends can make regrets because it is not in accordance with their talents, interests and preferences.

The second internal factor is a lack of understanding of the concept of complex acid-base titration material, especially in the use of formulas. Some of the difficulties experienced by students in learning chemistry tend to be caused by students not knowing how to learn, difficulty connecting between concepts of previous material with advanced material, and lack of logic, math and language skills. This is in accordance with research [18] that the factor causing student learning difficulties is because students do not understand the supporting concepts of acid-base titration material. The supporting concepts in question are stoichiometric material, acid-base pH, buffers and hydrolysis.

The third internal factor is low mathematical ability, based on the results of interviews students have not been able to calculate the multiplication of powers and roots correctly used in acid-base titration material. This causes students to have difficulty learning acid-base titration and difficulty in solving the problems that have been given [18]. This is in accordance with research [19] as many as 68.3% of students have learning difficulties in buffer solution material which is the calculation of pH and pOH. External factors are the influence of peers, when learning takes place my classmates invite chatting so that students cannot concentrate [20]. Learners who hang out with friends who like to chat or joke have a bad impact, namely lazy learning.

**Action Description of Cycle II Action Results**
**Planning**

Action in cycle II is focused on improving learning in cycle I. The corrective action in question is to improve the quality of learning by managing time in working on LKPD as effectively and efficiently as possible, the division of heterogeneous groups consisting of 4-5 students so that each member can learn and contribute in the group to solve the problems that have been presented and when the teacher guides the group fairly. To improve students' learning outcomes, teachers provide additional for students who do not understand the prerequisite concepts outside of class hours, for example during breaks. Teachers conducting chemistry learning of acid-base titration material are expected to pay more attention to the characteristics of students and the characteristics of the lesson. Teachers also connect the subject matter that is closest to the daily lives of students. At the beginning of the lesson the teacher gives macroscopic motivation to students to increase interest in learning that chemistry is close to everyday life.

**Implementation of Action**

Cycle II was held one meeting for 2x45 minutes. This meeting was held on Thursday, May 25, 2023, discussing how to draw and interpret titration graphs with data obtained from the results of previous acid-base titration calculations and determine the equivalent point and the appropriate indicator. At the beginning before learning, a pretest was carried out first with 5 essay questions and at the core meeting observations were made of the psychomotor of students during the discussion process of working on LKPD based on Discovery Learning syntax, presentation and giving responses to measure the activeness of students. This LKPD contains phenomena that are in accordance with cycle I so that in cycle II it continues the same LKPD with the syntax of data processing-verification and generalization. Closing the learning is done posttest, students answer 10 essay questions with type C3-C4 about acid-base titration that has been studied.

**Action Reflection**

Based on the results obtained in cycle II actions, significant improvements were obtained from each aspect measured. It can be concluded that the application of the Discovery learning can improve the learning outcomes of students. reflection actions taken based on the learning that has been done include: time management is good, and teachers can guide groups in discussion activities intensely and fairly.

**Results and Discussion**

Based on the results of observations and the results of pretest and posttest assessments during the cycle I learning process can be seen in figure 2:
Figure 1. Results of Observation Student Activity Learning Cycle I

Figure 2 shows that in cycle I there were still many students who were passive in the learning process. In the learning process, learners are only able to ask questions and provide responses as they are while learners who are less capable in understanding the subject matter and lack confidence do not ask questions. In cycle 1, there were weaknesses in the verification and generalization syntax of Discovery learning. During the discussion forum, students were less active in responding and giving responses to other groups. Learners lack discipline in collecting assignments that have been given by the teacher. When learning takes place there are some learners who are engrossed in playing online games and even chatting.

Whereas in cycle II there was a change in the activeness of learners, active learners increased when compared to cycle I. When the discussion forum or presentation, learners are less active in responding and responding to other groups. During discussion forums or presentations, learners are active in providing responses and input for other groups. Learners in collecting tasks that have been given by the teacher are on time. This percentage has increased by 40% from cycle I.

Table 1. Distribution of Students’ Chemistry Learning Outcomes in Cycle I and II

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>Cycle I Pretest</th>
<th>Posttest</th>
<th>Cycle II Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 25</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>26 – 50</td>
<td>16</td>
<td>2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>51 – 74</td>
<td>13</td>
<td>18</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>75 - 100</td>
<td>4</td>
<td>15</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>Sum</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 2. Descriptive Statistics of Chemistry Learning Outcomes in Cycle I and II

<table>
<thead>
<tr>
<th>Descriptive</th>
<th>Cycle I Pretest</th>
<th>Posttest</th>
<th>Cycle II Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowes Score</td>
<td>0</td>
<td>45</td>
<td>35</td>
<td>60</td>
</tr>
<tr>
<td>Highest Score</td>
<td>80</td>
<td>85</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>Average</td>
<td>52.4</td>
<td>76.8</td>
<td>68.9</td>
<td>80.7</td>
</tr>
</tbody>
</table>
Based on Tables 1 and 2, it can be seen that the average posttest in cycle 1 is still below 75 as the KKM value. This shows that chemistry learning outcomes have not achieved the expected results because of the 35 students whose scores are above the KKM only 15 children and as many as 20 children still get scores below the KKM. The percentage of posttest students who achieved scores above the KKM was 42.8%. Cycle II learning has increased, the number of students whose posttest scores are above the KKM is 29 children and only 6 children still score below the KKM. This shows that the learning outcomes of acid-base titration material have increased. The percentage of students' posttest is 82.8%. Therefore, the research is sufficient until cycle II. A comparison of the percentage of completeness of student learning outcomes in cycle I and cycle II is shown in the following figure:

<table>
<thead>
<tr>
<th>Students Not Completed</th>
<th>31</th>
<th>20</th>
<th>23</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Complete</td>
<td>4</td>
<td>15</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>Percent Completeness</td>
<td>11.4%</td>
<td>42.8%</td>
<td>34.3%</td>
<td>82.8%</td>
</tr>
</tbody>
</table>

Based on Figure 3 above, the percentage of posttests of students who are complete is 82.8%, it can be said that cycle II was successful. Therefore the research was stopped in cycle II and it was proven that the application of the Discovery Learning model which consists of 6 syntaxes, namely stimulation, problem identification, data collection, data processing, proof and drawing conclusions can improve the learning outcomes of students on acid-base titration material. This learning model provides opportunities for students to actively build their knowledge. This is in accordance with research [21] that the application of Discovery Learning can improve student learning outcomes in thermochemistry material. In cycle 1, the percentage of students who had reached the KKM was 52.38% and increased in cycle II by 88.10%. According to [22] in the study stated that there was an effect of increasing student learning outcomes by 93.33% and in the control class by 60%. Supported by [23] that the application of the discovery learning model on temperature and heat material can improve learning outcomes. This is indicated by the increase in the average score of students from 27.97 to 72.50. While the average value of the control class was 29.83 and taught with conventional learning of 65.67.

CONCLUSIONS
Based on the results of data processing and data analysis in the study, it can be concluded that the learning outcomes of class XI Chemistry 2 one of the high schools in Sidoarjo district on acid-base titration material can be improved by applying the Discovery Learning model. Students' learning completeness also increased from 42.8% in cycle I to 82.8% in cycle II. In addition, the application of the Discovery Learning model also increases the activeness of students in discussion forums or answering teacher questions.

LITERATURE


