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Implementation of Discovery Learning to Improve Students' Activities and Learning Outcomes in Basic Laws of Chemistry

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Abstract
This study aims to improve the activities and learning outcomes of students using the discovery learning model on the material of basic laws of chemistry. This research was conducted in Class X.2 of SMA Negeri 6 Surabaya in the 2022/2023 academic year. This type of research is class action research which consists of planning, implementation, observation and reflection. The data analysis method in this study uses the percentage formula and the N-Gain formula. Based on the results of data analysis, it is known that student activities have improved from cycle I to cycle III. The activity of students obtained in cycle I was 54.33%, in cycle II it was 65.66%, and in cycle III it reached 82%. Experienced an improve from cycle I to cycle II by 11.33%, from cycle II to cycle III by 16.33%, and from cycle I to cycle III reached 27.66%. The learning outcomes of students also improved from cycle I to cycle III. From the calculation of the N-Gain formula, it was obtained that the improve in student learning outcomes in cycle I was 0.29 with low criteria, in cycle II it was 0.41 with medium criteria, and in cycle III it reached 0.71 with high criteria. Based on the results of data analysis, it can be concluded that the discovery learning model can significantly improve the activities and learning outcomes of students on the basic laws of chemistry. Thus, the applied discovery learning has a positive impact on the process and learning outcomes of students in each cycle

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INTRODUCTION

Education have a very important role in the process of improving the quality of human resource (Puspadewi et al., 2014). The main problem in learning in formal education (schools) nowadays is the low absorption of students. This can be seen from the average student learning outcomes which are always a cause for concern (Suyono, 2016). Hamalik (2014) suggests, learning outcomes are when someone has learned there will be a change in that person's behavior, For example, from not knowing to knowing, and from not understanding to understanding. To declare that the learning process can be said to be successful, then the learning process that has been implemented must be measured. The measurement of student learning outcomes referred to in this study was carried out through prettest and posttest. In the context of learning activities, learning outcomes will not be seen without learning activities. According to Sardiman in Sofyan (2021) suggests that, learning activities are activities that are both physical and mental. In learning activities the two activities must always be related Meanwhile Hanafiah and Suhana (2009) explained that, learning activities process, both physically and spiritually so that the acceleration of change can occur quickly, precise, easy, and correct, related to cognitive, affective and psychomotor aspects.

Based on the results of observations and interviews with chemistry teachers and students that have been conducted at SMA Negeri 6 Surabaya, information was obtained that many students still have difficulty in understanding the basic laws of chemistry and apply the concept of the basic laws of chemistry both theoretically and computationally, and the low average value of daily exams in chemistry, this shows that students' learning outcomes are still low. Factors that cause low learning outcomes includes: 1) Presentation of material used the conventional method and discussions that make the teacher the center of learning, 2) student involvement (activities) is still low in learning, students are used to just listening to the teacher, 3) lack of motivation of students in learning activities caused by the limited media used, 4) the ability of students on material related to calculations is still weak.

According to Trianto in Listiani (2022), One way to improve the quality of the learning process and results is by the implementation of a learning model that is in accordance with the characteristics of the material and the conditions of the students. The material characteristics of the basic laws of chemistry contain concepts that can be built by students. This is very relevant if the teaching and learning activities use the discovery learning model. The material of the basic laws of chemistry consists of five interconnected concepts (Effendy, 2016). Through discovery learning, students are expected to build knowledge based on new information and collect data in an exploratory learning environment. An exploratory learning environment can be realized through real experiments that are experienced directly by the students themselves, so that the knowledge acquired by students will be more meaningful.

According to Baharudin and Wahyuni in Windasari et al., (2016), discovery learning has several advantages in learning, among others, learners have motivation from within themselves to complete their work until they find answers to the problems they face In addition, students also learn to be independent in solving problems, because they have to analyze and manage information. In this learning, students will exchange opinions and discuss with each other to solve a problem, so that in the final conclusion they will find a concept and principle independently. Learning with discovery learning will encourage students' understanding of a concept to become deeper with higher students' critical thinking skills (Lailasari et al., 2018).

This is supported by several previous studies that the implementation of the discovery learning model has a positive impact on both the process and learning outcomes of students. The results of research using the discovery learning model have been conducted by Suyati and Sutiani (2018) which states that the discovery learning model can improve student learning outcomes in thermochemical material. While the results of research by Hermanto and Winaryati (2018) show that the activities and learning outcomes of students on atomic structure material by applying the discovery learning model have increased. Likewise the research that has been carried out by Sofyan (2021), the results obtained are that the discovery learning is effective in increasing the activities and learning outcomes of students in basic laws of chemistry.

Based on the description above, it is necessary to conduct Class Action Research (PTK) to improve students' activities and learning outcomes. Therefore, the authors conducted a study entitled, "The Implementation of Discovery Learning to improve the activities and learning outcomes of students on the material of the basic laws of chemistry in Class X.2 SMA Negeri 6 Surabaya in the 2022/2023 Academic Year.

METHOD

This type of research is class action research (PTK). This research was conducted collaboratively. This class action research was conducted in 3 cycles. Each cycle consists of four stages of activity: planning stage, implementation stage, observation stage, and reflection stage (Arikunto, 2015). The class action research flow is shown in Figure 1 as follows.

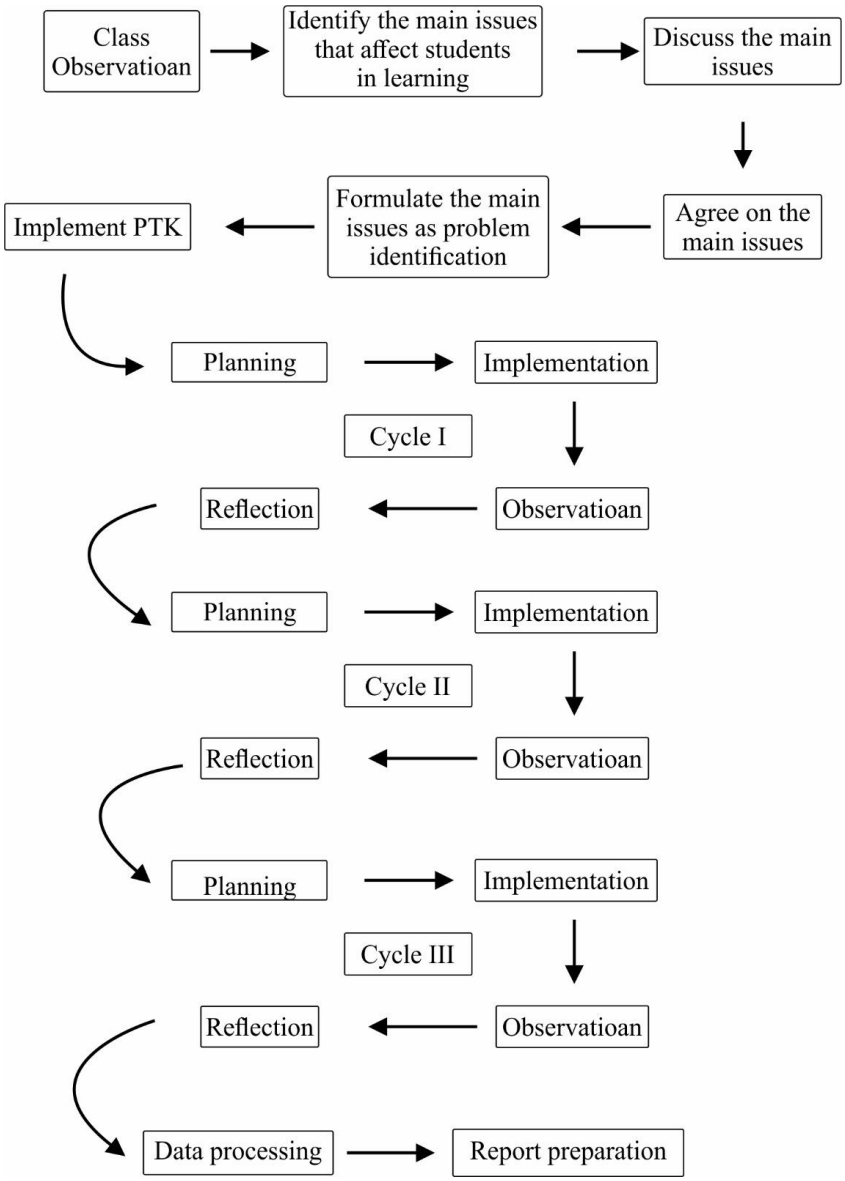

Figure 1. Research flow chart

Research Subject

The subjects of this Class Action Research were 35 of Class X.2 Students of state senior high school (SMAN) 6 Surabaya in the 2022/2023 academic year.

Research Instruments

The instruments in this study are a series of tools used in a study to report the desired data. In accordance with the desired data collection technique, the instruments used are: observation sheet and test.

Data Collection Technique

Observation

The observation technique in this study was used to collect data on students' activities during the learning process.

Test

The test technique is used to determine the learning outcomes of class X students in chemistry subjects on the basic laws of chemistry. The tests used are prettest and posttest for each cycle.

Data Analysis

Student Activities

To find out the increase in learner activity, it can be seen from the increase in learner activity carried out in each cycle The formula used to analyze student activities data.

$$S_n = \frac{\sum Xn}{N} \text{ x } 100\%$$

Source: (Ramadhan, 2019)
Description:
S_n : Percentage of the number of students who do certain activities each cycle
$\sum X_n$: The number of students who carry out certain activities each cycle
N : Total number of students

Learning Outcomes

To determine the improvement of students' cognitive learning outcomes, it can be seen from the increase in prettest and posttest scores for each cycle through the N-Gain index value. The equation for determining the gain index value is as follows:

$$\text{N-Gain: } \frac{Spost - Spre}{Smaks - Spre}$$

Description:
Smaks : Maximum score
Spre : Average prettest score
Spost : Average posttest score
The results of the calculation of the gain value are then interpreted into table 1.

Table 1. N-gain Grouping Criteria

Gain Value	Category
$g \geq 0,7$	High
$0,7 > g \geq 0,3$	Medium
$g < 0,3$	Low

Source: (Riduwan & Akdon, 2013)

RESULTS AND DISCUSSION

Student Activities

Based on the results of the study, the activities of students through the discovery learning model have improved every cycle. The enhancement can be seen in Table 2. It can be seen that the activities of students have improved from cycle I to cycle III. Based on the results of the study, the data on student activities obtained in cycle I reached 54.33%, in cycle II 65.66%, and in cycle III 82%, and improved from cycle I to cycle II by 11.33%, cycle II to cycle III 16.33%, and cycle I to cycle III reached 27.66%. it can be explained that the details of the observed student activities are as follows.

Participate in Group Learning

Based on the data obtained, the data on students' activities in participating in group learning reached 65% in cycle I, 75% in cycle II, and 85% in cycle III, and improved from cycle I to cycle II 10%, cycle II to cycle III 10%, and cycle I to cycle III 20%. The data shows that students' participation in group learning has improved in each cycle, this is because the teacher intensively provides explanations, guidance, and motivation to all students so that they are not selfish, cooperate with each other, and share ideas in their groups to achieve common goals in

the group. This is in line with research conducted by Nurhamidah et al., (2022) that learning will run well and be fun if we as teachers always provide direction, guidance, motivation and can explore the potential that exists in these students. In addition, at the data processing stage, the teacher reminds that in group activities, cooperation between group members is needed, because there is an individual assessment. The teacher also told the group leader to divide the tasks to each group member so that they have their own responsibilities. This action was effective in shortening the time used in the data processing phase in cycle III, students became more serious in working together to solve problems by knowing their respective roles.

Table 2. Student Activities Cycle I, II, and III

No	Observed activities	Cycle			Improvement of each cycle		
		I	II	III	I to II	II to III	I to III
1	Participate in group learning	65%	75%	85%	10%	10%	20%
2	Pay attention to the teacher's explanation	56,66%	70%	81,66%	13,34%	11,66%	25%
3	Answer the Questions	55%	66,66%	86,66%	11,66%	20%	31,66%
4	Expressing Opinion	45%	56,66%	80%	11,66%	23,34%	35%
5	Asking Questions	50%	60%	76,66%	10%	16,66%	26,66%
Amount		271,66%	328,32%	410%	56,66%	81,66%	138,32%
Average		54,33%	65,66%	82%	11,33%	16,33%	27,66%

Pay Attention to The Teacher's Explanation

Based on the data obtained, the data on students' activities in paying attention to the teacher's explanation reached 56.66% in cycle I, 70% in cycle II, and 81.66% in cycle III, and improved from cycle I to cycle II 13.34%, cycle II to cycle III 11.66%, and cycle I to cycle III 25%. The data shows that students are very enthusiastic in participating in the learning process. This is realized because in learning the teacher always pays attention to the condition of the students, the teacher provides feedback as often as possible at the stimulus stage, and the right explanation at the verification stage and the conclusion stage so that no misconceptions occur, so that the activities of students in paying attention to the teacher's explanation can be focused.

Answer the Questions

Based on the data obtained, the data on students' activities in answering questions from the teacher reached 55% in cycle I, 66.66% in cycle II, and 86.66% in cycle III, and experienced an improvement from cycle I to cycle II 11.66%, cycle II to cycle III 20%, and cycle I to cycle III 31.66%. The data shows that students are enthusiastic about answering questions. This is realized because in learning the teacher provides phenomena in the stimulus stage with a contextual approach that is in the environment of students such as the reaction of wood, water, and the reaction of vinegar and baking soda, so that students easily answer construct questions given by the teacher. According to Andriani et al., (2019), the use of a contextual approach can encourage students to connect their knowledge with its application in everyday life. In addition, there is a class agreement in the form of giving gifts from the teacher in the form of points for students who answer questions from the teacher.

Expressing Opinion

Based on the data obtained, data on students' activities in expressing opinions were obtained, namely 45% in cycle I, 56.66% in cycle II, and 80% in cycle III, and experienced an improvement from cycle I to cycle II 11.66%, cycle II to cycle III 23.34%, and cycle I to cycle

III 35%. With the discovery learning model at the problem identification stage, students are asked to make hypotheses related to the phenomenon displayed by the teacher at the stimulus stage, thus encouraging students to think critically. Before expressing opinions, there is a class agreement between students and teachers, namely students who express will be rewarded by the teacher in the form of points, this can improve the motivation of students. The improvement in each cycle is because the teacher emphasizes to students the importance of the ability to express opinions in public because opinion is one of the important assessments in this learning. Arguing train students to communicate well. Mardhatillah et al., (2023) states that the discovery learning effectively train and improve students' oral communication skills.

Asking Questions

Based on the data obtained, the data obtained on the activities of students in asking questions were 50% in cycle I, 60% in cycle II, and 76.66% in cycle III, and improved from cycle I to cycle II 10%, cycle II to cycle III 16.66%, and cycle I to cycle III 26.66%. This can happen because the teacher provides phenomena in the form of pictures of burning wood and videos of burning gasoline in the stimulus phase that attracts students to ask questions. By attracting students' interest, it will motivate them to ask. This is in accordance with research conducted by Nurhamidah et al., (2022) that the discovery learning model is a learning model that can arouse interest and change from receiving to finding information yourself. In addition, the researcher emphasized that each learner in each group must express their questions and ideas, that courage in speaking is important in the learning process in class, by asking questions, the understanding of the material will increase by mastering the material.

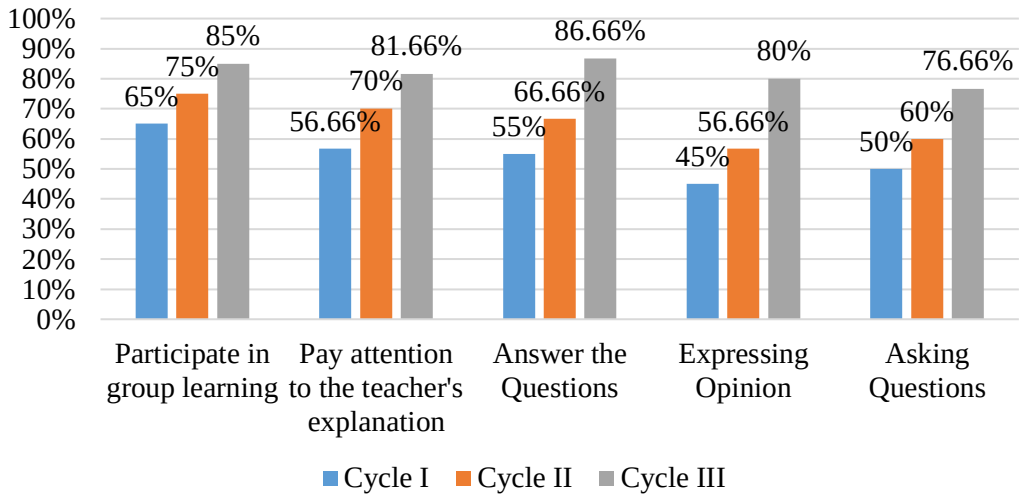

Figure 2. Improvement in The Activities of Students in Cycle I, II and III

The improvement in students' learning activities is due to many factors, including the discovery learning model which requires students to be more active in finding concepts & materials, discussion activities that train students to be active in the learning process. With discussions, students are more courageous in expressing opinions, responding to statements from both friends and teachers, and asking questions about things that have not been understood (Desti, 2019). In addition, discussion activities train students to work in groups, so that students are not only able to work individually. Data on the improvement of students' activities in cycles I, II and III can be visualized in the diagram on Figure 2.

Student Learning Outcomes

Based on the results of research conducted in class X.2 SMAN 6 Surabaya on the material of the basic laws of chemistry using the discovery learning model, during the learning process as a whole from cycle I, cycle II and cycle III, the following data were obtained.

Table 3. Data on Student Learning Outcomes Cycle I, II and III

No	Cycle	Average		N-Gain	Category
		Prettest	Posttest		
1	I	55,71	68,57	0,29	Low
2	II	56,25	74,30	0,41	Medium
3	III	56,94	87,50	0,71	High

Based on these results, it is known that the learning outcomes of students after being given action have improved every cycle. The data obtained, namely, in cycle I the prettest results were 55.71 and the posttest results were 68.57, an improvement of 0.29 in the low category. In cycle II, the prettest results were 56.25 and the posttest results were 74.30, an improvement of 0.41 in the medium category. While in cycle III the prettest results obtained were 56.94 and the posttest results reached 87.50, an improvement of 0.71 with a high category.

The data above also shows that the improvement in learning outcomes (N-Gain) of students also improved each cycle. Based on the data above, it is proven that learning using discovery learning, which consists of 6 stages, namely stimulation, problem identification, data collection, data processing, verification, and conclusion making, can improve students' learning outcomes on the material of basic laws of chemistry. This is because the discovery learning model is learning that provides opportunities for students to actively participate in building the knowledge they will gain.

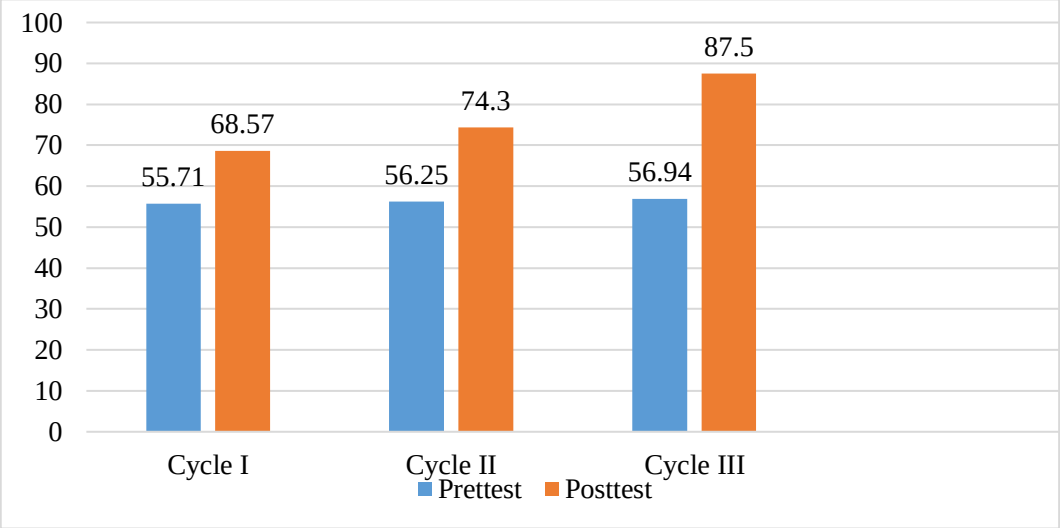

Figure 2 Diagram of Student Learning Outcomes Cycle I, II and III

The discovery learning model consists of stages that can bring students to think critically, analytically and systematically in solving problems as a process of concept formation. In discovery learning, learners are not given the concept in its final form, but learners are invited to participate in finding the concept. Learners build knowledge based on new information and data sets that they use in learning (Hermanto and Winaryati, 2018).

Another research conducted by Nugrahaeni et al., (2017) showed that the cognitive learning outcomes of students improved by implementing the discovery learning model. Meanwhile, research conducted by Apsari (2022) showed that the implementation of discovery learning can improve students' learning activities and achievements in chemistry learning in each cycle. Similarly, research conducted by Istiana et al., (2015) stated that learning that applies discovery learning has a positive impact on the learning process as seen from the improvement in the class average score which improves every cycle. Data on learning outcomes of students in cycle I, cycle II and cycle III, the N-Gain value can be visualized in the diagram below.

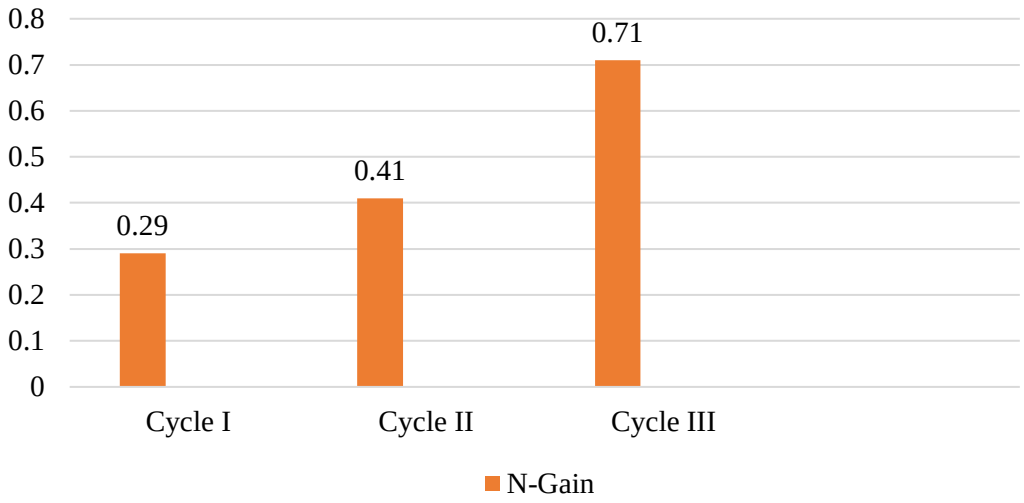

Figure 4. The Improvement N-Gain Value of students learning outcomes in cycle I, II and III

The improvement in student learning outcomes from cycle I to cycle II is because teachers used the discovery learning model in combination with actions that are more focused on refining and improving the obstacles that arise and have not been resolved in cycle I. The actions taken were as follows: First, changing groups according to the learning results (posttest) of cycle I. Second, the use of interactive media so that students can easily understand the material in the form of burning videos at the stimulus stage and providing learning videos at the data collection stage. By giving videos, students are more interested and enthusiastic about learning. Third, teachers pay more attention to students who are having difficulty and provide more opportunities for students to ask things that have not been understood. Fourth, teachers encourage learners who are still shy to ask questions to ask questions. Fifth, teachers motivate students to continue learning because at the end of each meeting there is always an evaluation (posttest). Likewise, the improve in student learning outcomes from cycle II to cycle III occurred because the teacher again used the discovery learning model in combination with actions to refine and improve the obstacles that arose and had not been resolved in cycle II.

The actions taken are as follows: First, the division of groups remains based on the results of the posttest, for group formation in cycle III based on the posttest in cycle II. Second, the use of learning media in the form of experimental videos about vinegar and baking soda in the stimulus stage, providing video material in the data collection stage then giving quizizz games after the generalization / conclusion stage. The purpose of giving quizizz games is to improve students' motivation and learning outcomes. This is supported by research conducted by Erwandi (2021) which shows that quizizz can improve student motivation and learning outcomes. Likewise, research conducted by Dewi et al., (2021) shows that the implementation of quizizz as an online assessment media provides higher learning outcomes compared to those using written methods. Third, teachers add more discussions and practice questions so that students better understand the material being studied. Fourth, teachers encourage students to be more active during discussions, both group discussions and class discussions, this can help improve students' understanding of the material. The third cycle of research was stopped because the learning outcomes of students had entered the high category.

Thus, the discovery learning that is applied has a positive impact on the learning process which is seen from the improve in the class average score which increases every cycle. This research can be concluded successful because the activities and learning outcomes of students have reached the target and have improved.

CONCLUSION

The use of the discovery learning model significantly improved the learning activities and learning outcomes of students on the material of the basic laws of chemistry. The activity of students obtained in cycle I was 54.33%, in cycle II it was 65.66%, and in cycle III it reached 82%. Experienced an improvement from cycle I to cycle II by 11.33%, from cycle II to cycle III by 16.33%, and from cycle I to cycle III reached 27.66%. From the calculation of the N-Gain formula, it was obtained that the improvement in student learning outcomes in cycle I was 0.29 with low criteria, in cycle II it was 0.4 with medium criteria, and in cycle III it reached 0.71 with high criteria. Thus, the discovery learning model applied has a positive impact on the learning process and results of each cycle.

RECOMMENDATIONS

Based on the results of the research that has been done, the recommendations given are: (1) the discovery learning model can be used by teachers on different subjects because it has been proven to improve students' learning activities and results, (2) in implementing learning using the discovery learning model, it should be able to manage learning time well, so that it is in accordance with the planned time allocation, 3) for teachers who want to implement the discovery learning model, students should be ensured to have constructed the concept well at the data collection and processing stage, so that students understand the material well, 4) for teachers who want to implement the discovery learning, mastery of the material and learning steps in the model must be precise and sequential so that learning objectives can be achieved.

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