**Improving Learning Outcomes and Student Activities at SMA Negeri 13 Surabaya Through the Implementation of the Discovery Learning Model on Mol Concept Material**

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**Abstract**

This study aims to describe the implementation of discovery learning, the responses of students which are supported by the activities carried out by students, as well as the learning outcomes of students through the implementation of discovery learning models on the mole concept material. This research is a Classroom Action Research (CAR) which was carried out in two cycles. The research subjects were class X-3 students at SMA Negeri 13 Surabaya for the 2022/2023 academic year. The data generated in this study are summarized as follows: (1) The implementation of the learning syntax of the discovery learning model in cycle 1 and cycle 2 obtained a percentage of implementation of 90.97% and 95.37% with excellent criteria. (2) The application of the discovery learning model received a positive response with a percentage of 81.25-100 so it was declared excellent and supported by a greater percentage of relevant student activities than irrelevant activities. (3) In cycle 1, the learning outcomes of students obtaining a score of ≥ 75 were declared complete with an average score of 85.34 with classical completeness of 78.12%. In cycle 2, the learning outcomes of students obtaining a value of ≥ 75 were declared complete with an average score of 96.90 with classical completeness of 100%.

***Keywords:*** *Discovery Learning, Learning Outcomes, Student Activities, Mol Concept*

***How to Cite:***

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**INTRODUCTION**

The educational process that functions as an instrument to achieve education goals is competence achievement. In line with that, the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia explained that each educational unit carries out lesson plans, implements the learning process, and evaluates the learning process to increase the efficiency and effectiveness of graduate competencies (Mayudana & Sukendra, 2020).

One of the efforts to realize an innovative learning process that follows the needs of students (student-centered) is to update the education curriculum in Indonesia. The current curriculum is the Independent Curriculum (Vhalery et al., 2022). The Independent Curriculum involves independent conditions in fulfilling the goals, methods, materials, and evaluation of learning for both teachers and students. With this, it can be seen that the learning process in the independent learning curriculum is more directed to the needs of students whereas previously the concept of learning was still centered on the teacher (Pertiwi et al., 2022).

The independent Curriculum is present as an answer to the intense competition for human resources globally in the Era of Society 5.0 which takes place in the 21st Century which is the glory of the digital world (Indarta et al., 2022). The 21st-century learning model also requires students to achieve 4C skills consisting of critical thinking, communication, collaboration, and creativity (Hidayati et al., 2021). In line with this, learning with a scientific approach is needed. For the sake of realizing learning with a scientific approach, one way that can be done is to implement an effective learning model (Nurkholik & Yonata, 2020).

Based on the outcomes of observations of the implementation of learning conducted by researchers in class X-3 SMA Negeri 13 Surabaya, the researchers obtained results if the teacher still applied the lecture method in the class. The teacher applies the lecture method because it is considered more practical and can be done without using learning media. The lecture method can make students accept whatever the teacher gives without giving opinions or asking questions. This learning method results in students not having the opportunity to build their knowledge so students understanding of the learning material presented is still lacking.

Based on the results of observations made by researchers when students worked on daily chemistry test questions, students could only work on questions with a low level of difficulty and simple types of questions that had been exemplified by the teacher. Whereas in questions that are more varied and with higher difficulty, students have difficulty finding ways to work on these questions.

The field study results showed that 50% of class X-3 students at SMA Negeri 13 Surabaya received daily chemistry test scores under the Minimum Completeness Criteria (MCC) with an average score of 71.75. The minimum completeness criterion for chemistry class X at SMA Negeri 13 Surabaya is 75. The daily test consists of 20 essay questions about electron configurations, quantum numbers, and the periodicity of elements. Contrary to students' understanding, as much as 81.25% of students like chemistry material because students like material that contains algorithmic understanding.

Based on the above problems, researchers will conduct Classroom Action Research. Classroom Action Research (CAR) is carried out using learning models and media that are adapted to the material to be delivered, the characteristics of the students, the learning facilities available, and the learning objectives so that it is expected to improve student learning outcomes (Arham & Dwiningsih, 2016). One learning model that can be applied is discovery learning.

Discovery learning is a learning model that trains and guides students to learn, acquire knowledge, and construct concepts so that they discover for themselves (Ferdiansah et al., 2020). Following the demands of the Independent Curriculum, students are expected to be more actively involved and not only depend on explanations from the teacher. Wilcox (in Wulandari, 2016) states that discovery learning motivates students to learn through their involvement with concepts and principles (Wulandari, 2016). The concept discovery process is carried out through students observing, classifying, hypothesizing, explaining, formulating conclusions, and so on (Kari et al., 2022). By selecting the discovery learning model, students are expected to be able to increase their learning activities in gaining knowledge so that it will have an impact on improving learning outcomes (Nugrahaeni et al., 2017). Discovery learning can be applied, among others, to chemistry subjects about the concept of moles (Siahaan et al., 2022).

The concept of the mole is one of the subject matter of chemistry. The material discussed in the mol concept is a relative atomic mass (Ar), relative molecular mass (Mr), moles, mass, number of particles, and gas volume (Sari et al., 2020). This material is abstract because students must apply conceptual and algorithmic understanding. This statement is supported by the results of Nilawati's research which was obtained before learning activities with the chosen learning model, as much as 100% of students still had conceptual errors in calculating Relative Molecular Mass (Mr), and 70% of students still experienced conceptual errors in calculating the number of particles of a substance (Nilawati et al., 2017).

Research conducted by Siahaan related to the effect of the use of discovery learning-oriented student worksheets on student learning outcomes in the mole concept material. In seeing how much influence the use of discovery learning-oriented student worksheets has, Siahaan performs calculations using Effect Size. In calculating the Effect Size using Glass's Delta formula, the results show that there are significant differences in student learning outcomes in the mole concept material with high changes (Siahaan et al., 2022).

Based on the description of the problem above, it is necessary to do research with the title “Improving Learning Outcomes and Student Activities at SMA Negeri 13 Surabaya Through the Implementation of the Discovery Learning Model on Mol Concept Material.”

**METHOD**

The research was conducted at SMA Negeri 13 Surabaya. This type of research is Classroom Action Research, which has 2 cycles. Researchers apply the learning model of discovery learning in 2 cycles. The subjects in this study were students in class X-3 at SMA Negeri 13 Surabaya. Teachers and students are a source of data in this study. Data collection techniques through tests and non-tests consisting of the implementation of discovery learning models, response questionnaires, student activity sheets, and tests to determine student learning outcomes. Data analysis in the implementation of Classroom Action Research was carried out from the beginning until the last data was obtained. The results of the data obtained from the research were then analyzed and processed in a qualitative and quantitative descriptive manner.

The implementation of the stages of the discovery learning model is obtained from the score given by the observer. The assessment criteria are listed in Table 1:

**Table 1.** Teacher Ability Criteria Score

| **Score** | **Criteria** |
| --- | --- |
| 0 | Not implemented |
| 1 | Implemented, out of order, not interactive, and not on time |
| 2 | Implemented, in sequence, not interactive, and not on time |
| 3 | Implemented, in sequence, interactive, and not on time |
| 4 | Implemented, in sequence, interactive, and on time |

The score obtained from the observer's assessment is entered with the following formula:

Syntax execution (%) = × 100%

**Table 2.** Criteria for the Implementation of the Discovery Learning Learning Model

| **Percentage(%)** | **Criteria** |
| --- | --- |
| 0-20 | Very less |
| 21-40 | Less |
| 41-60 | Enough |
| 61-80 | Good |
| 81-100 | Excellent |

(Riduwan, 2015)

Based on Table 2. The implementation of the Discovery Learning learning model is stated to be good if the percentage is ≥ 61%.

The response questionnaire instrument was used to determine the response to the learning material developed and the response to discovery learning-oriented learning provided by researchers. Student response questionnaires contain filling instructions, statements, and yes-no columns. Analysis of student response questionnaires by changing the frequency values ​​into percentages using the formula:

P (%) = × 100%

Description:

P = response percentage

F = number of students who responded positively

N = number of respondents

**Table 3.** Assessment Criteria for Implementation of the Discovery Learning Learning Model from Student Questionnaire Results

| **Percentage (%)** | **Criteria** |
| --- | --- |
| 0-20 | Very less |
| 21-40 | Less |
| 41-60 | Enough |
| 61-80 | Good |
| 81-100 | Excellent |

(Riduwan, 2015)

Based on the criteria in Table 3, if the percentage of student responses is ≥ 61%, then the implementation of the discovery learning model can be said to be good and very good. The practicality of implementing discovery learning models is also supported by the activities of students when carrying out learning activities if the percentage of relevant activities is greater than irrelevant activities.

Activities were carried out by students while receiving learning, then analyzed descriptively quantitatively based on the average results of 3 observers for 5 minutes once. The results of the data are calculated by the following formula:

Activity Percentage (%) = × 100%

(Arifin, 2009)

Based on the results of these calculations the learning activities of students support improving learning outcomes using the discovery learning model if the relevant percentage of activities carried out by students is higher than activities that are not relevant.

Data analysis of learning outcomes in the realm of knowledge was obtained from the results of the test working on multiple choice questions as many as 8 questions in 2 cycles. The value of learning outcomes is calculated using the formula:

Score = × 100%

Indicators of success in applying the Discovery Learning model can be seen from students' learning outcomes if students achieve a Minimum Completeness Criteria (MCC) of ≥75. Class classical completeness can be calculated through the following formula:

Classical completeness (%) = × 100%

(Arifin, 2009)

The cycle will stop if the percentage of classical completeness obtained is ≥85%. If the percentage of classical completeness obtained is ≤85%, then the researcher will conduct classroom action research (Suprapti, 2021).

**RESULTS AND DISCUSSIONS**

**Implementation of the Discovery Learning Model**

Observation of implementation was assessed using the instrument of observation of implementation sheet. The observers consisted of a chemistry teacher at SMA Negeri 13 Surabaya and 3 Unesa Chemistry Teacher Professional Education students. The percentage of learning implementation for 2 cycles uses the Discovery learning model which is divided into 6 phases. The sub-subjects studied in cycle 1 are calculating the Relative Atomic Mass (Ar) and Relative Molecular Mass (Mr) of a substance; calculating moles, mass, and the number of particles of a substance; converting the number of moles with mass and number of particles; deduce the relationship between moles and mass and number of particles. The sub-topics studied in cycle 2 are calculating the volume of a substance; converting the number of moles to the volume of a substance; correctly converting the volume of a substance with moles, mass, and number of particles through discussion and question and answer activities; conclude the relationship between the concept of moles and the volume of a substance. The results of the implementation of cycle 1 and cycle 2 are shown in Figure 1.

**Figure 1.** Implementation of the Discovery Learning Model

Based on Figure 1. Activities in phase 1 namely Stimulation (Imawan, 2015). The function of the stimulation phase is to prepare conditions for learning interaction that can develop and assist students in exploring learning material (Karoni, 2023). In phase 1, the teacher divides students into 7 heterogeneous groups then divides student worksheets, invites students to read phenomena, provides several questions related to phenomena in everyday life, and gives advice to students to read material literacy that leads to the preparation of problem-solving. Phase 1 activities in cycle 1 successively get scores from observers of 100%; 91.67%; 91.67%; and 83.33% so an average of 91.67% is obtained with excellent criteria. Phase 1 activities in cycle 2 successively get scores from observers of 100%; 100%; 91.67%; and 91.67% so that an average of 95.83% is obtained with excellent criteria.

Activities in phase 2 namely Problem Identification (Imawan, 2015). The function of the problem identification phase is to provide opportunities for students to identify and analyze problems in a given case so that they can build an understanding of the concept (Sartika et al., 2020). In phase 2, the teacher provides opportunities for students to identify problems that become learning materials and make hypotheses that are temporary at the beginning of learning activities. Phase 2 activities in cycle 1 successively obtained scores from observers of 91.67% and 91.67% so an average of 91.67% was obtained with excellent criteria. Phase 2 activities in cycle 2 successively obtained scores from observers of 100% and 91.67% so an average of 95.83% was obtained with excellent criteria.

Activities in phase 3 namely Data Collection (Imawan, 2015). The main function of the data collection phase is to provide opportunities for students to answer questions or prove whether the hypothesis from the previous phase is correct or not (Karoni, 2023). In phase 3, the teacher provides opportunities for students to collect relevant information through literacy activities and present information about the mole concept through discussion activities. Phase 3 activities in cycle 1 successively obtained scores from observers of 91.67% and 83.33% so an average of 87.50% was obtained with excellent criteria. Phase 3 activities in cycle 2 successively obtained scores from observers of 91.67% and 91.67% so an average of 91.67% was obtained with excellent criteria.

Activities in phase 4 namely Data Processing (Imawan, 2015). The function of the data processing phase is to invite students to carry out activities to process data and information that has been obtained in the previous phase (Karoni, 2023). In phase 4, the teacher invites students to analyze and process data by working on questions on student worksheets. Phase 4 activities in cycle 1 get a score from observers of 91.67% with excellent criteria. Phase 4 activities in cycle 2 get a score of 100% from observers with excellent criteria.

Activities in phase 5 namely Verification (Imawan, 2015). In phase 5, the teacher guides students in presenting the data from the discussion results, gives instructions that other groups can ask questions about the results of the discussions submitted, provides feedback on the results of students' answers. In cycle 2, the teacher and students carry out quiz activities using the Numbered Heads Together (NHT) method to present the results of group discussions, give instructions that other groups can ask questions about the results of the discussions submitted, provide feedback on the results of student answers. The Numbered Heads Together (NHT) method is a form of cooperative learning that requires students to work together in small groups to complete their subject matter. Collaboration in groups is expected to encourage students to develop their thoughts, experiences, and active participation in learning so that learning interactions are established between students (Fitri et al., 2022). In practice, the teacher calls one of the student's headband numbers randomly. Students in a group with that number are asked to submit answers to the results of group discussions (Yenni & Mathematics, 2016). The teacher corrects the students' answers and writes down the scores obtained. Phase 5 activities in cycle 1 successively get scores from observers of 100%; 91.67%; and 83.33% so an average of 91.67% is obtained with excellent criteria. Phase 5 activities in cycle 2 successively get scores from observers of 100%; 100%; 91.67% so an average of 97.22% is obtained with excellent criteria.



**Figure 2.** Quiz Activity with the NHT Method

Activities in phase 6 namely Generalization (Imawan, 2015). In phase 6, the teacher asks students to draw a conclusion that can be used as a general principle. Phase 6 activities in cycle 1 and cycle 2 get scores from observers of 91.67% with excellent criteria.

The most dominant phase is phase 4. In phase 4, students analyze and process data by working on questions on student worksheets so that students can test problem formulations, hypotheses, and conclude.

Based on the description of the Discovery learning phases implemented at SMA Negeri 13 Surabaya, it can be said that each learning stage gets a percentage of ≥81% and gets excellent assessment criteria in the first cycle and the second cycle.

**Student Activity**

The learning activities of the students observed included activities in class and group activities. The number of observers was 3 people from Unesa Chemistry Teacher Professional Education students, one observer observed 2-3 groups with an observation frequency of 5 minutes by ticking on the observation sheet the most dominant activity appearing in that 5 minutes interval. The observation results obtained are shown in Figure 3.

**Figure 3.** Student Activities

Figure 3. describes the learning activities of 32 students. Student activities consist of class activities (listening to explanations from the teacher, answering teacher questions, expressing opinions, conveying the results of group discussions) and group activities (reading phenomena in LKPD, conducting group discussions, identifying problems, formulating problems, formulating hypotheses, collecting data, processing data, proving the results of group discussions through quiz activities with the NHT method, and drawing conclusions). The percentage of relevant activities is greater than irrelevant activities (playing on cellphones, disturbing, being busy, and doing other activities that can interfere with teaching and learning activities). Relevant activities carried out by students increased from cycle 1 of 94.41% to 96.71% in cycle 2.

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**Figure 4.** Data Processing Activities

The most dominant activity in each cycle is data processing activity with an average percentage value of 20.03%. This activity requires quite a long time to analyze and process data by working on questions on student worksheet so students can test problem formulations, hypotheses, and conclude.

**Student Response**

Assessment of the learning process by students was obtained from the results of response questionnaires distributed to students after learning activities were carried out. The following table 4 contains the results of data processing related to student response questionnaires:

**Table 4.** Response Questionnaire Analysis Results

| **No.** | **Rated Aspect** | **Response Percentage (%)** | **Criteria** |
| --- | --- | --- | --- |
| 1. | Based on the learning you have done, are you interested in the following components? | Interested | Excellent |
| The learning process, materials, student worksheets, learning atmosphere, and the way the teacher teaches | 100 |
| 2. | Do you find it easy to understand the components of learning activities contained in student worksheets? | Easy | Excellent |
| Materials, phenomena, descriptions, questions, information, and terms | 81.25 |
| 3. | Do you agree with the following components: | Agree | Excellent |
| Presentation of the learning process can motivate learning, encourage to be active, and arouse curiosity. Presentation of pictures in student worksheets helps to understand the material, formulas, and symbols are stated clearly. | 90.62 |
| 4. | Can you follow the following components? | Yes | Excellent |
| Identifying problems, collecting data, processing data, proving, and making conclusions | 93.75 |
| 5. | What do you think about the way the teacher provides learning with the discovery learning model on the mole concept? | Good | Excellent |
| Discovery learning stages from phase 1 to phase 6 | 93.75 |
| 6. | Do you find it easy to answer evaluation questions? | Easy | Excellent |
| 81.25 |
| 7. | Are you interested in participating in learning as you have done now to be applied to the next learning activity? | Interested | Excellent |
| 96.87 |
| **The results of the student response questionnaire** | | 81.25-100 | Excellent |

Based on Table 3. The application of the discovery learning model was stated to be very good because the percentage obtained was 81.25-100 indicating a positive response and supported by data from observations of student activity ≥ 61% of students were active during the implementation of learning activities.

**Student Learning Outcomes**

The learning outcomes test is a test of the ability of students after receiving learning the mole concept by implementing the discovery learning model. The learning outcomes test is used to see the completeness of learning outcomes in the realm of students' knowledge by working on questions developed from indicators originating from the development of learning outcomes in the mole concept material.

In each cycle, students worked on 8 questions with a correct score of 12.5 per item. At the end of the learning process in cycle 1, students are given a test to determine the level of success of students in the learning process that has been carried out. The following is a recapitulation of student learning outcomes in cycle 1.

**Table 5.** Recapitulation of Student Learning Outcomes in Cycle 1

| **No.** | **Description** | **Results from Cycle 1** |
| --- | --- | --- |
| 1. | Average test score | 85.34 |
| 2. | The number of students who complete learning | 25 of 32 |
| 3. | Percentage of learning completeness | 78.12% |

From the table above it can be explained that the application of the discovery learning model in cycle 1 obtained an average value of student learning outcomes of 85.34. There were 26 out of 32 students who had finished studying so that the learning completeness reached 78.12%. These results indicate that students have not finished studying in a classical manner because students who obtain a Minimum Completeness Criteria (MCC) score of ≥75 are only 78.12%. These results are smaller than the specified classical completeness percentage. The percentage of classical completeness that must be achieved is ≥85%. This is because students are still unfamiliar with the implementation of learning using the discovery learning model.

Based on the results obtained in the first cycle where learning completeness has not reached the achievement target, it is necessary to take further action by conducting learning in cycle II. Learning in cycle II is carried out to improve the learning process in cycle I so that it is hoped that all students can achieve MCC scores. Learning activities in cycle II were carried out by the teacher by implementing the same learning model as cycle I, namely Discovery Learning, but the teacher also applied a new learning method, namely Numbered Heads Together (NHT) based quiz activities in phase 5 in the Discovery Learning model. With these learning models and methods, it is expected that student learning outcomes will increase. In addition, teachers also improve their ability to implement discovery learning learning models. The following is a recapitulation of student learning outcomes in cycle 2.

**Table 6.** Recapitulation of Student Formative Test Results in Cycle 2

| **No.** | **Decription** | **Results from Cycle 2** |
| --- | --- | --- |
| 1. | Average test score | 96.90 |
| 2. | The number of students who complete learning | 32 of 32 |
| 3. | Percentage of learning completeness | 100% |

From the table above it can be explained that the application of the discovery learning model in cycle 2 obtained an average value of student learning outcomes of 96.90. All students in the class have finished studying so that the learning completeness reaches 100%. These results indicate that students complete learning classically because students who score ≥75 are 100%. These results have met the specified completeness percentage criteria, namely ≥85%. The following graph compares the percentage of completeness in cycle 1 and cycle 2.

**Figure 5.** Completeness Percentage in Cycle 1 and Cycle 2

Graph 3. shows that there is an increase in the percentage of students who complete from cycle 1 to cycle 2. The increase in the completeness of student learning outcomes from cycle 1 is 78.12% to 100% in cycle 2.

The completeness of the learning outcomes is supported by the quality of the implementation of the discovery learning learning model with excellent criteria and the relevant activities carried out by students during the learning process are greater than irrelevant activities. This is in line with the research conducted by Siahaan regarding the effect of the use of discovery learning-oriented student worksheets on student learning outcomes on the mole concept material. The results of the research statistical tests conducted by Siahaan showed that there were significant differences in student learning outcomes in the mole concept material with high changes. This shows that student learning outcomes and student activities can increase after the discovery learning model is applied to learning activities for 2 cycles (Siahaan et al., 2022).

**CONCLUSION**

The implementation of learning activities using the discovery learning model in cycle 1 and cycle 2 obtained successive percentages of 90.97% and 95.37% with very good criteria. This is shown from the results of the percentage of the quality of implementation of each phase in cycle 1 and cycle 2 which is dominant with excellent implementation quality criteria, namely above 80%.

The application of the discovery learning model received a positive response with a percentage of 81.25-100 so that it was declared excellent and supported by a greater percentage of relevant student activities than irrelevant activities. Student activity observed in each phase of learning activities using the discovery learning model shows that the percentage of relevant activities from cycle 1 and cycle 2 gets percentages of 94.41% and 96.71%. While activities that are not relevant are 5.59% in cycle 1 and 3.29% in cycle 2.

In cycle 1, the learning outcomes of students obtaining a score of ≥ 75 were declared complete with an average score of 85.34 with a classical completeness of 78.12%. In cycle 2, the learning outcomes of students obtaining a value of ≥ 75 were declared complete with an average score of 96.90 with a classical completeness of 100%.

**RECOMMENDATION**

Implementation of the discovery learning model on mole concept material can be done by utilizing the development of learning media such as student worksheets, learning videos, and others. Researchers can also apply the discovery learning model to improve student learning outcomes in other chemistry materials.

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