Improving the Student's High Order Thinking Skills Using the Inquiry Learning Model on the Rate of Reaction Topic

Mohamad Nurkholik*, Bertha Yonata, Suyatno Sutoyo****

*Senior High School-1 Dawarblandong, Mojokerto, East Java, Indonesia
**Department of Chemistry, Universitas Negeri Surabaya, Indonesia

DOI
mohammadkholik@sman1dawarblandong.org

DOI: 10.29322/IJSRP.11.03.2021.p11171
http://dx.doi.org/10.29322/IJSRP.11.03.2021.p11171

Abstract- The aim of research is to describe the effectiveness of the inquiry learning model to improve the student's high order thinking skills that have an impact on the completeness of the student learning outcomes at MAN 2 Gresik on the factors affecting the rate of reaction topic. This study used the One Group Pretest- Posttest Design. The data obtained from this research were as follows: (1) The implementation of the stages of the inquiry learning model showed that the percentage of implementation from the first to fourth meetings are 92.74%; 93.99%; 96.61%; and 97.13% with very good predicate. (2) The HOTS ability of students had increased. This could be seen from the pretest and posttest values processed with N-gain, getting a percentage of 96% in the high category and 4% in the medium category. (3) The completeness of learning outcomes in the domain of knowledge of class XI IPA 1 students obtained a value of ≥ 75 was declared as complete with an average value of 88 with classical completeness of 100%. Based on these results it could be concluded that the application of the inquiry learning model could improve the student's High Order Thinking Skills.

Keywords*:* *Inquiry learning model, HOTS, Reaction Rate*

I. INTRODUCTION

Life in the 21st century is marked by the existence of a global society, the strong current of globalization has led to various competitions in various fields of life, including the field of education. However, the low quality of human resources, especially in the field of education, is a challenge facing the Indonesian nation at this time as evidenced by the results of PISA which state that in 2018 Indonesia ranks 72 out of 77 countries on the average score of science and mathematics (OECD, 2019). Improving the quality of education in Indonesia is a written plan designed to expedite the process of learning activities called the curriculum

Based on the 2013 revised curriculum, chemistry subjects are included in the Mathematics and Natural Sciences specialization lessons. The aim of studying chemistry is finding out about natural phenomena that exist in the environment, so that the learning process of chemistry does not only mastery the cognitive learning form of theory but also the process of discovery. Students after receiving chemistry learning are expected to gain experience in applying scientific methods such as those in the scientific approach to the 2013 curriculum (Permendikbud, 2016).

Chemistry learning involves thinking and reasoning process skills. Chemistry learning requires proving a concept through experiment. Several chemical materials that require proof through experiments in accordance with the demands of KD 4 in Permendikbud No. 24, 2016, one of them is the reaction rate material.

The characteristics of the sub-material factors that affect the rate of the reaction require verification through an experiment. So that students are able to find their own concept of the material. Based on this, it is necessary to train High Order Thinking Skills (HOTS) in order to make students build their own concepts and create better understanding of the studied concepts and its application in life.

HOTS is needed to solve problems, understand and interpret chemical concepts. HOTS can also describe cognitive activities. According to Andreson (2001) argues that "For many teachers, operating with their state standards and curriculum documents, higher-order thinking is approached as the top end of Bloom's taxonomy: Analyze, Evaluate, and Create, or, in the older language". Based on the revised Bloom Taxonomy, which is included in the HOTS category, namely the ability of C4 (Analyze), C5 (Evaluate) and C6 (Create) (Anderson, 2001).

Based on the results of the pre-research by taking a sample of each class XI IPA with total 27 representatives. The results of the pre-research at MAN 2 Gresik shows that the scores obtained for the cognitive domain category C4 are in the range of values 0-31.25; C5 cognitive domain only reaches the value range 0-21.50; and the cognitive domain of C6 only reaches a value range of 0-25;. The average HOTS is still at ≤ 75, so that the HOTS ability is classified in the low category. It is also supported by the results of interviews with chemistry teachers, which teacher in the classroom still implement teacher center learning where students are still passive, the learning method is not independent and there is no practicum learning which results in the concept of direct learning being conveyed by the teacher which results in less training in HOTS learners

One of the learning models as a solution for practicing HOTS is the inquiry learning model. The main character of the inquiry model is the activity of students who are maximally mobilized to seek and find concepts done by thinking critically and analytically (Sanjaya, 2013).

The learning process by implementing the inquiry model places students to solve problems or phenomena and develop scientific ways of thinking in seeking knowledge that is investigative or discovery so that they can understand scientific concepts (Amilasari, 2008).

Inquiry strategies in learning activities not only place students as learning subjects through verbal teacher explanations (lectures), but also require them to find their own concepts from the material being studied by logical and critical reasoning that is used to solve a problem in life or study material from others in various realms of science.

Based on the facts above, the researcher considers it necessary to apply an inquiry learning model to train HOTS. In this paper we report the effectiveness of the Inquiry Learning Model to improve the students' High Order Thinking Skills at the XI IPA-1 class MAN 2 Gresik on the Reaction Rate topic.

II. RESEARCH METHOD

This research was conducted at the XI IPA1 class MAN 2 Gresik during the middle of the odd semester and the researcher as a teacher by applying the guided inquiry learning model at the first and second meetings, while the third and fourth meetings used semi-guided inquiry models.

The research design used in this research were One Group Pretest-Posttest Design with formula:

O1 X O2

Explanation:

O1: Pretest the initial HOTS ability

X: The treatment given is to apply an inquiry model to train HOTS

O2: Posttest increase in students' HOTS

(Sugiyono, 2015)

Previously, researchers identified the initial conditions in students by doing the HOTS pretest. Then do the treatment. At the end of the activity the condition was measured by the HOTS posttest. The pretest results obtained will be compared with the posttest results, then these results can be analyzed in terms of improvement and conclusions

The observer gives a score to see the feasibility of the stages of the Inquiry learning model. The assessment criteria are listed in Table 1.

Table 1. Teacher Ability Criteria Score

Score	Criteria
0	Not done
1	Implemented, out of order, not interactive and not on time
2	Implemented, in order, not interactive and not on time
3	Implemented, in order, interactive, not on time
4	Done, in order, interactive and on time

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

$$\%\ \text{syntax compliance} = \frac{(\text{total score})}{(\text{maximum number of scores})} \text{ x } 100\%$$

The implementation of the learning model is declared good if the percentage is ≥ 61%.

Data analysis of HOTS enhancement was carried out to determine whether HOTS had been trained or not after the application of the inquiry learning model. The HOTS increase can be determined by the N-gain index value as follows.

$$< g >= \frac{(posttest\ score - pretest\ score)}{(maximum\ score - pretest\ score)}$$

(Hake, 1998)

The value of the N-gain obtained is then converted into the following categories in Table 2:

Table 2. N-Gain Criteria

N-gain score	Criteria
$<g> \geq 0{,}7$	High
$0{,}3 \leq <g> < 0{,}7$	Moderate
$<g> \leq 0{,}3$	Low

Inquiry learning is said to be successful if the HOTS ability criteria of students measured using the N-gain score gain from the medium and high categories.

The data analysis of learning outcomes in the domain of knowledge was obtained from the results of the test containing 16 multiple choice questions. The value of learning outcomes in the domain of knowledge is calculated using the formula:

$$Value = \frac{\sum true}{\sum number\ of\ questions}\ X\ 100\%$$

Class classical completeness can be calculated using the following formula:

$$\%\ Classical\ completeness = \frac{\sum students\ who\ reach\ KKM)}{\sum students\ who\ take\ the\ test)}\ X\ 100\%$$

(Arifin, 2009)

III. RESULT AND DISCUSSION

3.1 Implementation of inquiry learning model

Observation of feasibility is assessed using the compliance observation sheet instrument. The observers consisted of a chemistry teacher at MAN 2 Gresik and a chemistry students at Department of Chemistry of Universitas Negeri Surabaya. The percentage of implementation of inquiry learning for 4 times offline learning using the inquiry learning model according to Arends which is divided into 6 stages of learning. The results of the implementation of the first to fourth meetings are shown in Table 1.

Table 1. Implementation of the Learning Model Inquiry

Learning Phase	First meeting	Second meeting	Third meeting	Fourth meeting
Phase 1	100	95,83	100	100
Phase 2	95,83	95,83	95,83	95,83
Phase 3	84,37	96,87	93,75	93,75
Phase 4	95,83	87,5	95,83	100
Phase 5	91,07	94,64	93,75	93,75
Phase 6	87,5	93,75	93,75	93,75

Based on Table 1, activities in phase 1 are focusing attention and explaining the inquiry process (Arends, 2012). The activities carried out by the teacher in phase 1 were the teacher starting the lesson by doing apersepsi, namely linking the material to the previous meeting. In addition, teachers also provide motivation to students and convey the objectives of learning. Phase 1 activities at the first to fourth meeting respectively get an observer score of 100%; 95.83%; 100% and 100% with each meeting getting very good criteria

The activity in phase 2 is to present inquiry problems (Arends, 2012). Activities carried out by the teacher, namely divided students into 5 groups heterogeneously, then distributed students worksheet and given time to read the phenomena that exist in students worksheet. There are 2 phenomena, namely phenomena in everyday life and laboratory phenomena that will be investigated through practicum activities. The score given by the observer at the first to fourth meeting was carried out with very good criteria with a percentage of 95.83%.

Phase 3 activities are formulating hypotheses to explain the problem (Arends, 2012). In phase 3, the teacher began to train HOTS to students by guiding students to work on students' worksheets, first identifying the appropriate problem (cognitive domain C5) based on the phenomenon, then determining the experimental variable (cognitive domain C4) after finding the keyword in the form of student variables. Students are guided by the teacher to formulate a problem (cognitive domain C4), after which students are guided to make a hypothesis, before making a hypothesis students are directed by the teacher to read literature in chemistry textbooks so that the temporary assumptions made by students are grounded. The observer gave a score at the first meeting until these four meetings in this phase were carried out with a percentage of 84.37%; 96.87%; 93.75% and 93.75% with very good criteria.

Learning in phase 4, where students collect data to test hypotheses (Arends, 2012). Activities carried out at the first and second meetings used a guided inquiry model, where students were guided to design experimental procedures, recognize tools and materials and conduct experiments to collect data. While the third and fourth meetings applied a semi guided inquiry learning model, where each group designed an experimental procedure creatively in accordance with the phenomena that had been presented in the LKPD and carried out experiments according to the design that had been made to get experimental results. Learning in phase 4 gets very good criteria with the percentage of the first to third meetings of 95.83%; 87.50%; 95.83% and 100%.

Phase 5 activities are formulating explanations and conclusions (Arends, 2012). Activities in this phase are analyzing the experimental data by answering 4 questions of analysis and drawing conclusions based on the analysis and results of the experiments that have been carried out. Phase 5 activities get a score of observation at the first to fourth meetings with a percentage of 91.07%; 94.64%; 93.75% and 93.75% with very good criteria.

Reflecting on the problems and thought processes are used during the investigation is an activity in phase 6 (Arends, 2012). Activities of students, namely working on application questions, so that students remember how the process of solving the problems that have been given and students also provide another example in everyday life. The assessment of the implementation in each meeting was carried out very well with a percentage of 87.50%; 93.75%; 93.75% and 93.75%.

The most dominant phase in training the HOTS of students is in phase 4, because in phase 4 the students activities is testing a hypothesis through collecting data by conducting experiments directly, so that students can test the formulation of problems, hypotheses, variables and experimental steps made and students can analyze the experimental data and conclude.

Based on the description of the inquiry model syntax implemented in MAN 2 Gresik, it can be said that each learning stage gets a percentage of ≥61% and gets very good assessment criteria at the first to fourth meetings. This is appropriate with the results of previous studies which state that learning by applying the inquiry learning model can be carried out in a very good category in practicing HOTS (Julistiawati, 2013).

3.2 High Order Thinking Skills (HOTS)

The skills trained in this study are High Order Thinking Skills. HOTS skills are trained every time the meeting is outlined in the students worksheet 1-4. It contains a cognitive level, namely C4, which are formulating problems, determining variables, and analyzing the results of the experiment. C5 cognitive level which consists of identifying problems, designing experimental steps, and drawing conclusions. While the C6 cognitive level includes formulating hypotheses and expressing idea (Anderson, 2001)

HOTS trained in the realm of cognitive analyzing (C4), includes formulating questions (formulas problem); determining experimental variables; and analyzing data. The activities in phase 3: formulating hypotheses to explain the problem or phenomena in applying the learning model Inquiry activities are trained to participant students. Analyzing is breaking matter into main parts and describing how the parts are connected to each other as well as an overall structure or purpose (Kuswana, 2012). In practicing composing skills of problem formulation the teacher directs and guides students to observe and read the phenomena presented in the students worksheet as well as identification of problems that have been made. Then the teacher gives the students time to discuss with the group to formulate a problem statement. Next in practice variable determination skills experiment, the teacher has a discussion with all students to provide clarification about imprecise definitions of each variable according to the understanding of students who have previously owned. Likewise, when training skills in analyzing experimental data, teachers practice these skills by giving questions that cover the real cognitive analysis (C4) contained in students' worksheets.

HOTS can be trained in the realm of cognitive evaluating (C5) including, identifying problems; designing experimental procedures; and making conclusions based on the experiments conducted. Higher order thinking skills involve merging and use of all levels of mastery of the initial concepts of students in evaluating and making decisions (King, 2011). Skills to identify the problem are trained in phase 3: formulating a hypothesis to explain a problem or phenomenon in the initial stage, the teacher directs students to observe the phenomena presented in the students worksheet. Then in groups of students directed to identify problems accordingly with the phenomenon in the students worksheet. In training skills of designing experimental procedures, the teacher directs and provides explanations in making designs. The experiment includes several criteria, among others in the form of clear sentences, experimental procedures which are made sequentially and complete together material specifications for example, the volume amount and unit of solution concentration. Skills to make conclusions are trained in phase 5: formulate an explanation or conclusion. Teacher directing learners that deep formulating conclusions must include several aspects, namely according to the data experiments that have been analyzed, can link facts (experimental results) withtheory (hypothesis), and there is agreement with hypotheses that have been prepared previously.

HOTS is trained in the cognitive realm to create (C6) which includes making hypotheses and proposing ideas. Questions in skills C6 (create) ask students to find a solution to the problem through creative thinking (Sani, 2016). Skills of making hypotheses are trained in phase 3: formulate a hypothesis to describe the problem or phenomenon. Teacher guide students in a way explain that in formulating a hypothesis must correctly conform to the theory or the concept of reaction rate as well as covering several categories, including in the form of sentences if-and- then statement, corresponds to phenomena that are presented in students worksheet and consist of two related variables, namely, manipulation variables and response variables.

HOTS assessment data is used to determine the development of HOTS abilities of students before and after HOTS training by applying the inquiry learning model. The increase in HOTS can be seen from the results of the pretest and posttest with the assessments criteria in the assessment rubric. Before processing the data, the data obtained from the pretest and posttest results were tested for normality first to determine the normality of a data by using SPSS and find out that the resulting data was normally distributed.

There is an increase of the trained ability of HOTS with the evidence of the N-gain score from pretest-posttest results of 1 student with moderate improvement criteria results and 24 students with high category N-gain results. This is appropriate with previous research regarding HOTS skills with categories C4, C5, and C6 that have been trained well with the results of the study, namely classically students have completed and obtained a completeness percentage of 85% (Andriani, 2018). This shows that students' HOTS skills increased after the inquiry learning model was applied to learning activities for 4 meetings.

3.3 Knowledge domain learning outcomes

The learning outcome test is a test of the ability of students after receiving reaction rate learning by implementing the inquiry model. The learning outcome test is used to see the completeness of the learning outcomes in the domain of students' knowledge by working on questions developed from indicators derived from KD development. 3.6 and 4.7 (Berliana, 2019). There were 16 questions with a correct score of 6.25 per item.

The results obtained stated that as many as 25 students obtained complete learning outcomes with an average value of 88 and classical completeness of 100%. The completeness of learning outcomes is supported by the percentage of the implementation of the inquiry learning model discussed in the previous discussion with very good quality of implementation. If learning using the inquiry model is implemented properly it will support the completeness of learning outcomes. This is also supported by relevant research which shows that all students obtain the completeness of learning outcomes after applying the inquiry model (Permendikbud, 2016).

IV. Conclusion

1. The implementation of learning activities using the inquiry learning model obtained a percentage of implementation successively from the first to the fourth meeting are 92.47%; 93.99%; 96.61%; and 97.13%. This result shows the quality of the implementation of each phase at the first, second, third, fourth dominant meeting with very good quality of implementation criteria, which is above 80%.

2. Students' HOTS abilities have increased. This can be seen from the pretest and posttest values processed with N-gain, getting a percentage of 96% in the high category and 4% in the medium category.

3. Completeness of the learning outcomes of class XI IPA students get 100% completeness of learning outcomes and the average value of the test results of learning in the realm of knowledge is 88.

REFERENCES

[1] Amilasari, A., & Sutiadi, A. (2008).Increasing Academic Skills of High School Students in Learning Physics through the Application of Guided Iinkuiri. *Jurnal Pengajaran MIPA*. 12 (2) 1-8.

[2] Anderson, L. W., & Krathwohl, D. (2001). A Taxonomy for learning, teaching, and assessing. New York: Longman Publishing

[3] Andriani, D. W., & Yonata, B. (2018).Practicing High Order Thinking Skills for Class XI Students of SMA Negeri 12 Surabaya Through the Implementation of Inquiry Learning Models in Chemical Equilibrium Material. *UNESA Journal of Chemical Education*, 7, 333-339.

[4] Arends, R. I. (2012). Learning to Teach Ninth Edition. New York: The Mc Graw-Hill Companies Inc.

[5] Arifin, Z. (2009).Learning Evaluation. Bandung: PT Rosada Karya

[6] Berliana, & Yonata, B. (2019).Thinking Skills Levels C4, C5 & C6 Revision of Bloom's Taxonomy Class X-3 Students of SMAN 1 Sumenep on the Application of Inquiry Learning Model Subjects of Electrolyte and Non-Electrolyte Solutions. *UNESA journal of Chemical Education*, 9, 57-62.

[7] Hake, R. R. (1998). Interactive-engagement Verus Traditional Methods: A six-Thousand- Student Survey of Mechanics Test Data for Introductory Physic Coures. *Journal of Physic*, 66.

[8] Julistiawati, R danYonata, B. (2013). Thinking Skills Levels C4, C5 & C6 Revision of Bloom's Taxonomy Class X-3 Students of SMAN 1 Sumenep on the Application of Inquiry Learning Model Subjects of Electrolyte and Non- Electrolyte Solutions. *UNESA Journal of Chemical Education*. 2 (2) 57-62.

[9] King, F., Goodson, L., & Spiritual, F. (2011). Higher Order Thinking Skills. Assessment And Evaluation Educational Services Program: Center for Advancement of Learning and Assessment

[10] Kuswana, W. S. 2012. Cognitive Taxonomy.Bandung: PT RemajaRosdakarya.

[11] OECD. (2019). PISA 2018 Insight and Interpretation. New York: Columbia University

[12] Permendikbud. (2016).Basic and Secondary Education Process Standards Law Number 22 Year 2016. Jakarta: Mendikbud.

[13] Permendikbud. (2016).Core Competencies and Basic Competencies of Lessons in the 2013 Curriculum Law Number 24 of 2016. Jakarta: Mendikbud.

[14] Sani, R. A. 2016. Learning Innovations.Jakarta: Bumi Aksara

[15] Sanjaya, Wina. (2013).Research, Education, Types, Methods, and Procedures. Jakarta: Kencana Prenada Media Group.

[16] Sugiyono. (2015).Quantitative Research Methods, Qualitative, and R & D. Bandung: Alfabeta.

AUTHORS

First Author – Mohamad Nurkholik, Senior High School-1 Dawarblandong, Mojokerto, mohammadkholik@sman1dawarblandong.org

Second Author – Bertha Yonata**,** Department Chemistry of Universitas Negeri Surabaya, berthayonata@unesa.ac.id

Third Author – Suyatno Sutoyo, Department Chemistry of Universitas Negeri Surabaya, suyatno@unesa.ac.id

Correspondence Author - Mohamad Nurkholik, Senior High School-1 Dawarblandong, Mojokerto, mohammadkholik@sman1dawarblandong.org