

Oe3r Strategy Implementation as an Innovation on Inquiry Based Learning toward Redox Reaction Mastery

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ARTICLE INFO	ABSTRACT
<p>Article history Received January 25, 2019 Revised February 23, 2019 Accepted May 13, 2019</p> <p>Keywords Oe3r strategy Redox reaction Learning chemistry in inquiry</p>	<p>The Oe3r strategy is an effort to develop a learning model based on inquiry. Oe3r strategy consists of orientation, exploration, explanation, elaboration, and reflection. This study aims to describe the implementation of the Oe3r strategy on the chapter redox reaction and obtain student responses on it. The research used a quantitative descriptive method. Implementation description is derived from observations on the learning process, while student responses are obtained by capturing responses through questionnaires. The implementation of the Oe3r strategy was carried out in High school students with 35 students. The results of this research indicate that students give good to respond, felling meaningful on the learning process and expect the Oe3r strategy can be applied in other chapters.</p> <p>Strategi Oe3r merupakan sebuah upaya untuk mengembangkan model pembelajaran secara inkuiri. Strategi Oe3r terdiri dari orientasi, eksplorasi, eksplanasi, elaborasi, dan refleksi. Penelitian ini bertujuan untuk mendeskripsikan implementasi startegi Oe3r pada materi reaksi redoks dan memperoleh respon siswa terhadap strategi Oe3r. Metode yang digunakan adalah deskriptif kuantitatif. Deskripsi implementasi diperoleh dari observasi pada saat pembelajaran, sedangkan respon siswa diperoleh dengan menjaring tanggapan melalui angket. Implementasi startegi Oe3r ini dilakukan pada siswa SMA dengan jumlah 35 siswa. Hasil penelitian ini menunjukkan bahwa siswa memberikan respon yang baik, merasa pembelajaran menjadi bermakna dan mengharapkan strategi Oe3r dapat diterapkan untuk materi kimia lainnya.</p> <p>This is an open access article under the CC-BY license.</p> 

I. Introduction

Chemistry is one of the natural sciences based on real-world phenomenon. The concepts in chemistry always refer to the preceding thoughts. The latter phenomenon is observed and reviewed through the thinking process, accompanied by the right methods and instruments to reveal the fundamental concept and information. That newly discovered concept is then symbolized and explained up to its particle level. The review process covers three primary features of chemistry, namely microscopic, sub-microscopic, and symbolic (Johnstone, 1991). These three features of thinking level are called triple representation.

Once those three levels are connected, then students who learn chemistry can well-visualized chemistry concepts. Besides, they also strengthen students' understanding of a phenomenon. These three chemical domains are aligned with what earlier chemists have done to find and explain a concept or law. In explaining Earlier, chemists always referred to a real phenomenon to express a concept. After they studied the information related to that phenomenon with the correct experiment, they found a new accurate concept. (Enger & Yager, 2009) mention that natural sciences include (1) concept, (2) process, (3) application, (4) attitude, (5) creativity, and science substances. According to them, the concept is the center of science. Thus, conceptual mastery becomes the

domain that determines the result of scientific learning, including chemistry. The failure of conceptual understanding indicates the failure of the learning process.

The investigation methods and scientific behavior of the earlier chemists should be habituated to the students. According to (Sotiriou & Bogner, F, 2015) state that in solving a scientific problem, students have to act like a scientist and follow the scientific processes. In the initial process of learning, students must start observing the phenomenon in their surroundings. After the observation, students must explain it with an explicit method and flow of thinking. From those steps, students will better understand a particular material. Thus, learning becomes more meaningful. An approach that covers those learning steps is an inquiry approach.

The inquiry is a learning approach for students to find information or idea to accelerate their understanding of a problem through scientific activities. Those scientific activities are such as doing observation, asking questions, finding the source of information, utilizing tools to find information, analyzing and interpreting data, explaining, predicting, and communicating the results. Inquiry-based learning has developed into various versions. However, they have identical learning features. The examples of inquiry-based scientific learning are (1) Process-Oriented Guided Inquiry Learning or POGIL (Hanson, 2006), (2) The Model-Observe-Reflect-Explain (MORE) Thinking Frame, (3) five steps, namely observation manipulation generalization, verification application (Wenning, 2005), (4) 5 phases developed by (Pedaste et al., 2015), consisting of orientation conceptualization investigation-conclusion discussion, and (5) that, consisting of orientation exploration explanation elaboration reflection (Sutrisno et al., 2020). From those learning models, the first two models are commonly used in inquiry-based chemistry learning (Trout et al., 2008). Those types of inquiry learning mainly guide students to act as a chemist in finding, reviewing, and explaining a phenomenon through a scientific method. In this research, the strategy was used.

The learning model is an effort to develop and combine every inquiry learning stage. This strategy can be implemented in both laboratories based and non-laboratory-based learning. This strategy well-explains the theories, even during the practices. This strategy was chosen for this research due to all its stages can be

clearly and strictly followed. Thus, this strategy was expected to support students to solve problems and find the concept independently. Besides, the implementation of this strategy is part of the evaluation of the innovation of inquiry-based learning strategy.

According to the 2017 revised version of the 2013 Curriculum, the redox reaction learning should be accompanied by the practices. However, based on the observation of several schools in Malang, the redox reaction learning mostly only consists of the theory explanation. Therefore, the researchers implemented a strategy in the redox reaction concept. The learning activities of every that learning stages are explained below.

II. Method

This research uses descriptive quantitative research method. The research objects of this research were 35 students of X Science in State Senior High School 1 Kepanjen, Malang. The data collection stages were: First step: develop teaching instrument, consisting of the lesson plan, students' worksheet, assessment instrument, observation sheet, and respond questionnaire. Second: implementation of the learning strategy with the instrument to collect data or proofs on the application of the learning. The data or proof was gained by using the questionnaire sheet. The collected data were descriptive-qualitatively analyzed. Third step: examine the effect of that strategy implementation toward the students, including: (1). Conceptual understanding or competency mastery that refers to the minimum mastery criteria. This data was in the form of test scores. The data was quantitatively obtained and analyzed, then referred to the schools' minimum mastery standard. (2.) Students' responses or reactions toward the strategy on the redox reaction learning gained through the respond questionnaire the obtained data were descriptively analyzed.

III. Results

The learning activities with the strategy on the redox reaction material are summarized in Table 1.

Table 1. Learning Activities with oe3r Strategy

Stages of oe3r Strategy	Learning Activities	Findings	Supports	Time (minutes)	
				Lesson Plan	Implemen- tation
Orientation	Identify students' prior knowledge (oxidation number, chemical reaction, and the nomenclature of chemical compound)	Several students faced difficulties with answering questions about the oxidation number and nomenclature of the chemical compound. Some students were passive and had not habituated with the teacher asking the question.	The teacher gave more stimulus to guide students to answer the question.	15	15
Exploration	Observe the chemical reaction phenomena of HCl with NaOH, Na metal with H ₂ O, AgNO ₃ with NaCl, Zn metal and CuSO ₄	Most of the students were enthusiastic during the practice, but some of them did not understand the procedure yet. There was a discrepancy between the required time for the practice and the time allocated in the lesson plan.	The teacher gave a stimulus to help students construct the knowledge obtained during the practices.	80	110
Explanation	Write the reaction formula and decide whether there were changes in the oxidation number.	Most of the students wrote the correct chemical reaction and agreed on the exact oxidation number changes. Some students had difficulties in writing the proper chemical reaction. The time required for writing the chemical reaction was relatively long; thus, it did not match the time allocated in the lesson plan.	Teacher re-explained the concept of chemical compound nomenclature. Teachers guided students to write the correct reaction formula.	30	45
Elaboration	Decide the redox or non-redox reaction.	Most of the students were enthusiastic and did not have any difficulties in working on the questions. Some students seemed to have difficulties in answering the questions.	The teacher supervised and guided students in answering the questions.	30	30
Reflection	Write the conclusion and answer some questions.	Some students communicated the obtained reflection results. Students expressed their difficulties and obstacles during the learning process.	Teachers gave reinforcement toward students' conceptual understanding.	10	10

The students' conceptual mastery from the experiment class was obtained from the posttest result on redox reaction material. The test consists of more than 15 multiple-choice questions. The data is presented in Table 2.

The recapitulation data of students' reactions toward inquiry-based learning with oe3r strategy on the redox reaction material is presented in Table 3.

Table 2. Students' Conceptual Mastery Data from Experiment Class

Number of Students	Minimum Mastery Criteria	Average Score	Students with Score above the Minimum Mastery Criteria	Maximum Score	Minimum Score
35	75	77,14	24	100	46,67

Table 3. Proportional Recapitulation of Students' Responses toward the Implementation of oe3r Learning

No.	Questions	Yes	Don't Know/ in Doubt	No
1	Do you have meaningful learning on oxidation number, chemical compound nomenclature, and redox reaction?	94,29	5,71	-
2	Does this learning process affect your correct and comprehensive understanding of oxidation number, chemical compound nomenclature, and redox reaction?	82,86	17,14	-
3	Do you feel you have a better learning result from oxidation number, chemical compound nomenclature, and redox reaction learning than the previous learning?	57,14	42,86	-
4	Do the learning stages ease your conceptual mastery on oxidation number, chemical compound nomenclature, and redox reaction concepts?	65,71	34,29	-
5	Do you feel this learning is different from the previous learnings?	77,14	17,14	5,71
6	Do you feel this learning has more systematic stages and plots than the previous learnings?	80,00	20,00	-
7	Have you ever had this learning model in other subjects with other teachers?	25,71	25,71	48,57
8	Do you agree if this learning model is implemented on the other chemistry materials you have not learned?	62,86	37,14	-
9	Do you agree if this learning model is implemented in other subjects?	42,86	57,14	-
10	This learning is part of the evaluation of learning innovation; please write a short suggestion for the improvement of this learning model.	54,29	-	45,71

IV. Discussion

The learning activities presented in Table 1 are explained below.

A. Orientation Stage

Prior knowledge is an essential object for the concept that will be learned. The activation of this prior knowledge is related to the process of associating the new knowledge with the existing knowledge (Dolmans et al., 2005). Some students had difficulties to answer the questions about oxidation number and chemical compound nomenclature. This is caused by students who forget that concept and assume that previous concepts are not related to the one they about to learn. Consequently, some students were passive in this stage. According to (Abdullah et al., 2012), students' passive participation is generated by some factors; namely, they are not focused, not interested in learning, not interested in the discussed topic, not confident, or afraid to ask and have less knowledge.

Students with good prior knowledge easily understand the concept they are about to learn. Based on research conducted by (Hailikari et al., 2008) on the pharmaceutical chemistry course, students with deep prior knowledge get a better final score. Thus, if students have difficulties in digging their prior knowledge, the teacher should give stimulus to help them remember that knowledge. The stimulus allows students to identify and observe the new things, as well as the ones they have learned before (User, 2010).

B. Exploration Stage

In the practices on the exploration stage, the students were grouped into small groups of 5-6 students. Thus, students could actively learn, discuss, and construct their understanding independently. The use of small groups maximizes the learning activities since a bigger number of group members limits the interaction between the member (Thibaut, 2017). Students seem to be more enthusiastic and active in

practice following the procedures written in the students' worksheet.

Through this practice, students can delve their knowledge through direct observation toward the process and result of the practice. Thus, students can construct their knowledge independently and realize meaningful learning. (Schoffstall & Gaddis, 2007) state that organic chemistry learning with practice improves students' conceptual understanding. It is also supported by research conducted by (Wang et al., 2016) that shows spectrophotometry learning that is done with practice accelerates students' knowledge, critical thinking, and research skill.

In addition, there were students with a low understanding of the correct practice procedure. This is caused by students' low understanding of the tools and ingredients being used in practice. Thus, they asked many questions to the teacher. Consequently, it increases the amount of time required for the practice, longer than the time allocated in the lesson plan.

C. Explanation Stage

In this stage, most of the students wrote the correct chemical reaction and oxidation number changes. This is because students' prior knowledge of oxidation number, chemical compound nomenclature, and the chemical reaction was well-delved. Based on (Ambrose et al., 2010), when student correlates what they are learning with their relevant prior knowledge, then the student can master the new knowledge. However, there were still some students who had difficulties in writing the formed chemical reaction during the practice due to the lack of prior knowledge.

Other than that, in this stage students were brave enough to express their opinion about the concept in front of the classroom. Besides, they also refuted the misleading opinion from their friends. Thus, an interactive discussion was created. This helped students to construct their knowledge and give positive toward the conceptual mastery. According to (Gull & Shehzad, 2015), in cooperative learning, students seem to be more enthusiastic than the regular learning. That research also explains that cooperative learning improves students' motivation and competitiveness. Therefore, students compete to be the best and struggle to obtain maximum academic achievement. The finding of this research is in accordance with research conducted by (Melihan & Sirri, 2011) that states learning with discussion accelerates students' academic achievements.

D. Elaboration Stage

Most of the students were enthusiastic and faced no difficulties in solving the given problem. This was because they had found and explained the concept independently, during the explanation stage. In this stage, the teacher can identify the students who have mastered the concept they had discussed and those who have not. The excellent conceptual construction brings the correct conceptual knowledge and good retention toward the discussed concept. (Weller et al., 2018) mention one of the learning designs that improve retention toward conceptual mastery is collaborative learning. Proper collaboration and communication help students to learn a concept deeper, independently. This finding is in line with the findings from previous research.

E. Reflection Stage

Some students communicated the results of the obtained reflection. In this stage, students wrote the conclusion about the redox reaction material they have learnt and answered the questions in their worksheet. Most of the students said that they felt it easier to learn the concept with this strategy. Besides, the used strategy also accelerated students' learning motivation. The reflection stage in the learning process is essential for students' learning success since students are expected to measure their ability after the learning process (Clegg et al., 2002; Thorpe, 2004). Through reflection, students can better identify and understand their ability. Thus, they can ask a question to or open discussion with the teacher if they have not understood a concept.

According to students' conceptual mastery data presented in Table 2, the average students' conceptual mastery score was 77.14, while the minimum score was 46.67 and the maximum score was 100. Besides, there were 11 students (31%) got the score below the minimum mastery criteria (75). These students got that score because they have not been habituated with the implemented inquiry learning model. Prior to this research, students always learnt chemistry with conventional learning. Besides, there were also students who got the maximum score. That shows that this learning strategy gives a positive effect on students' understanding.

The analysis of the Oe3r learning questionnaire shows that 94.29% and 82.86% of students gave positive responses on the first and second questions, respectively. This shows that students have meaningful learning on the redox reaction conceptual materials. Besides, they

also have a correct and complete understanding of the redox reaction through Oe3r learning. Additionally, 57.14% of students also gave positive responses to the third question. That shows that Oe3r learning gives better learning results than the previous learning's.

The 65.71% and 77.14% of students also gave positive responses on the fourth and fifth questions, respectively. Thus, the students agreed that as a new strategy. Students also gave positive responses, 80.00%, for the sixth question. On the other words, they are happier and more comfortable with this strategy due to its systematic learning. Consequently, they become more enthusiastic to learn oxidation number, chemical compound nomenclature and redox reaction with Oe3r learning.

There were 48.57% of students gave negative responses on the seventh question, showing that they had not had Oe3r learning on the chemistry materials, primarily the redox reaction. On the other hand, 62.86% of students gave positive responses for the eighth question, meaning that they agreed if this strategy is implemented in chemistry and other subjects. The students gave 57.14% negative respond for the ninth question, showing that they did not agree if the OE₃R learning is not suitable for other subjects. On the tenth question, students gave 54.29% and 45.71% positive and negative responses, respectively. This shows that Oe3r learning has positive effects, but its implementation still needs to be improved. Thus, based on the entire questionnaire analysis, students gave positive responses and expect that Oe3r is implemented in other chemistry materials learning.

V. Conclusion

Prior knowledge helps students to understand the correlation between topics. Oe3r learning strategy transforms students to be more active, brave to express their opinion, and still gain scores below the minimum mastery criteria. The students gave positive respond that the Oe3r strategy helps them to have meaningful conceptual learning (94.29%) and expect that this strategy is implemented in the other chemistry material learning. Oe3r strategy can be implemented on the other chemistry materials with similar features to redox reaction materials. However, in this strategy time management, as well as tools and ingredients availability should be considered. construct their knowledge independently during the learning process (which have not occurred in the previ-

ous learning's). Besides, with this strategy, there were 24 students (69%) who got scores above the minimum mastery criteria. However, there were 11 students (31%) who

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