



The Effect of the POE Learning Model on Students' Cognitive Learning Outcome

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Abstract

This study investigates the effectiveness of the POE learning model in enhancing cognitive learning outcomes of chemistry education students, with particular emphasis on redox reaction concepts in the Basic Chemistry 2 course. The research is motivated by the persistent challenge that chemistry is perceived as abstract and calculation-intensive, which hinders students' conceptual understanding and reduces academic achievement. Employing a pre-experimental one-group pre-test – post-test design, data were collected from 12 second-semester students at Musamus University. Validated essay-based instruments were used to measure learning outcomes, and data analysis included N-Gain testing, Shapiro–Wilk normality testing, and paired sample t-tests. Results revealed a significant improvement in students' performance, with mean scores rising from 19.4 (pre-test) to 74.6 (post-test), an N-Gain score of 0.67 categorized as moderate, and a t-count of 9.360 exceeding the t-table value of 2.22. The novelty of this research lies in the contextual application of the POE model under pandemic-induced learning constraints, demonstrating that active learning strategies integrating prediction, observation, and explanation are effective even within limited instructional settings. The contribution of this study is twofold: theoretically, it reinforces constructivist approaches in chemistry education by providing empirical evidence of POE's impact on cognitive outcomes; practically, it offers lecturers a viable pedagogical alternative to foster motivation, engagement, and deeper understanding of abstract chemical concepts. These findings underscore the potential of POE as a scalable instructional strategy to address learning challenges in higher education science contexts.

Keywords: Chemistry Education; Cognitive Outcomes; POE Learning Model; Redox Reactions; Higher Education

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INTRODUCTION

Education is a process of learning, knowledge, and skills that each individual goes through and has become a habit that is passed on to the next generation through teaching, training, and research activities (Vasile, 2022). Education is an important benchmark for the progress of a nation (Spiel et al., n.d.; Zheng & Huang, 2025). The main purpose of education is to prepare someone to be more responsible in running their life (Sharma & Ankit, 2023; Sriatun et al., 2024). Education is a process carried out by individuals or groups of individuals to produce a change in attitude, way of thinking, and behaviour of a person (Kleebbua & Siriparp, 2016). The education process is carried out in a conscious and directed state to create an active learning process in order to produce the personality of the individual and society (Habsy et al., 2024). Education in Indonesia in the scope of higher education has currently implemented the Indonesian National Qualification Framework curriculum (KKNI), one of the qualification levels in the KKNI curriculum is being able to work together and having social sensitivity. In achieving the objectives of the curriculum and as a manifestation of the benefits of this curriculum, which is increasing human resources by standardising qualifications between learning outcomes obtained through formal, non-formal, informal education, or work experience (Ahid & Chamid, 2021; Insani et al., 2017; Lubis et al., 2023). Therefore, students must have skills in order to become individuals who have good human resources and work together or compete between countries in the world without leaving the characteristics and personality of the Indonesian nation (Badeni et al., 2025).

Based on the curriculum objectives above, the skills that must be mastered by students include thinking skills that include critical, creative, and innovative thinking that can improve student learning outcomes (Fatmawati et al., 2019). Learning outcomes are achievements resulting from an assessment or evaluation process that takes place in a certain time unit. In the learning process, learning outcomes are one of the problems that continue to be sought for solutions in order to achieve optimal learning outcomes (Almulla, 2023; Bhuttah et al., 2024; Kardoyo et al., 2020). Learning Outcomes are changes in individual behaviours that include cognitive, affective, and psychomotor aspects. Cognitive learning outcomes have the perspective that students process information and lessons through their efforts, organizing, storing, and then finding the relationship between new knowledge and existing knowledge (Brayadi et al., 2022).

Chemistry is one of the science groups that are closely related to everyday life. Chemistry studies the properties of matter, structure, composition of matter, changes in matter, and energy that accompany changes in matter. The chemistry course aims to provide knowledge and understanding to students about chemical concepts. The basic chemistry 2 course taught in the Chemistry Education Department, FKIP UNMUS contains material that is arranged based on the basic competencies that are expected to be created in students. The material consists of solution chemistry, colloids, reaction rates, collision theory, redox reactions, elemental chemistry, and nuclear chemistry. All of these materials have been studied in high school, so the basic chemistry 2 courses are not new to students so learning will be easier. The results of interviews conducted with 4th-semester chemistry education students which became the initial cause of low student learning outcomes were the assumptions that never disappeared that chemistry is one of the materials that is never free from concepts that sometimes make students difficult to understand or have an abstract nature, and that chemistry is always associated with symbols and calculations (Apsari, 2025). The understanding inherent in these students affects learning outcomes. So that management is needed in learning that can affect student learning outcomes in chemistry learning, besides that it is also necessary to provide opportunities for interaction and cooperation between students and learning innovations that involve students directly in understanding and applying a concept through experiments and observations.

One alternative learning model that is expected to overcome the above problems is the Predict Observe Explanation (POE) Learning Model. This model is an efficient activity to form student discussions about scientific concepts. This learning model accommodates students in predicting a phenomenon, and conducting observations through demonstration or experimental activities so that in the end students can explain the results of their previous demonstrations and predictions. The

application of this model can investigate students' ideas and how they apply knowledge to real situations. This learning allows students to move or move and work or study and provides opportunities for students to be directly involved in learning. POE is one of the learning strategies that allows students to learn scientific concepts so that POE can improve learning outcomes (Budi & Mardati, 2024; Fatwadi et al., 2019; Ferny M. Tumbel, Verawati I.Y Roring, 2025). This study aims to determine the effect of the POE learning model on the cognitive learning outcomes of chemistry education students in the basic chemistry 2 course.

RESEARCH METHODS

Research Design

This study is categorized as pre-experimental research with a one-group pre-test – post-test design. The research was carried out during the even semester of the 2019/2020 academic year at Musamus University, located on Jalan Kamizaun, Merauke.

Research Subject

The population in this study consisted of students majoring in Chemistry Education at Musamus University. The sampling technique used was saturated sampling, which involves taking all members of the population as samples (Sugiyono, 2016). Based on this technique, the sample of the study was second-semester chemistry education students.

Research Procedure

The research was conducted during the COVID-19 pandemic, which led to limitations in face-to-face meetings. The study was carried out in two meetings. The first meeting was used to administer the pre-test, followed by learning activities on the topic of redox reactions. In the second meeting, the redox learning process was continued, and at the end of the session, a post-test was administered. The material taught consisted of basic chemistry concepts focusing on two topics of redox reactions.

Instruments and Data Collection Techniques

The instrument used in this study was a written test consisting of six essay questions that had been validated by experts. Data collection techniques involved administering a pre-test and a post-test to measure students' learning outcomes.

Data analysis technique

The data analysis techniques applied included the N-Gain test to measure the improvement in learning outcomes, normality testing to ensure the data distribution, and the paired sample t-test to examine the effect of the POE learning model on student learning outcomes (Fatihah et al., 2023)

RESULTS AND DISCUSSION

Results

This study aims to determine the effect of using the POE learning model on the cognitive learning outcomes of 2nd-semester chemistry education students in the basic chemistry 2 course in the 2019/2020 academic year. The population in this study was 12 second-semester chemistry education students. Before providing treatment in the form of implementing the POE model to second-semester chemistry education students, the researcher first conducted a pre-test to find out the initial data on learning outcomes in the basic chemistry 2 course. After being given treatment, the researcher provided a post-test which was useful for obtaining final data on learning outcomes in redox material (Amahoru et al., 2023; Lela et al., 2023). The pre-test and post-test data obtained can be seen in the Table 1.

Table 1. Cognitive learning outcomes

No	Aspects	Pre Test	Post Test
1	Sample	12	12
2	Ideal value	100	100
3	The highest score	36	95
4	Lowest value	7	45
5	Average value	19.4	74.6

The results of the pre-test value calculation obtained an average value of 19.4 with the highest value of 36 and the lowest value of 7. This happened because students had not studied the concept of redox reactions in corrosion before. From the results of the post-test value calculation, the average cognitive learning outcomes of students were 74.6 with the lowest value of 45 and the highest value of 95. The difference in the average pre-test and post-test values was 55.2, which showed an increase in understanding of the concept of redox reactions in corrosion in the questions studied by students after using the POE learning model. The learning outcome data obtained using the POE learning model has increased as seen from the difference between the average pre-test and post-test scores, which is 55.2. The data from the students' pre-test and post-test results obtained were then calculated using N-Gain. The results of the N-Gain calculation can be seen in the Table 2.

Table 2. N-Gain value

Data	Pre-Test	Post-Test	Ideal value	<i>N-Gain</i>
Average	19.4	74.6	100	0.67

The N-gain score test is a test conducted to calculate the difference between the pre-test and post-test scores. Gain indicates an increase in students' conceptual understanding after learning using the POE model. The N-gain score acquisition category can be determined based on the N-gain value with the division of the value acquisition category, namely if $g > 0.7$ is high, $0.3 \leq g \leq 0.7$ is medium and if $g < 0.3$ is low. Based on the results of the N-Gain calculation, it shows that there is an increase in student learning outcomes of 0.67 which is included in the moderate category because $0.3 \leq g \leq 0.7$. From the explanation above, it is known that the increase in cognitive learning outcomes of basic chemistry material 2 using the POE model is in the effective category. Before conducting a hypothesis test, a prerequisite test for data analysis will be conducted first, namely the researcher conducted a normality test on the basic chemistry learning outcome score data of 2 students before and after being given treatment. The normality test used is Shapiro-Wilk, the test is an effective and valid normality test method used for small samples with the assumption that the sample is said to be normal if the sig value < 0.05 , so that the data is not normally distributed and the sig value ≥ 0.05 , the data is normally distributed. The results of the pre-test and post-test data normality tests can be seen in Table 3.

Table 3. Normality test

No	Shapiro-Wilk	
	df	Sig.
Pre-test	12	0.551
Post-test	12	0.401

Based on the explanation above, the results of the normality test calculation show that in the pre-test a significant value of 0.551 was obtained, so the pre-test data was normally distributed because it was more than 0.05. In the post-test normality test, a value of 0.401 was obtained, so the post-test data was normally distributed because it was more than 0.05. To determine the effect of students' cognitive learning outcomes before being given treatment with the testing criteria, namely H_0 is accepted if t count

$\leq t$ table, and H_0 is rejected if t count $>$ t table with $dk = (n-1)$ and a significance level of 5%. The results of the hypothesis test can be seen in Table 4.

Table 4. Hypothesis test (t-Test)

Testing	N	Dk	A	t-count	t-table
Pre Test	12				
Post Test	12	11	0.05	-9.360	2.22

The results of the hypothesis test calculation obtained a negative t count of -9.360. The negative t count is because the average value of the pre-test results is lower than the average value of the post-test, in a context like this, the t count value can have a positive meaning. The t count value was obtained at 9.360 and t table 2.22, so t count $>$ t table, it can be concluded that H_0 is rejected and H_a is accepted. The accepted H_a is that POE learning has an effect on the learning outcomes of basic chemistry of 2 semester 2 students.

Discussions

Making students majoring in chemistry education as research samples, of course, researchers have certain considerations, namely by seeing the POE learning model applied is very suitable for chemistry education students (Kahraman, 2023). This model requires students to make direct observations through experiments or practicums, where chemical materials are always related to practicums (Harta et al., 2020). The study was conducted in 2 meetings, the first meeting was used for pre-test and working on student worksheets in the prediction section, and the second meeting was used to work on student worksheets in the observation section by conducting video observations and experiments, then continuing to work on the explanation section and post-test. The material taught in this study is basic chemistry material 2 topics of redox reactions on indicators applying the concept of redox reactions to corrosion and prevention methods (Hagerman & Alcántara-García, 2023).

The first meeting the researcher gave a pre-test in the form of descriptive questions consisting of the material to be taught related to the practicum. The pre-test activity lasted for 35 minutes, during which most students seemed to have difficulty when solving the questions (Bartl et al., 2025). This happened because most students did not understand the material and concepts, so the calculation of the pre-test results showed that the highest score obtained during the pre-test was 36 and the lowest score was 7 with an average of 19.4. After the pre-test was conducted, the learning process continued (Pan & Carpenter, 2023). After completing the observation through the video, students are asked to fill out the student worksheet in the prediction sheet section. At this stage, students must write down their predictions, guesses, or initial understanding regarding the concept of redox reactions in the iron rusting process before students will be explained the material on the redox concept and conduct direct experiments.

In the second meeting, explain the material about the concept of redox reactions, namely in the corrosion process, and also explaining the experimental work procedures that will be carried out by students. The next stage is that students are asked to conduct experiments according to those attached to the module and carried out individually while still discussing the work procedures and observation results in groups. After preparing the tools and materials, students will be directed back to complete the student worksheet on observation and explanation. On the observation sheet, students are asked to write down the results of the experiments obtained, and then students must combine the two results by drawing conclusions about whether the prediction and observation results are the same or not by writing them on the explanation sheet. After the learning ends, a post-test is given to students. The post-test given aims to get a final score after being given treatment. The post-test scores obtained by students showed satisfactory results, with the highest score obtained being 95 and the lowest score being 45 with an average score of 74.6. The percentage of completion of students' cognitive learning outcomes after the POE learning model was implemented in the post-test results showed that on average students could work on post-test

essay questions (Gustina et al., 2023; Ilma et al., 2022; Jiang & Li, 2024; Nasution et al., 2024; Setiyani et al., 2019).

The increase in cognitive learning outcomes of the average post-test score is higher than the pre-test results, this indicates an increase in cognitive learning outcomes of chemistry after being given treatment with the application of the POE learning model in basic chemistry learning 2. Proven by the results of the N-Gain calculation of 0.67 in students included in the moderate category, where the N-Gain value is the difference between the post-test and pre-test values which means there is an increase in student mastery of concepts and understanding after learning using the POE model (Amahoru et al., 2023; Dewi & Rahmawati, 2024; Lela et al., 2023). Learning activities with this model require students to make observations through experiments so that they are interested increase learning motivation and make learning more interesting and enjoyable (Kahraman, 2023).

Based on the results of cognitive learning conducted through the paired sample t-test hypothesis test, a prerequisite test was first carried out, namely the normality test which obtained a significant pre-test value of 0.551, so that the pre-test data was normally distributed because it was more than 0.05. The post-test normality test obtained a significance value of 0.401 so that the post-test data was normally distributed because it was more than 0.05. The results of the hypothesis test obtained a t-count value of 9.360 and t-table 2.22, so that t-count > t-table. It can be concluded that H₀ is rejected and H_a is accepted, the accepted H_a is that POE learning has an effect on students' cognitive learning outcomes (Kusdayanti, 2019).

In conducting the research, obstacles were found such as the time for implementing learning activities that were less efficient because the protocol for implementing face-to-face learning in the midst of the Covid pandemic was very limited, and also the lack of student discipline during learning which then affected the effectiveness during the activity so that researchers had to pay more attention to students (Paramita, Ainun Amaliya et al., 2021). In order for the research to run even with the limitations, researchers used time as efficiently as possible, before the research activity took place, the researcher conducted an experiment first using the same tools and materials with the aim that on the second day of research which required students to conclude the results of their observations, students could see and conclude the changes that occurred through the experiment that the researcher had prepared (Kranz et al., 2023). Because the corrosion process in the experiment can only be seen after three days, this condition must be done to overcome the limitations of the research time (Frankel, 2008).

CONCLUSION

Based on the results of the study, it can be concluded that there is an influence of the POE learning model on the cognitive learning outcomes of basic chemistry 2 students of semester 2 chemistry education. This is indicated by the percentage of learning outcome completion of 91%, N-gain of 0.67 (moderate category), and tcount of 9.360 (t-count > t-table) and the percentage increase in value of 58% which indicates an increase in understanding in students which influences cognitive learning outcomes. The POE model can be a recommendation for lecturers teaching courses as a variation of learning models in the teaching and learning process.

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