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The Predict-Observe-Explain Model: Is It Effective to Improve Science Process Skills?

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Abstract. Science process skills are one of the demands of new skills needed by students in the 21st century. One of the learning models that can sharpen science process skills is the predict-observe-explain (POE) model. Heretofore, research related to science process skills with POE model in understanding human digestive system material is still minimal. Therefore, this research needs to be done. This study aimed to analyze the effect of the POE model on improving students' science process skills. This study used a quasy experiment, and research design of the matching only pretest-posttest design. This study's population was all VIII students of SMP Negeri 19 Bandar Lampung, Lampung, Indonesia, in 2020/2021 academic. The sample in this study used a cluster random sampling technique, so that this study used 60 students as the research sample. Data collection techniques in the form of tests and observation sheets of science process skills. Data analysis in this study consisted of two, namely the N-Gain test and hypothesis testing using the independent samples t-test test. The results showed that the results of the N-Gain test in the experimental class were 0.66 (medium category), while the control class is a score of 0.34 (medium category). Meanwhile, The results of the research on the independent samples t-test on science process skills are the sig value. 0.000, p<0,05. This implies that POE model facilitates in improving students' science process skills on human digestive system.
Keywords: Predict-observe-explain model, science process skills, human digestive system

Introduction

Technological advances in the field of education that produce teachers and students are required to have a relevant teaching and learning process in the 21st century. 21st-century learning requires various skills. These skills are termed 4C, which stands for critical thinking, collaboration (the ability to work well together), communication, and creativity (Scott, 2015). Students are required to solve problems in the learning process, while the task of the teacher is only to help students to achieve this by making the teaching and learning process more active and fun, including stimulating students' thinking abilities and skills (Häkkinen et al., 2017). Therefore, teachers and schools must be able to develop all the potential that exists in students so that students have adequate provisions to overcome challenges and global competition in the Industrial Revolution 4.0 of the 21st Century (Stehle & Peters-Burton, 2019).

In addition, the nature of science learning consists of scientific processes and scientific attitudes (Nuangchalerm & El Islami, 2018). Science learning is related to all students systematically discovering natural phenomena, so science is not only a collection of reliable knowledge in the form of facts, concepts, or principles but also includes the scientific method (Ritter et al., 2018). Science learning in the 2013 curriculum has two approaches, namely a process skills approach and a scientific approach to be applied in science learning in schools that aim to achieve competence in the 2013 Curriculum (Wijayaningputri et al., 2018). Science learning will produce high-quality students with strong values, attitudes, and critical thinking skills, resulting in a generation capable of solving problems (Baydere et al., 2020). The material obtained does not have to be delivered by the teacher, but by students who actively participate in the teaching and learning process (Patterson et al., 2018). Science learning does not only refer to the application of theories and concepts but also the need for skill processes in learning. Science education plays an important role in designing reliable and quality young generations to face the challenges of the 21st century (Syukri et al., 2021).

Science process skills are scientific abilities that must be possessed by students in the 21st century (Wardani & Djukri, 2019), in order to be able to use the scientific method in understanding problems, and developing and discovering knowledge, and these skills are essential, for students as a provision to use the scientific method in developing science, and become able to gain a new understanding (Zeidan & Jayosi, 2015). According to Tawil & Liliasari (2014), science process skills have several indicators in order to achieve a scientific process, namely observing, classifying, interpreting, predicting, communicating, asking questions, hypotheses, planning experiment, using tools/materials, apply concepts, and conduct experiments as necessary tools in science. However, in this case the main problem in the world of education is regarding the quality of education, especially the quality of science process skills which are still very low in the process (Darmaji et al., 2019). Science process skills are needed by students to study science and technology in more detail, and students can learn science meaningfully through the exploration of science process skills (Kurniawan & Djukri, 2022).

The results of observations of students and the learning process at SMP Negeri 19 Bandar Lampung, Lampung, Indonesia, indicate that science process skills are not emphasized enough, and the implementation of laboratory practicums is still rarely carried out due to the lack of tools and practicum materials. This causes the science process skills of students to not be formed optimally. In accordance with research conducted by Artun et al., (2020), state that two factors cause low science process skills, namely low scientific background and lack of laboratory infrastructure. It is necessary to strive for a learning process that can accompany change, and motivate students to develop their reasoning power in planning and solving problems encountered by providing direct experience by carrying out a series of scientific processes and linking them between science and technology.

In addition, the factors that influence the low science process skills of students in Indonesia include the learning model applied by the teacher (Gumilar et al., 2019). Students should be directed to activities that encourage active learning. The teacher does not only convey concepts to students. However, students must also be able to understand the process of a phenomenon through practical activities. Through practical activities, it is expected that students can construct knowledge based on their own experiences so that they can improve students scientific process skills. Teachers must use strategies, models, and learning methods that are more creative and use a constructivist approach (Yulianti et al., 2018). One of the learning models that can be used is predict-observe-explain (POE). The POE model was developed by White and Gustone in 1992, which consists of three learning stages, namely (1) the Prediction stage is the process of making assumptions about an event; (2) the Observation stage is the phase of observing what happens. In other words, students are invited to conduct experiments and test the correctness of predictions made by students, and; (3) the Explanation stage is the stage of providing explanations, especially regarding the suitability between the assumptions and experimental results from the observation stage (Nasution, 2016). This POE learning model directs students to play an active role in the learning process. Students are required to express their opinions and knowledge so that they will construct between prior knowledge and new knowledge obtained from the learning process (Arsy et al., 2020). The POE learning model emphasizes a constructivist approach such as predicting, where students are asked to make predictions about a phenomenon. Furthermore, the proof of the assumption is through observation, namely by conducting discussions and collaborating in conducting experiments or practicums to obtain data and provide an explanation of the suitability between predictions and observations (Syamsiana et al., 2018).

According to previous research conducted by Arslan & Emre (2020), states that the POE model can make students easily understand concepts related to science, encourage them to build their knowledge, and improve their attitude towards science, so it is effective. to teach scientific concepts to students and improve students' scientific process skills. This statement is also supported by Hilario (2015), asserting that the POE model can cause contradictions in the minds of students when they learn new concepts and these contradictions encourage students to compare their predictions with their observations which results in meaningful learning.

The application of the POE model to improve students' science process skills is still very rarely done in biology learning, especially on the material of the human digestive system. Therefore, this study was conducted to answer the research question of whether the application of the POE model can improve students' scientific process skills on the material of the human digestive system. The purpose of this study was to determine the effectiveness of the POE model in improving students' science process skills on human digestive system material.

Methods

The research method used is quasy experiment and the matching only pretest-posttest design research design, so there are two classes, namely the experimental class and the control class. Both classes were given a pretest and posttest treatment of science process skills. The matching only pretest-posttest control group design pattern in Table 1.

Table 1. The Matching Only Pretest-Postest Control Group Design

Class	Pre-test	Treatment	Post-test
Experiment	O_1	X	O_2
Control	O_1	C	O_2

Note: O_1 = Pretest, O_2 = Postest, X = The POE model, C = Lecture and demonstration learning method

This research was conducted at SMP Negeri 19 in Bandar Lampung, Lampung, Indonesia, in the 2020/2021 academic and implements the Indonesian National Curriculum of 2013. The population in this study were all VIII students of SMP Negeri 19 Bandar Lampung. The sample in this study used a cluster random sampling technique to produce two classes, namely the experimental class and the control class. The samples consist of 60 students who are divided into 2 classes, namely the experimental class, and control class so that it consists of 30 students.

This research procedure consists of four stages, namely (1) measurements were carried out before being given treatment, so that they were given a pretest of science process skills to the experimental class and control class to determine the initial conditions related to the dependent variable; (2) the experimental class, namely giving a treatment by applying an POE learning model, while the control class was treated by applying a conventional learning model (lecture and demonstration learning); (3) measurement after being given treatment, namely giving a post-test of science process skills. Both classes were given the same weight of science process skills questions. It aims to see the difference in student scores before and after applying the interactive POE learning model, and; (4) the data is analyzed using normalized gain (N-Gain), and inferential statistical analysis consists of prerequisite test and hypothesis testing.

The data collection techniques in this study is a multiple-choice tests and observation sheets of science process skills. The test instrument of science process skill in this study adopted indicators from Tawil & Liliasari, (2014), which consisted of twelve indicatorss, namely observing, classifying, interpreting, predicting, communicating, asking questions, hypotheses, planning experiment, using tools/materials, applying concepts, and conduct experiments. The instrument test of science process skill consists of 20 questions about the material of the human digestive system, while on the instrument of observation sheet of science process skills using the Guttman scale which consisted of two intervals, namely Yes and No. Each question represents an indicators of science process skills.

The data analysis technique of the science process skills was carried out in two ways, namely as follows: (1) descriptive statistical analysis was carried out by describing the data from the test results of science process skills. Furthermore, the analysis of science process skills was carried out using the N-Gain test. The use of the N-Gain score test can describe the extent of the influence of the POE learning model in improving students' science process skills. The N-Gain value refers to the interpretation of the data which can be seen in Table 2; (2) inferential statistical analysis consists of prerequisite test and hypothesis testing. Analysis of science process skills through qualitative data converted to quantitative data.

Table 2. Interpretation of N-gain Value

Large N-gain Value	Interpretation
N-gain < 0,30	Low
0,31 < N-gain < 0,71	Medium
N-gain ≥ 0,70	High

Inferential statistical analysis of the data results of science process skills consisted of prerequisite tests and hypothesis testing. The prerequisite testing and hypothesis testing in this study used the IBM SPSS statistics 26 application. Statistical analysis is carried out by first conducting a prerequisite test analysis to determine whether the data obtained will be processed using parametric or non-parametric statistics. The prerequisite test in this study consisted of a normality test using kolmogorov smirnov test, while the homogeneity test used the Lavene test. Statistical test using independent sample t-tes, and using a significance level of 5% (Subali, 2017). Hypothesis testing in this study assumes that there is an effect of the POE model on the improvement of students' science process skills in the human digestive system.

Results and Discussion

Measurement of science process skills is carried out in two ways, namely tests and observation sheets. Measurement of science process skills is given to students at the beginning and end of learning to determine improvement. The results of the pretest and posttest of science process skills in the experimental class and control class are presented in Tabel 3.

Table 3. The Results of The Pretest and Posttest of Science Process Skills In The Experimental Class and Control Class

Description	Control Class		Experimental Class	
	Pretest	Posttest	Pretest	Posttest
Amount Sample	31	31	31	31
Average	47.41	66.93	49.03	83.38
Category	Very Low	Medium	Very Low	High

Based on Figure 3, it can be seen that the results of the science process skills pretest have no significant difference in value between the experimental class and the control class. In the experimental class, the pretest score got 49.03, while the control class got a score of 47.41. The low pretest in the experimental class and control class was caused by several factors, including rarely doing practicum and doing questions on the types of science process skills. In addition to the pretest, a posttest was also conducted to see the improvement of science process skills after being given treatment in the form of applying the POE model. In the posttest, there is a difference between the experimental class and the control class (Table 3). The experimental class scored 83.38, while the control class scored 66.93, so it can be interpreted that the POE model carried out in the experimental class is more helpful for students in mastering science process skills compared to using lecture and demonstration methods (conventional methods) carried out in the control class. This is in accordance with research conducted by Arslan & Emre (2020), stating that the application of the POE model in the experimental class is better in improving science process skills compared to the control class without using the POE model, because in the learning process and activities by applying the learning model POE has a learning syntax that stimulates students to be more active in learning, such as students being allowed to develop their knowledge and the opportunity to think, search, find and explain examples of applying concepts that have been studied independently, including discussions with other peers.

The factor causing the low science process skills is caused by the model or learning method used at the time of learning that has not facilitated students to develop science process skills. This is following research Harahap et al. (2019), which states that one of the factors causing the low science process skills of students is because in general teaching and learning activities still use lecture and demonstration methods (conventional methods). In addition, in research Rahayu et al. (2015), states that the POE model can create more varied forms of learning so that students are expected to be involved in various experiences. The experience gained can develop the basic abilities of students to be creative, active, skilled in thinking, and acquire knowledge. Meanwhile, there is a comparison of the pretest scores for the indicators of science process skills between the experimental class and the control class. The comparison of the pretest scores of indicators of science process skills in the experimental class and control class is presented in Figure 1.

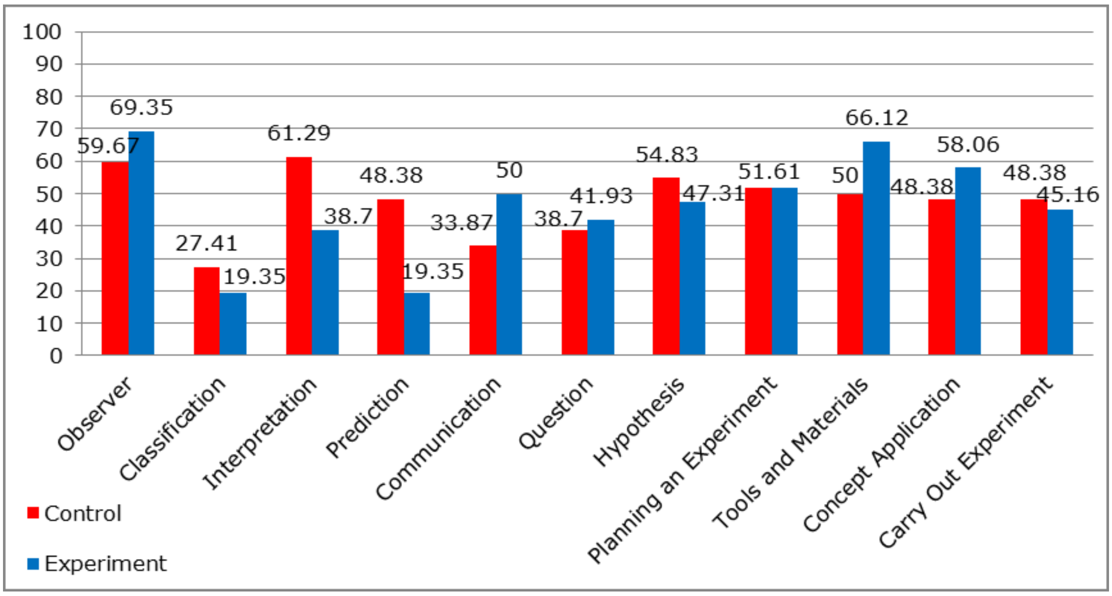

Figure 1. The Pretest Scores of Science Process Skills

Based on Figure 1, shows that students in the experimental class and control class already have science process skills. However, the science process skills possessed by the two classes are categorized as very low so they have met the requirements to be treated with the application of an POE learning model. In addition, there are differences in the posttest scores of indicators of science process skills in the experimental class and the control class. The comparison of the posttest scores of indicators of science process skills in the experimental class and control class is presented in Figure 2.

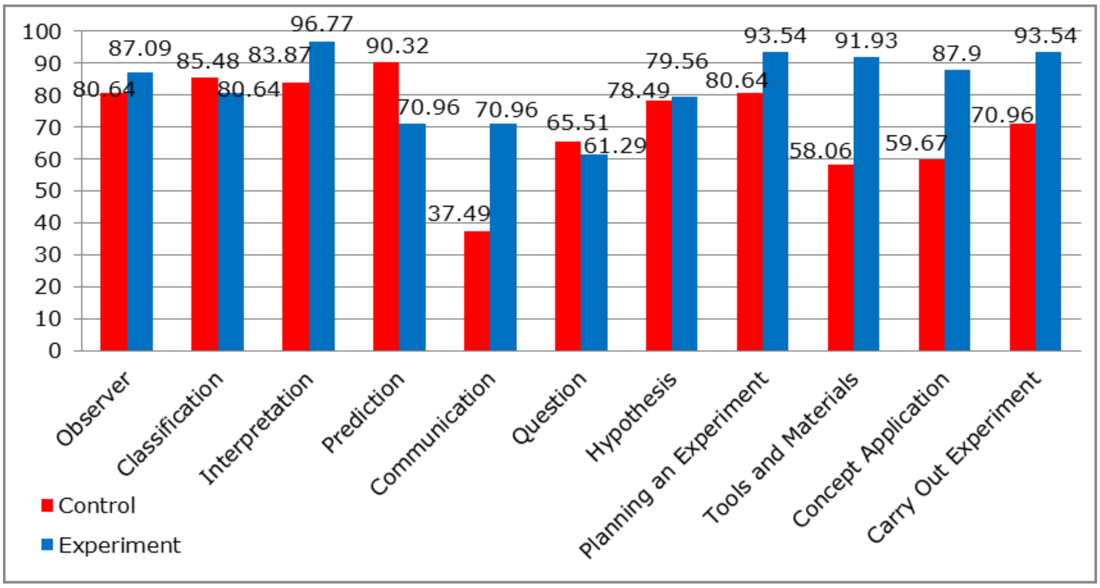

Figure 2. The Posttest Scores of Science Process Skills

Based on Figure 2, there are differences in the posttest scores of indicators of science process skills in the experimental class and the control class. In the experimental class, the highest posttest score achieved by the interpretation indicator is 96.77 (very high), while in the control class is 83.87 (high). This is because, in the experimental class that applies the POE learning model, students are asked to predict an event that they have never observed before, then they make direct observations of the material being studied so that students can participate actively. Then, students are asked to explain again the results obtained by linking student predictions with the results of observations that have been made, thus providing opportunities for students to be able to observe directly through practical activities on human thinking systems so that they can conclude learning outcomes. This is following research conducted by Ayvaci (2013), that the POE learning model can provide real new knowledge to students and can increase student participation to be more active and creative in learning. In addition, the POE learning model can train students to find and find answers or problems they face for themselves (Sreerekha et al., 2016).

In addition, there are differences in N-Gain scores in the experimental class and the control class. The analysis of the N-Gain test in this study is useful for knowing the difference in the improvement of students' science process skills between the experimental class and the control class. The results of this N-Gain value can be seen in Table 4.

Table 4. The Results of The N-Gain Score of Science Process Skills In The Experimental Class and Control Class

Description	Control Class	Experimental Class
Amount Sample	31	31
N-Gain Average	0.34	0.66
Category	Medium	Medium

Based on Table 4, the N-Gain value obtained by the experimental class was 0.66 in the high category while the control class obtained the N-Gain value of 0.34 in the medium category. The average value of N-Gain in the experimental class is higher than in the control class. This is in accordance with research conducted by Zulaeha et al., (2014), the study showed an increase in the ability of students' science process skills in the experimental class using the POE model. Likewise, a study conducted by Yulianto et al., (2014), stated that the POE learning model provides more meaningful learning because it is in accordance with the constructivism view, namely students build knowledge through the experience of POE learning activities. So that the teacher's task is no longer to provide knowledge, but to prepare situations that direct students to observe, ask questions, and find facts and concepts on their own.

Meanwhile, students' science process skills will increase if they have the experience to perform or practice these skills (Juhji & Nuangchalerm, 2020). However, practicum activities are carried out not only to find results but so that students better understand the experiment (Nuzulia et al., 2017). In the explain activity, students classify through group discussions. The goal is that students are trained to express ideas based on experiences that have been done. In this explain stage, the teacher facilitates students to conduct discussions based on the findings during the observe stage. Findings that are not in accordance with predictions are discussed. So that the classification indicators are formed in classes that use the POE learning model. According to Kurniawan & Djukri (2022), practicum activities in the laboratory that are carried out continuously will become a habit to develop self-potential to be more optimal in students' science process skills. As has been done in this study, by applying the POE learning model through practical activities, it is hoped that students can construct their own knowledge and develop scientific process skills (Özdemir, Bağ, & Bilen, 2011).

The data of science process skills were then analyzed using the analysis technique of the independent sample t-test. Normality test using kolmogorov-smirnov test. The results of the normality of science process skills for the N-gain in the experimental class and control class obtained the value of sig. 0.200 from Kolmogorov-Smirnov of > 0.05, Therefore, the research data obtained comes from the normally distributed population. Meanwhile, The results of the homogeneity test used the Homogeneity of Variance test obtained the value of sig. 0.881 from the homogeneity test of > 0.05 can be concluded that the data is homogeneous.

The results of the normality test and homogeneity test data are normally distributed and homogeneous, so it was continued to the parametric testing stage using the independent sample t-test as a hypothesis test. The results of the science process skills hypothesis test are presented in Table 5.

Tabel 5. The Result of Hypothesis Test

Instrument Type		Significance Value	Descprition
Science Process Skills	Equal variances assumed	0.000 (2-tailed) $\leq \alpha$ (0,05)	H_a accepted
	Equal variances not assumed	0.000 (2-tailed) $\leq \alpha$ (0,05)	H_a accepted

Based on Table 5, the results of the hypothesis test on science process skills obtained sig. 0.000 (2-tailed) 0.05, then H_a is accepted. Hypothesis testing using the independent sample t-test shows that there is a difference in the average value between the experimental class that uses the POE learning model and the control class that uses the lecture and demonstration method (conventional method), so it can be said that the POE learning model can improve science process skills of students. In the control class, the learning process uses lecture and demonstration methods (conventional methods). In the control class, practicum activities are also carried out, but students are not actively involved, due to the lack of student activity in the learning process. students in the control class did not make predictions so they did not hone the students' initial abilities. The control class was only given an explanation of the practicum activities and the teacher instructed them to make observations. In the control class, students' activities tend to be passive. This is in line with the results of research conducted by Nasution (2016), which states that the POE model as a whole can improve science process skills better than students who receive learning using conventional learning models.

The experimental class was better in improving science process skills compared to the control class, because in the learning processes and activities, by applying the POE learning model, there was a learning syntax that stimulate students to be more active in learning, such as students being given the opportunity to develop their knowledge and the opportunity to thinking, searching, finding and explaining examples of the concept applications that have been studied independently, including discussions with other peers. It was confirmedly agreed by Adebayo & Olufunke (2015), stating that the POE model can make teachers act as facilitators and direct students when something goes wrong or misconceptions to minimize the teacher's role and give students a lot of flexibility to make discoveries.

Likewise, conducted by Pane et al. (2020), the studies showed there was an increase in students' science process skills even though the results were not significantly different between the experimental class and the control class. Similarly, the findings of Yulianti et al., (2018), demonstrated that the POE learning model using controlled and simple experimental methods were able to influence students' science process skills. The POE learning model using a controlled experimental method had a higher science process skills average score compared to a simple experimental model. According to Fathonah (2016), the application of the POE learning model in the experimental class makes students actively involved in learning, this can be seen in the learning process by carrying out practical activities consisting of prediction, observation, and explanation activities. Students are asked to predict before starting learning activities. After making predictions, students do observation activities. Students then conduct discussion activities to explain the relationship between prediction and observation. These activities can train students' science process skills. This is confirmed in the research of Algiranto et al. (2019), which states that science process skills are related to academic skills, which are often called intellectual skills or scientific thinking skills. These skills consist of formulating hypotheses, selecting tools and materials, writing experimental data, analyzing data, interpreting data, and providing conclusions so that practicum activities are needed to support science process skills.

The POE learning model has advantages, namely that it requires students to be active in learning activities. In the experimental group, students are actively involved in learning, this can be seen from the learning process by carrying out practical activities consisting of prediction, observation, and explanation activities (Hsiao, et al., 2017). Practical activities can give students the opportunity to engage in authentic scientific practice, so that students can develop science skills, and engage collaboratively in designing, collecting data, interpreting data, and communicating scientific content. Besides, this POE learning model can also sharpen the patterns of thinking and improve student learning outcomes. The gained experience can develop students' basic abilities to be creative, active, and skilled in thinking and gaining their knowledge (Permatasari, et al., 2019). Besides, this POE learning model can also sharpen the patterns of thinking and improve student learning outcomes. The gained experience can develop students' basic abilities to be creative, active, and skilled in thinking and gaining knowledge (Alfiyanti, et al., 2020).

Conclusion

Implementing the predict-observe-explain (POE) model is proven to influence in improving students' science process skills on human digestive system material. In addition, the science process skills of students who are taught POE model are higher than students who are taught by conventional learning. Thus, POE model can be recommended in facilitating and improving students' science process skills on human digestive system material. This research implies that teachers can use the POE model and collaborate with practicum activities, so that students can develop science process skills. The POE model makes the teacher a facilitator and stimulates students to be more active in authentic learning, so that students can develop science skills, and engage collaboratively in designing, collecting data, interpreting data, and communicating scientific content.

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