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Research Article

Implementation of Process Oriented Guided Inquiry Learning Model Learning (Pogil) on Understanding of Science Concepts, Skills Science Process and Student's Critical Thinking Ability

Beslon Samosir*

Informatics and Communion Engineering, State Vocational High School 2 Pematangsiantar, 21151, Indonesia

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**Corresponding author:*
E-mail:
samosirbeslon@gmail.com

ABSTRACT

The purpose of this study was to determine the effect of the Audi Video Tenik Class XI Student Learning model at SMK Negeri 2 Pematangsiantar who had not carried out scientific inquiry in an effort to grow the ability to think, work, and behave scientifically. This study is a quasi-experimental design study with a nonequivalent control group. Sampling technique with a simple random sample. Hypothesis testing using Manova analysis and t test. The results showed that (1) there was an effect of the POGIL learning model on understanding science concepts, (2) there was an effect of the POGIL learning model on science process skills, (3) there was an effect of the POGIL learning model on critical thinking skills, and (4) there was a significant effect. significant application of the POGIL learning model simultaneously to understanding science concepts, science process skills, and critical thinking skills.

Keywords: *critical thinking skills, POGIL learning model, science process skills, understanding science concepts*

Introduction

Science aims to prepare students who are literate in science and technology, to understand themselves and the surrounding environment through the development of process skills, scientific attitudes, thinking skills, mastery of essential science concepts, technological activities and environmental management efforts Zhang et al., (2017);Pangaribuan et al., (2022). Science learning should develop the ability to think, be carried out by scientific inquiry, work, and behave scientifically and be able to communicate it as an important aspect of life skills. Osher et al., (2016); states, learning at school is more than just a process of helping students to learn. In this case, the teacher must be sure that students are really helped to learn the subject matter and skills required in the curriculum (Burbules et al., 2020). Theoretically, the subject matter is designed so that

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students learn by building knowledge and skills based on what has been previously learned and preparing ways to face the challenges that will come. Physics as part of science has a goal that goes hand in hand with the goal of that science Suhendi et al., (2018);Siahaan et al., (2020). Similar to learning science, physics also has the nature of being a process, product and affective (Gao et al., 2020). The nature of this science demands that physics learning be carried out through a constructivist process that facilitates students to practice process skills, build their own cognitive abilities, and foster a positive attitude Sari et al., (2020);Yin et al., (2020). The results of the Joint Examination (USB) for the Odd Semester Academic Year 2021/2022 show that in science subjects the average value of class XI Audio Video Engineering 1 is 65, class X Audio Video Engineering 2 is 60, class X Audio Video Technique 3 is 70 with KKM 75, this means that the average value of USB results in the odd semester of the 2021/2022 academic year is still lower than the KKM value for Physics subjects. Thus it can be said that students do not understand the concepts of the material they are studying, so we need a learning process that directs students to find out for themselves the answers to questions or problems, thus helping them to gain a deeper understanding. Similarly, science process skills and critical thinking owned by students is still very low, because the science learning process implemented has not facilitated students to conduct scientific investigations in order to obtain facts that support the answers to the questions they face, learning models, which can develop conceptual understanding, science process skills, and critical thinking skills (Pratama & Retnawati, 2018). Concept understanding, science process skills, and critical thinking skills in students can be built with a learning model that applies multi-directional communication between students and students and teachers, such a learning model is student centered. One of the learning models that apply student centered is Process Oriented Guided Inquiry Learning (POGIL). Rodriguez et al., (2020); Aiman et al., (2020); Treagust et al., (2020)explains that in the POGIL learning model students learn in groups in activities designed to improve mastery of the content of the subject and develop abilities in the learning process, thinking, problem solving, communication, group work, management and evaluation. POGIL is a research-based, student-centered philosophy and science pedagogy in which students work in small groups and engage in guided inquiry using materials that have been designed to directly guide students to rebuild their knowledge (Rodriguez, Lazenby, et al., 2020).

The POGIL Learning Model according to Wijaya & Handayani, (2021) has two broad goals, namely to develop mastery of content through the construction of students' own understanding, and to develop and improve key learning skills such as information processing, oral and written communication, critical thinking, problem solving, metacognition and assessment. Based on the above opinion, it can be said that the POGIL model is part of the inquiry learning model, especially guided inquiry which is process-oriented to facilitate the implementation of the inquiry learning process. Thus POGIL has an emphasis on process and content related to the application of concept understanding, science process skills, and critical thinking. The POGIL learning model is important to implement because in its learning activities POGIL works in a team form so that guided inquiry activities can be used to develop understanding and questions, problem solving and individual responsibility. This is in line with the opinion that the POGIL model requires students to work in small groups, look at the model or diagram, and answer carefully designed questions that guide them to understand the subject matter, with minimal guidance from the instructor. The POGIL model is an elaboration of 3 components, namely learning teams, guided inquiry activities, and metacognition. The three components are packaged through a learning cycle consisting of 3 phases, namely exploration, concept discovery, and application (Aiman et al., 2020).

Figure 1 presents the learning model with POGIL proposed by (Muhammad & Purwanto, 2020). The POGIL learning cycle begins with an exploration of a 'model'. This model contains sufficient information so that groups of students can extract the target concept. Students are then guided with critical thinking questions

that serve as guides to the target concept. Activities learning is then continued with class activities in the form of open discussions between groups, for example to find a pattern or relationship in the data. This activity continues so that a consensus is reached on the concept of IPA.

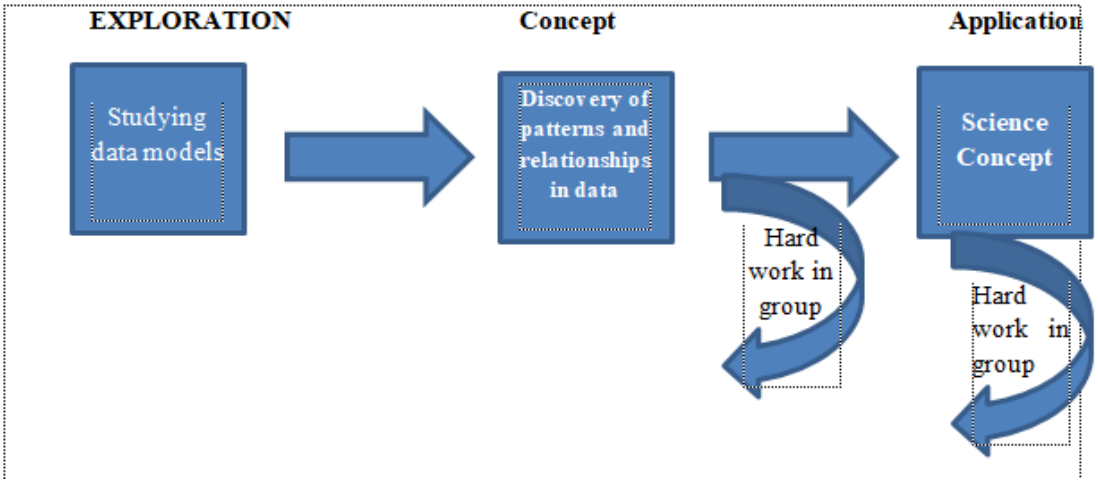

Figure 1 POGIL Model (Straumanis, 2010: 3)

The research that strengthens the researcher's opinion is also the research of Sanggara et al., (2018) which states that the mathematical problem solving ability of students who are taught using the POGIL model is more effective than students who are taught using Direct Learning. The results of research by Octaria, (2018) also show that learning the POGIL model can develop skills and think critically unless the indicator gives a reason. POGIL which has an emphasis on content and process, thus has a relationship with understanding and process skills, especially science process skills and critical thinking.

Methods

This type of research is a quasi-experimental design using a nonequivalent control group design (Siedlecki, 2020). The subjects of this study were 30 students of class XI Audio Video Engineering at SMK Negeri 2 Pematangsiantar City. This subject was chosen because the student had never previously applied the POGIL model for learning Physics. Observations sourced from teachers and students were carried out to measure student activity during learning using POGIL. With the design in Table 1 below.

Table 1. Research Design

Group	Pretes	Treatment	Postes
E	O1	X_1	O2
C	03	-	O4

Information:
E : Experiment Class
Control Class O1 : Pretest Experiment Class
O2 : Experiment Class Posttest
O3 : Pretest Keela Control
O4 : Control Class Posttest

The research activity begins with a pretest for both the experimental class and the control class. In the experimental class the POGIL learning model was applied) and the control class with a conventional learning model. After receiving different treatment, both classes were given posttests on understanding science concepts, science process skills and critical thinking skills. The population in this study were all students of class XI Audio Video Engineering at SMK Negeri 2 Pematangsiantar in the 2021/2022 academic year which consisted of 3 classes. The sampling technique in this study used a simple random sampling technique. From the three population classes, 4 sample classes were randomly selected. The four classes were randomly selected again, two

classes to be experimental classes and two classes to be controls. Data collection was carried out using test techniques. Science concept understanding test to measure concept understanding indicators, namely (1) translation (translation) (2) interpretation (interpretation) and (3) initial extrapolation.

The science process skills test used to measure the process skill indicators are observing (observing), predicting (predicting), hypothesizing, planning experiments, using tools/materials, applying concepts and communicating (Juniar et al., 2018). The critical thinking ability test measures critical thinking ability indicators which refer to critical thinking ability indicators (Ennis, 1985) including (1) providing simple explanations, (2) building basic skills, (3) concluding, (4) providing explanations (5) organizing strategy and tactics. The data analysis technique in this study is the Independent Sample t Test and the Manova test with first the normality test and homogeneity test. The normality test used Lilliefors (Kolmogorov-Smirnov compatibility test) which was processed with SPSS 22 software for windows. With Asymp criteria. Sig. (2tailed) > 0.05 data is normally distributed. The homogeneity test in this study uses the Lavene Test and the Box's M test. The Lavene Test aims to determine whether the data on each dependent variable has homogeneous variances or not. Box's M test aims to find out the data on all variables together have homogeneous variances or not. The decision criteria if Sig. > 0.05 then the data is homogeneous or vice versa. Data processing using SPSS software. Testing the hypothesis on each dependent variable using the Independent Sample t Test, with the criteria if tcount > ttable H0 is rejected at a significance level of 0.05 or vice versa, while to test the effect of independent variables on the dependent variable simultaneously, the Manova test is used with the criteria if the Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root scores show significance (Sig) > 0.05, then H_o is accepted and if the significance score (Sig) < 0.05, then H_0 is rejected. Calculations using SPSS 22 software for windows (Purba et al., 2021).

Results

The results of student test scores obtained after treatment are in table 2 below.

Table 2. Obtaining Mpmp XI TAV Uas Scores at SMK Negeri 2 Pematangsiantar

NO	Timestamp	Nama Lengkap	Kelas	Score
1	6/9/2022 9:43:34	RIO FACHRY ANUGRAH SIALLAGAN	XI TAV 1	81 / 100
2	6/9/2022 9:43:35	Ridho Rahman Siregar	XI TAV 1	81 / 100
3	6/9/2022 9:47:18	Angga kurniawan	XI TAV 1	61 / 100
4	6/9/2022 9:47:23	PIKI RAMADANI	XI TAV 1	25 / 100
5	6/9/2022 9:47:41	Rahmat muharsyah lubis	XI TAV 1	84 / 100
6	6/9/2022 9:49:12	ANDRI ALFANDI MANIK	XI TAV 1	85 / 100
7	6/9/2022 9:49:34	Eliesar Sitanggang	XI TAV 1	85 / 100
8	6/9/2022 9:49:48	Yendi arya mawada	XI TAV 1	44 / 100
9	6/9/2022 9:50:25	BAYU ARISANDHI	XI TAV 1	22 / 100
10	6/9/2022 9:51:31	MHD.AFDAL IKYAS SYAH	XI TAV 1	84 / 100
11	6/9/2022 9:51:39	Muhammad Al Amin	XI TAV 1	69 / 100
12	6/9/2022 9:51:41	Daniel Pernando Purba	XI TAV 1	77 / 100
13	6/9/2022 9:52:15	Yetro zifora Elkana Sitohang	XI TAV 1	60 / 100
14	6/9/2022 9:52:32	Jaka saputra	XI TAV 1	72 / 100
15	6/9/2022 9:52:36	Khairul Amru Nasution	XI TAV 1	71 / 100
16	6/9/2022 9:52:58	Teguh sanjaya nasution	XI TAV 1	75 / 100

NO	Timestamp	Nama Lengkap	Kelas	Score
17	6/9/2022 9:53:31	Gunawan	XI TAV 1	48 / 100
18	6/9/2022 9:53:38	David francys Manurung	XI TAV 1	59 / 100
19	6/9/2022 9:54:16	Ilham zulfahreza siahaan	XI TAV 1	77 / 100
20	6/9/2022 9:55:40	Alex Efriandi Damanik	XI TAV 1	66 / 100
21	6/9/2022 9:57:15	Vicky Dwi Dio Efendi	XI TAV 1	69 / 100
22	6/9/2022 9:57:51	Khoiri aulia wildan	XI TAV 1	81 / 100
23	6/9/2022 9:58:31	Reno kurniawan	XI TAV 1	54 / 100
24	6/9/2022 9:59:15	Jita jaya nainggolan	XI TAV 1	45 / 100
25	6/9/2022 9:59:49	Abdul Manan Afiq	XI TAV 1	78 / 100
26	6/9/2022 9:59:55	Abror Riski	XI TAV 1	75 / 100
27	6/9/2022 10:01:26	Ricky Laurensius Siallagan	XI TAV 1	54 / 100
1	6/9/2022 9:22:28	Pirtoni Pratama sinaga	XI TAV 2	40 / 100
2	6/9/2022 9:24:11	Ripandi nainggolan	XI TAV 2	36 / 100
3	6/9/2022 9:24:52	Joy immanuel gultom	XI TAV 2	59 / 100
4	6/9/2022 9:27:22	Devit Saragih Jawak	XI TAV 2	24 / 100
5	6/9/2022 9:33:56	Ramlinus sitorus	XI TAV 2	29 / 100
6	6/9/2022 9:36:20	Liston parasian damanik	XI TAV 2	30 / 100
7	6/9/2022 9:36:51	Vrijan sinambela	XI TAV 2	73 / 100
8	6/9/2022 9:37:15	Agus tino aditya nainggolan	XI TAV 2	88 / 100
9	6/9/2022 9:41:49	ANDREW MICHAEL PRATAMA HU-TAPEA	XI TAV 2	24 / 100
10	6/9/2022 9:43:25	Febrian Rafael zebua	XI TAV 2	89 / 100
11	6/9/2022 9:45:56	Maikel lubis si tampan maut	XI TAV 2	19 / 100
12	6/9/2022 9:48:20	Tritya fidelito ebetnego Simanjuntak	XI TAV 2	25 / 100
13	6/9/2022 9:50:23	HARIL HUTAPEA	XI TAV 2	21 / 100
14	6/9/2022 9:51:29	Dicky Fernando Syaputra Purba	XI TAV 2	29 / 100
15	6/9/2022 9:52:11	Aril Lasito LumbanRajaa	XI TAV 2	9 / 100
16	6/9/2022 9:52:43	Rafles Sinaga	XI TAV 2	75 / 100
17	6/9/2022 9:52:58	DODDY FRANCEDO GARINGGING	XI TAV 2	72 / 100
18	6/9/2022 9:53:47	RICARDO PASKA SILALAHI	XI TAV 2	33 / 100
19	6/9/2022 9:54:11	Jhohannes Siregar	XI TAV 2	57 / 100
20	6/9/2022 9:56:03	Panistel Manurung	XI TAV 2	79 / 100
21	6/9/2022 9:56:32	Ivan E jeremia parhusip	XI TAV 2	75 / 100
22	6/9/2022 9:59:21	David. Z. A. Marpaung	XI TAV 2	72 / 100
23	6/9/2022 10:01:29	Alfron jesenko manurung	XI TAV 2	69 / 100
24	6/9/2022 10:02:59	Rendi Michael Sembiring	XI TAV 2	54 / 100
25	6/9/2022 10:03:21	Herry Siburian	XI TAV 2	65 / 100
26	6/9/2022 10:03:35	Yohana Aprillia Siburian	XI TAV 2	72 / 100
27	6/9/2022 10:04:03	Irwanto simbolon	XI TAV 2	58 / 100

NO	Timestamp	Nama Lengkap	Kelas	Score
28	6/9/2022 10:04:36	Tober Alexander sijabat	XI TAV 2	76 / 100
29	6/9/2022 10:04:51	Josua Hutajulu	XI TAV 2	58 / 100
30	6/9/2022 10:05:21	Christian johor manurung	XI TAV 2	68 / 100

The description of the research results is shown in Figure 1 below:

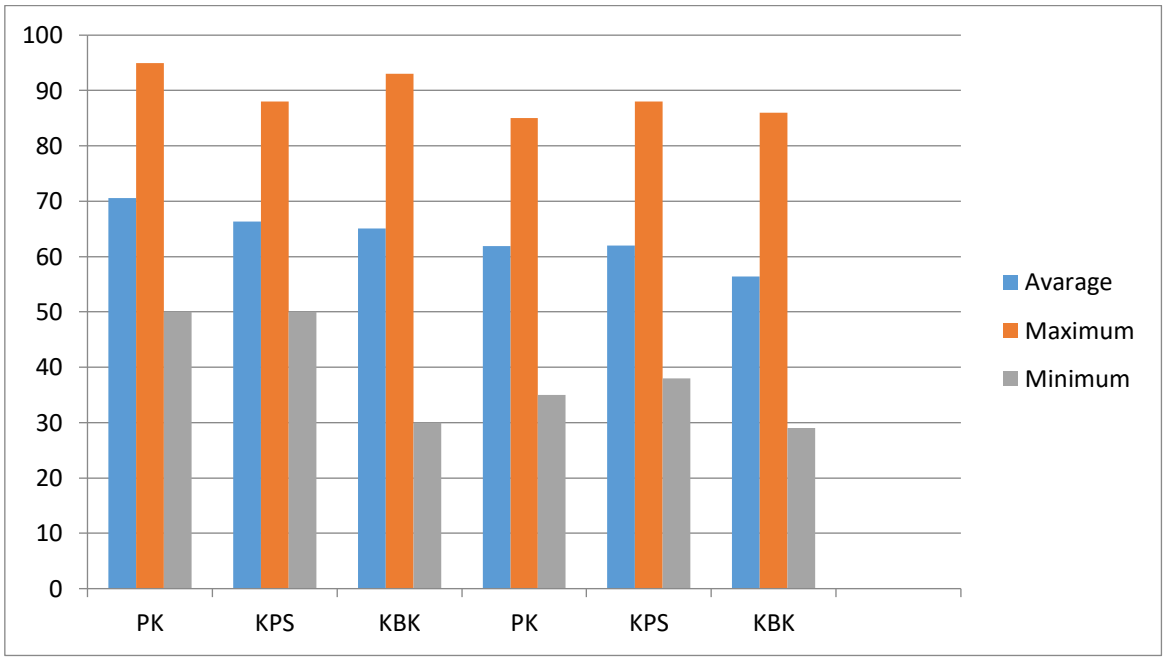

Figure 1. Table Description of group data

Information:
PK : Understanding of science concepts
KPS : Science Process Skills
KBK : Critical Thinking Ability

The figure above shows that the highest value of understanding science concepts in the experimental group is 95 and the lowest is 50 with an average of 70.56, in the control group the highest value is 85, and the lowest is 35 with an average of 61.88. Thus, it can be said that the value of the science process skills variable in the experimental group obtained the highest score of 88 and the lowest 46 with an average of 66.32. In the control group, the highest score was 88, the lowest was 38 with an average of 61.88. The value of critical thinking ability for the experimental group was 93, the lowest was 36, and the average was 65.03, while in the control group the highest score was 86 and the lowest was 29 with an average of 56.44. From the facts above, it can be said that the experimental group that applied the POGIL learning model had a higher average value than the control group that applied the conventional model.

Independent Sample t Test in this study to test the effect of the independent variables on each dependent variable. The data from the test results can be seen in the following table:

Table 3. Independent Samples t Test

Variabel t	df	Sig (2)	95% Confidence Interval of Difrence			
			Upper	Std. Error Difrence	Lower	
Understanding of Science Concepts Equal variances 4.161 assumed	142	.000	8.681	2.086	4.556	12.805
Science Process Skills Equal variances 2.126 assumed	142	.035	4.319	2.032	.304	8.335
Critical thinking Equal variances 3.564 assumed	142	.000	8.583	2.409	3.822	13.345

The results of the Independent Sample t Test in IPA have a t-count value of 4.161 and on the variables. The variable understanding of the concept of the value of ttable at a significant level of 0.05 is The results of the Independent Sample t Test in IPA have a t-count value of 4.161 and on the variables. The variable understanding of the concept of ttable value at a significant level of 0.05 of 1.977 means $t_{count} > t_{table}$. Thus, it can be concluded that H0 is rejected and H_1 is accepted, meaning that there is an effect of the POGIL learning model on understanding science concepts. The science process skill variable has a tcount value of 2.126 and t_{table} at a significant level of 0.05 of 1.977, meaning that the value of tcount > ttable. Thus, it can be concluded that H0 is rejected and H1 is accepted, meaning that there is an effect of the model Table 3: Multivariate Test Results of POGIL learning on science process skills. The tcount value for the critical thinking ability variable is 3.564 and ttable at a significant level of 0.05 is 1.977, meaning $t_{count} > t_{table}$, it can be concluded that H0 is rejected and H_1 is accepted, meaning that there is an effect of the POGIL learning model on critical thinking.

Manova test results can be seen in the following table.

Table 4. Multivariate Test Results

	Effect	Value	Hypothesis			Sig.	Partial Eta Squared
			F	df	Error df		
Learning Model	Pillai's Trace	0.513	49.235	3.000	140.000	0.000	0.513
	Wilks' Lambda	0.487	49.235	3.000	140.000	0.000	0.513
	Hotelling's Trace	1.055	49.235	3.000	140.000	0.000	0.513
	Roy's Largest Root	1.055	49.235	3.000	140.000	0.000	0.513

Based on Table 3 above, the value of Sig. which were tested with the Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root procedures all showed the number 0.000, meaning that the Sig value < 0.05 according to the criteria above, it can be concluded that H_0 is rejected and H_1 is accepted, meaning that there is a simultaneous influence of the POGIL learning model on Understanding of science concepts, science process skills, and critical thinking skills.

The results of data analysis show that there is an effect of the POGIL learning model on understanding science concepts. This influence is caused by the application of the POGIL model which directs students more easily to understand learning material because it is taught through teamwork or groups in solving problems and problems given by the teacher. This is in accordance with the statement put forward by Brown (2010) that learning in teams allows students to further develop their reasoning at a higher level, because the discussions carried out occur in the division of roles in groups, thus making learning more interesting and helping collaboration between members who work together. resulted in the growth of student activity in learning. In addition, guided inquiry

learning can encourage students actively to explore their own knowledge so that students can become independent, active, and skilled in solving problems based on the information and knowledge obtained (Siahaan et al., 2021) Thus the learning model can encourage the activeness of students to explore their knowledge independently in solving problems in the concepts they are studying.

The advantages of the POGIL learning model can be seen from the readiness of students in the learning process, because students first prepare themselves about the material to be studied. Therefore Therefore, students have readiness in the form of knowledge and understanding of initial concepts in the material to be studied. In applying the POGIL learning model at the end of each lesson the teacher requires students to read the learning material that will be studied at the next meeting. Thus, students who have studied the material first will find it easier to find concepts, so that their understanding of the concepts in the material they study is getting stronger. In addition, the concepts found received confirmation from the team or group and even from the teacher.

Based on the results of data analysis, it shows that there is an effect of the POGIL learning model on science process skills. This is because the experimental group that applies the POGIL learning model conducts an experiment or practicum. By conducting experiments students experience directly the process they are learning so that they are really focused on what they are doing or learning. Science process skills can be developed through direct experience because students can better appreciate the process or activity being carried out.

Many benefits are obtained by involving students in laboratory activities, including increasing the meaning of learning, conceptual understanding and understanding of the nature of science. Therefore, science process skills can be trained from the description of research data, known natural phenomena, and simple equipment around students. According to Rahadian et al., (2019) the learning process is not just an activity to convey and explain the concepts learned, but involves students to build knowledge and skills, formulate problems through laboratory activities.

The application of the POGIL learning model has an effect on critical thinking skills. The increase in students' critical thinking skills is caused by the application of the POGIL learning model which provides opportunities for students to think in solving problems found in the learning process. Rumain & Geliebter, (2020) explains that in the POGIL model students learn in groups in activities designed to improve mastery of the content of the subject and develop abilities in the learning process, thinking, problem solving, communication, group work, management and evaluation. Furthermore, Treagust et al., (2020) stated that POGIL learning involved students in developing information, knowledge, and helping students develop understanding by applying the learning cycle in guided inquiry activities.

The POGIL learning model invites students to think through experiments, in this study the experiments carried out were about photosynthesis in order to analyze and conclude the experimental results so that students have critical thinking skills. Research by Sanggara et al., (2018) also shows that the POGIL learning model can develop critical thinking skills. Wijaya & Handayani, (2021) states that the improvement of students' critical thinking skills occurs through POGIL, because students experience meaningful learning. In POGIL, students analyze experimental results guided by various critical questions that are sequential and continuous, on Finally, students can draw conclusions correctly so that critical thinking skills are built. The results of data analysis also show that there is a simultaneous influence of the POGIL learning model on understanding science concepts, science process skills, and critical thinking skills. The POGIL Learning Model has also been proven to theoretically influence understanding concepts, science process skills, and critical thinking skills in students in science learning. This is in accordance with research conducted by Aiman et al., (2020), the POGIL learning model has more influence in critical thinking in solving problems. In line with this opinion, Rumain & Geliebter, (2020) examines the comparison of student performance during learning using the POGIL model and the traditional model. He concluded that the POGIL model is an effective learning model to improve

students' academic performance and performance.

Another study related to the application of the POGIL learning model Rodriguez, Lazenby, et al., (2020) stated that the POGIL model had a positive influence on students' cognitive, affective and creative learning outcomes. Douglas & Chiu, (2013) conclude that theoretically the process oriented guided inquiry learning (POGIL) learning model has a positive effect on science process skills (KPS) and students' cognitive abilities. Muhammad & Purwanto, (2020) also stated that the POGIL model can improve critical thinking skills and improve aspects of hypothesizing, analyzing and concluding. From the various research results that have been carried out above, it can be concluded that the POGIL learning model provides positive results on understanding science concepts, science process skills, and critical thinking skills. Thus the POGIL learning model can be applied to science subjects because in this learning process students are trained to construct their own cognitive abilities, provide facilities for students to practice their science process skills and foster creativity in thinking. Thus the concepts learned will be easy to understand, then proven through experiments or practicums to build their scientific process skills and are given the opportunity to assess their performance and think about how to improve their shortcomings.

Conclusion

Based on the results of research and discussions that have been carried out, it can be concluded that there is a positive influence from the application of the POGIL learning model on understanding science concepts. In this case, the POGIL learning model emphasizes the formation of concepts independently by students with the guidance of the teacher, so as to give a deep impression of the concepts they are learning. There is also a positive influence from the application of the POGIL learning model on science process skills. In the learning process with the POGIL model, students carry out practical activities or experiments as an effort to prove the concepts or theories they have understood. And there is a positive influence from the application of the POGIL learning model on critical thinking skills. In this case, students explore problems as a critical thinking response, in the form of questions that lead to identifying concepts and understanding the concepts that are built and the application of knowledge. And lastly, there is a simultaneous influence from the application of the POGIL learning model on understanding science concepts, science process skills, and critical thinking skills.

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