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Comparative Study on Student's Critical Thinking Ability using POGIL, PBL, and TCL Models

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Abstract: The purpose of this experiment was to determine whether or not there were differences in the learning model between Process-Oriented Guided Inquiry Learning (POGIL), Problem Based Learning (PBL), and Teacher-Centered Learning (TCL) with the application of HOTS questions in their learning on students' critical thinking skills. This study used a quasi-experimental research design with the static group pretest-posttest design. The sampling technique used the cluster random sampling technique. The population of this research is the students of class XI MIPA SMA Negeri Gondangrejo in the academic year 2021/2022. The results showed that there were differences in students' critical thinking skills in the POGIL and PBL learning models with conventional learning, all three of which used the application of HOTS questions in their learning. This is based on the significant value of the One-Way ANOVA test, a significance value of <0.05 is obtained, which is 0.000, which means that H0 was rejected. Then, based on the calculation of the N-gain score for each POGIL, PBL, and TCL learning model, the results obtained are 0.71 in the high category; 0.54 in the medium category; and 0.39 in the medium category. However, based on the results of the Post Hoc-Scheefe test between the POGIL and PBL learning models, a significance value of > 0.05 was obtained, which was 0.098, so it could be concluded that there was no significant difference between the POGIL and PBL learning models on critical thinking skills. Therefore, both POGIL and PBL learning models can help improve students' critical thinking skills. The average critical thinking ability in the POGIL experimental class, PBL experimental class, and control class after treatment was 69.44%, 68.54%, and 59.72%.

Keywords: Critical Thinking Skills; HOTS Questions; PBL; POGIL

Introduction

The rapid development of knowledge and technology is one of the signs of 21st-century education. Education in this century has the aim of directing students to have the ability to be sensitive to changes in the times. One of the things that must be prepared is to develop self-excellence through science education. Science has urgency in everyday life to identify the conflicts encountered. One of the steps is to have high critical thinking skills (Prayogi et al., 2018; Rodzalan & Saat, 2015). Students who have high critical thinking skills are better able to analyze the positive and negative things of an event so that they can make the right decisions based on facts and can defend the arguments and decisions that have been assembled (Sari et al., 2019; Alpindo & Amir, 2014).

However, the rapid pace of development of knowledge and technology does not spontaneously increase Indonesia's ranking on PISA and TIMSS. Such as 2015 data where Indonesia is ranked 64th out of 72 countries that contribute to PISA and ranks 45th out of 48 countries that contribute to TIMSS (Nugroho, 2018). These results can indicate the low reasoning ability of students so that students' critical thinking skills are still relatively low. In addition, the low results provide a

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warning to the Indonesian education sector to immediately prepare for the rapid growth of knowledge and technology in this century, such as training students to use HOTS-based questions in classroom learning (Sukla, 2016).

Based on research conducted by Palennari (2017; Hadi et al., 2018), it is proven that the implementation of problem-based learning models such as Problem Based Learning (without being given training on working on HOTS questions) is not optimal in supporting the increase in students' critical thinking skills. The results of his research said that the model has been able to improve students' critical thinking skills but is still not so significant. Thus, creativity and other methods are needed to improve student's critical thinking skills quickly. One of the methods is to modify the learning model by incorporating HOTS elements in its implementation, such as getting students to practice doing analysis (C4), synthesis (C5), and creating (C6) questions.

Gondangrejo State High School is a school that implements Teacher-Centered learning. Based on observations, in the chemistry learning process teachers still apply the TCL (Teacher-Centered Learning) learning model which is accompanied by the lecture method, providing material and practice questions through Microsoft teams without a discussion process, where students act as objects or as recipients of insights that are transferred directly by the teacher. This statement indicates that in learning the main source of information obtained still comes from the teacher. Then, based on the results of interviews with the chemistry teacher in class XI MIPA, SMA Negeri Gondangrejo said that students still had difficulties in carrying out critical reasoning activities. When a question-and-answer forum was held, most of the students had not been able to express critical and in-depth chemistry questions and answers. In addition, it is still based on interviews with supporting teachers, that when students are given stimulated practice questions with a cognitive level of C4, most of the students are not able to work on and solve the questions correctly as a result of the learning process still using cognitive level questions C1, C2, and C3 and have not been trained to get used to working on questions with cognitive levels of C4, C5, and even C6. Based on the narrative from the subject teacher, it can be concluded that the level of critical thinking skills of students at SMA Negeri Gondangrejo is still relatively low, especially seeing how students have not been able to develop their analytical thinking in more depth on the given contextual problems.

In learning chemistry, students can be trained to improve their critical thinking skills. The step is to implement an innovative learning model that supports HOTS learning and critical thinking skills and can be applied in solubility and solubility product materials, namely Problem Based Learning (PBL) and Process-Oriented Guided Inquiry Learning (POGIL) (Walker & Warfa, 2017). This is because both models are student-centered.

Problem-Based Learning is a learning model that involves students solving a problem using the scientific method so that students can explore new insights that are still related to the problems presented (Warsono & Hariyanto, 2015). Research conducted by Rusmina (2014) revealed that the application of Problem Based Learning can increase the percentage of critical thinking skills and learning outcomes in colloidal chemistry.

Furthermore, the model applied is the POGIL model. The POGIL model is an inquiry learning model that is student-centered and based on reasoning development by incising questions and answers simultaneously. Learning requires students to actively participate in the process of concept discovery and solving science-based problems. Fitriani's research (2017) which compares the inquiry-based learning model, namely POGIL (Process-Oriented Guided Inquiry Learning) and GI (Guided Inquiry), stated that the use of the POGIL model was more effective in improving students' critical thinking skills in the Chemical Balance material compared to the use of the GI model. The average post-test shows that students' critical thinking skills with the POGIL model are 71.51% while the GI model is 62.2%. This shows that the POGIL model is more effective in improving students' critical thinking skills than the GI model.

Based on the description of the problem above, the researcher took the initiative to conduct a study entitled "The Influence of the Process-Oriented Guided Inquiry Learning and Problem Based Learning with High Order Thinking Skills on Students' Critical Thinking Ability" with the hope of finding the most effective learning model by applying HOTS questions and having a big impact on improving abilities. students' critical thinking.

Method

This research is quasi-experimental research using the static group pretest-posttest design. The subjects of this study were divided into three experimental groups I and II, and one control group. Experimental group 1 used the POGIL learning model, experimental group 2 used the PBL learning model and the control group used the conventional learning model (TCL). The subjects in this study were students of class XI MIPA SMA Negeri Gondangrejo for the academic year 2021/2022. The sample selection was taken by conducting an initial homogeneity test using the SPSS 25 program on the

value of PAS Chemistry Semester 1. The results of the homogeneity test showed a significance value of > 0.05, which was 0.091, which means that the four Mathematics and Natural Sciences classes that make up the population are homogeneous or the variance between groups is the same. Based on these considerations, the determination of the experimental class 1, experiment 2 and control class was carried out by randomization three times through the cluster random sampling technique. The instrument of this research is a written test in the form of an essay to measure students' critical thinking skills on the material solubility and solubility product (Ksp). The preparation of the test instrument was developed by adapting the indicators of critical thinking ability by Ennis (1995). Critical thinking ability test questions both on the pretest and post-test consist of 6 items of description that have previously been tested for validity, reliability, discriminating power, and level of difficulty. The initial analysis for the experimental prerequisite test used the normality test with Saphiro Wilk and the homogeneity test with Levene, while the hypothesis test used One-Way ANOVA. All analyzes were carried out with the help of the SPSS 25 program.

Result and Discussion

Based on the results of the normality test for the difference in pretest-posttest, it can be seen that all groups had a significance value >0.05, namely 0.117 for the POGIL experimental class, 0.267 for the PBL experimental class, and 0.071 for the control class which can be concluded that the data is normally distributed. Then, based on the homogeneity test, a significance value of > 0.05 was obtained, which was 0.118 so it could be concluded that the data had a homogeneous variance. Because it has met the requirements, namely the data is normally distributed and homogeneous, hypothesis testing can be done using parametric statistical tests using the One-Way ANOVA (Analysis of Variance) test. Based on the data above, it can be shown that the significance value <0.05 is 0.000, so H_0 is rejected, so it can be concluded that there are significant differences in the POGIL, PBL, and TCL experimental groups after being given treatment on students' critical thinking skills. After knowing the differences in students' critical thinking abilities between the three classes, further tests were carried out by the Post Hoc Test-Scheefe as shown in Table 1 to find out how big the difference between the three learning models was.

Based on the significance value, it can be concluded that there is no significant difference in students' critical thinking skills with the POGIL learning model and the PBL learning model. Then, there is a significant difference in critical thinking skills between the POGIL learning model and the TCL learning model. Furthermore, there are significant differences in critical thinking skills between the PBL learning model and the TCL learning model.

Table 1. Results of the Post Hoc Test-Scheefe

Inter-Class		Significance
POGIL	PBL	0.098
	TCL	0.000
PBL	POGIL	0.098
	TCL	0.000
TCL	POGIL	0.000
	PBL	0.000

This statement is also supported by the results of the N-Gain score which shows that the POGIL experimental class is in the "high" category with a value of 0.71 then the PBL and TCL experimental classes are in the "medium" category with a value of 0.54 and 0.40. In line with research conducted by Elis et al. (2019) regarding POGIL learning with the application of HOTS questions in learning, the N-Gain score for critical thinking skills is the same as this study, which is 0.71 and has the "high" criteria. Meanwhile, in the research conducted by Ginting & Setiawan (2021) regarding Problem Based Learning, the N-Gain score was 0.61 and the criteria were "medium". There are similarities in criteria with the PBL model carried out by the researcher, but the N-Gain scores were higher than the PBL model conducted by the researcher, this difference can be caused by the level of education in Ginting & Setiawan (2021); and Irwanto (2017), research was conducted in fifth-grade elementary schools.

This is in line with the research on the POGIL and PBL learning models conducted by Tyasning et al. (2015), which states that between the POGIL and PBL learning models there is no significant difference in the learning outcomes of the attitude aspect. Students' motivation and interest in learning chemistry can be increased by PBL learning. Students will be trained to actively gain their insights by conducting discussions with teammates and observing learning materials. This process aims to raise enthusiasm in students and is carried out based on curiosity about the problems presented by the teacher where these problems are still related to the material being taught and occur in real life. Then, the exploration stage in POGIL learning is also able to increase student interest because in the process the teacher will present the basic points of the material to be studied and the urgency of the material to foster student interest in learning and form the initial foundation for these insights. Therefore, these two learning models do not provide a significant difference

in attitude values because they can increase students' interest in learning chemistry. Furthermore, the relationship between interest and motivation in learning to students' critical thinking skills can be described through research conducted by Darwis et al. (2020), where interest in learning, self-steadiness, and concern for others have a positive correlation with critical thinking skills. This is reinforced by research by Eberlein (2008), cited in Tyasning et al. (2015), which states that the POGIL and PBL learning models aim to improve higher-order thinking skills and introduce and link students to be able to learn from problems and construct concepts. Thus, one of the reasons that there is no significant difference in students' critical thinking skills on the solubility and product solubility product using the adaptation of HOTS questions with the POGIL learning model and the PBL learning model is because both models can increase students' interest and motivation in learning which is positively correlated with increasing students' critical thinking skills.

Meanwhile, the significance value of the test between classes that use the POGIL learning model and the TCL learning model and the PBL learning model class with the TCL model are both worth 0.000. Thus, it can be concluded that there is a significant difference in students' critical thinking skills in the solubility and solubility product using the HOTS question with the POGIL learning model and the TCL learning model as well as with the PBL learning model and the TCL learning model. Still related to students' interest in learning, in the TCL learning model, students tend to have a low interest in learning so their critical thinking skills are low. This is in line with research conducted by Rohmah (2019), which states that generally students with conventional learning will get bored easily and are less interested in learning new things because there are no triggers from a monotonous learning system. Therefore, their critical thinking skills are still not better than the POGIL and PBL experimental groups.

In this study, Ennis (1995), used six critical thinking indicators which were adapted to the POGIL and PBL syntaxes. The complete indicator can be seen in Table 2. Then, the N-Gain score on each critical thinking indicator to find out how to improve and also the effectiveness of a learning model on existing critical thinking indicators. A comparison of the N-Gain scores can be seen in Figure 1.

Table 2. Percentage of Critical Thinking Indicators Achievement Indicator

Code	Indicator	Pretest (%)			Posttest (%)		
		POGIL	PBL	Control	POGIL	PBL	Control
A	Focusing on questions	37.88	60	67.24	86.36	86.67	75.86
B	Analyzing arguments	35.35	38.33	39.08	81.82	85.56	73.56
C	Making deductions and considering the results of deductions	23.48	20.83	23.28	81.82	80.42	68.97
D	Deciding on an action	16.67	10.83	12.64	41.92	41.11	30.46
E	Considering the credibility of a source	15.66	10.56	13.22	52.02	45.83	43.10
F	Identifying assumptions	20.45	20	22.41	72.73	71.67	66.38

The first is an indicator of focusing questions. The percentage of achievement of the highest critical thinking indicators in the three learning models in this study lies in the indicator of focusing questions. This gain is because at the beginning of each lesson the teacher will provoke focus and spark students' interest by providing an apperception regarding the application of the material in everyday life (POGIL and TCL) or a case (in the PBL model). Therefore, students can focus on the material that will be delivered by the teacher afterward. Kolayiş (2014) also states that the purpose of critical thinking indicators is to maintain a state of mind so that it can identify and formulate questions at the next stage. This is also supported by the N-Gain score of the POGIL experimental class on the indicator focusing questions which have the highest score of 0.78 compared to the PBL and control experimental classes which are 0.67 and 0.26 respectively. However, the highest percentage of achievement indicators focusing on questions is achieved by the PBL model, this is because the PBL model will train and prepare students early to identify problems and think about how to solve the problem correctly and quickly. According to Sani et al., (2020), in problem-based learning students are guided and trained to understand the context of problems and solve them in teamwork so that they can improve students critical thinking and socializing skills. Likewise, according to Farisi (2017), this PBL model does not require conveying the whole material directly to students but the main goal is so that students are accustomed to dealing with problems and can take the meaning of learning from the problems given and develop their critical thinking skills further.

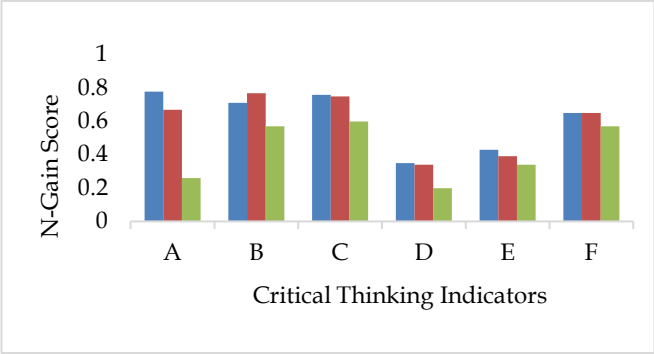

Figure 1. The Comparison of N-Gain Scores Based on Critical Thinking Indicators

Second, indicators analyze arguments. Based on Table 2, it can be seen that the achievement of this indicator percentage from the three models both occupies the second-highest percentage after focusing on the questions. This is because the indicators of analyzing arguments are located in the last stage of each learning model. As with POGIL, it lies in a closure, where at this stage students present the results of group work and draw conclusions from learning outcomes. Then, PBL lies in the syntax of analysis and evaluation of problem-solving where at this stage the teacher will direct students to reflect and evaluate the investigations that have been carried out and the processes used in solving problems. It is the same with TCL where this stage is when evaluating learning. The ability of students to analyze arguments is trained when discussion forums or questions and answers take place because in it students will be trained to be able to defend and accept the arguments of other groups based on the concepts of material that they have obtained in each previous learning process (Sani et al., 2020). The ideas of each student will be developed through group work. Nevertheless, the achievement of the largest percentage of the indicators of analyzing arguments after treatment was achieved by learning with the PBL model as much as 85.56%. This is also reinforced by the results of the N-Gain score of the PBL model on the indicator of analyzing arguments which obtained the highest score of 0.77 compared to the POGIL and TCL models which were 0.71 and 0.57, respectively. These results are in line with research by Defiyanti & Sumarni (2019), that in PBL learning students feel happy and interested so students become more active in voicing their ideas when discussions and analytical skills increase. In addition, the main material in PBL learning stems from real-life situation problems that are original/valid and unorganized and allow for more open and complex solutions to be found. It is intended that students carry out flexible critical thinking activities to create solutions to these problems. In addition, based on research conducted by Rahmawati et al., (2019) regarding the comparison of critical thinking skills between the PBL model and Guided Inquiry in the indicators of analyzing arguments, it can be seen that the achievement of the PBL percentage is higher than the GI due to the characteristics of the problem-based learning that supports students to find a basis for arguments. and also collect facts from various learning sources to strengthen their assumptions so that students will be more selective in sorting out information and not just jumping to conclusions. In this process, students are invited to describe questions reflectively and critically.

Third, make deductions and consider the results of the deductions. The percentage of critical thinking indicator achievement in the POGIL and PBL experimental classes is not much different and is in the same range of 80%. It is different from TCL which is below 70%. This is triggered because the TCL model does not have a special syntax that trains the ability to make deductions and consider the results of discussions. In the TCL model, after the teacher explains the material, it will be continued with HOTS questions. It is different from the POGIL and PBL models where this indicator is applied and honed in one of the learning syntaxes, namely the concept formation syntax in the POGIL model and the syntax for developing and presenting products in the PBL model. However, of the two experimental models, the POGIL model has a higher percentage of achievement than the PBL. This is reinforced by the results of the N-Gain score where the POGIL model has the highest score of 0.76 compared to the PBL and TCL models which are 0.75 and 0.60, respectively. This statement is caused by the stages of concept discovery in the POGIL learning model. In this stage, students will draw up a conclusion about a concept that has been successfully obtained and understood from a discourse. According to Rahmawati, et al (2019) students will be directed to be able to predict and understand a concept from the material being studied based on their understanding to make it easier and longer to remember the essence of the previously studied material. In POGIL learning, after exchanging ideas with their group of friends, students will later record the new concepts they get. By doing these writing activities, students have constructed their understanding of the material (Zamista & Kaniawati, 2015). Meanwhile, in PBL this indicator is located in the syntax of developing and presenting work where there is no activity of writing new concepts but rather writing how the steps for completion and solutions are presented so that students understand how to solve the problems presented but still do not understand the concept. applied to this problem. This is evident when faced with other similar problems, students are still confused in determining the initial steps to analyze the

solution. This is in line with Rahmawati et als research (2019), which states that there are no stages in PBL that emphasize formulating and answering hypotheses and conclusions from the material being studied. Therefore, the PBL model is no better than the inquiry on indicators of making deductions and considering the results of deductions. In addition, this PBL syntax does not focus on the deepening of material concepts significantly, unlike POGIL, in PBL the teacher does not provide an introduction to the concept terms being studied during the exploration process (Nurhayati & Angraeni, 2017). Therefore, the achievement of the percentage of critical thinking indicators is not better than the POGIL learning model. Likewise with TCL, learning the majority of which is a lecture activity from the teacher, so that in its stages nothing reflects the indicators of making deductions and considering the results of deductions.

Fourth, the indicator considers the credibility of a source. The highest percentage of critical thinking indicator achievement was achieved by the POGIL model which was strengthened by the N-Gain score of 0.43 compared to the PBL and TCL models which were 0.39 and 0.34 respectively. This is related to one of the POGIL syntaxes that train the ability to consider the credibility of a source, namely exploration. In this stage, students conduct simple experiments with nearby equipment to collect and explore observational data and then examine and analyze the data. When it is not possible to experiment, students are directed to see a virtual practicum presented via YouTube. With the process of seeing or doing, students will find it easier to understand and more thorough to observe what is happening. From the data obtained, students will be led to correlate their observations with the existing theory whether it is relevant or not. This process makes students more involved in the proof process and has their own experience so that when working on analytical questions in the form of work procedures, students are easier to understand the flow. In line with research by Defiyanti Sumarni (2019), concluded that the practicum applied in KBM can encourage students to be more active and have their own experiences, making it easier to recall concepts and analyze the data obtained. This is also supported by research conducted by Handayani et al. (2016), which states that the POGIL learning model can improve science process skills consisting of results processing skills so that students can acquire and develop concepts, theories, and identify the validity of a source. Furthermore, based on research by Malik et al. (2017), the POGIL learning model can improve critical thinking skills, especially on indicators considering the credibility of a source. Students are always involved in voicing ideas and proving an argument through simple experiments then analyzing the data and linking it with existing theories so that a decision is made that is strengthened by supporting evidence. It is different with PBL where the indicator considering the credibility of a source lies in the syntax guiding the student's learning experience where at this stage students collect information that is relevant to the solution to be constructed. Students in the PBL model do not conduct simple experiments or see virtual practicums, so when faced with procedural questions, they require a deeper analysis and understanding process than students with the POGIL learning model. Likewise with TCL, learning the majority of which are lectures from teachers and practice questions so that none of the stages reflect indicators considering the credibility of a source.

Fifth, indicators identify assumptions. Everything that is considered true and assumed is the meaning of the assumption (Kolayiş, 2014). When faced with a problem, students need in-depth reasoning and need evidence from existing theories so that they can identify assumptions accurately and factually (Malik et al., 2017). The achievement of the results of critical thinking skills with indicators identifying assumptions after being given treatment, namely in the POGIL experimental group, the lots were 72.73%; the PBL experimental group obtained 71.67% results and the control group with 66.38% results. This is because in the POGIL and PBL learning models, after being given an apperception at the beginning of learning, the apperception will be studied more deeply and the solution steps are sought at the next learning stage by determining important points related to the problem (formulating the problem) then proceeding with developing an assumption that will be proven in the next stage. This statement is also reinforced by the similarity of the N-Gain score of the POGIL and PBL models, which is 0.65, which means that the increase in critical thinking skills in these indicators is as high. In contrast to TCL, in the TCL model, after the teacher gives apperception, the case or discourse-given is not followed up or a discussion forum is not created so that students can solve problems in apperception while at the same time finding their concept of the material being taught. The teacher will go directly to the material then at the end of the session the teacher will provide answers related to the solution to the problem in the apperception that was conveyed at the beginning. In addition, the TCL model's N-Gain score is the lowest compared to the other two models, which is 0.57. Therefore, students taught by the POGIL and PBL models are more trained in making assumptions than students taught by the TCL model. Nevertheless, the POGIL learning model still achieves a higher percentage of critical thinking achievement than the PBL and TCL learning models on the indicator of identifying an assumption. This is because, in POGIL learning,

students are required to read the material in companion books or other sources before class starts, and when the learning process takes place students are not encouraged to look at other sources but rather match and link experimental data with students' prior knowledge from reading sources. Previously, discussions were held between groups to equally equate the concepts between group members. Whereas in PBL, students are advised not to read the material before class starts so that companion books and other reading materials will be used and read during the discussion process. Therefore, compared to PBL, students in the POGIL class have more prior knowledge. As is the case with research conducted by Tyasning et al. (2015), which states that based on Piaget's learning theory, one of the factors that influence knowledge processing is the initial ability of students. With the provision of adequate initial abilities, students' thought processes will run better so that students will be more responsive in identifying and expressing arguments and assumptions about discourse or cases. Therefore, the POGIL learning model obtained the largest percentage achievement on this indicator.

Sixth, indicators decide an action. The highest percentage achievement on the indicator of deciding action is achieved by the POGIL learning model which is also supported by the highest N-Gain score, which is 0.35 compared to the PBL and TCL learning models, which are 0.34 and 0.20. This is because in the previous POGIL stage the concept discovery stage was carried out. According to Malik, et al. (2017) at the application stage in the POGIL learning model, they can expand and open the creativity of student responses by analyzing the concepts they have obtained, then linking them with learning materials and previous responses so that they can examine the information to decide on the right action in responding. problem. Meanwhile, in the PBL learning model, no syntax focuses on concept discovery, even in this model the teacher does not introduce the term concept of the material to be studied so that students in deciding an action need to take a long time to ensure answers and the accuracy of the material concepts used (Cik'ani, 2021). Likewise with TCL, with learning in its stages, none of which reflect indicators of deciding an action.

From the results of the study, it was found that there was still a fairly low percentage of critical thinking indicators at both pretest and posttest. This relates to the cognitive level that is applied to the questions. In the indicator of deciding an action and determining the credibility of a source, there are questions with a conveyance of C5 so that the level of difficulty is higher than other indicators that are at the cognitive level of C4. The choice of the C5 cognitive level on these two indicators was taken into account in the implementation and training of critical thinking skills which coincided with the core syntax of both the PBL and POGIL learning models. As in the POGIL model, the indicator decides action is trained in the application syntax and the indicator considers the credibility of a source contained in the exploratory syntax. Then in the PBL model, indicators decide action and consider the credibility of a source contained in the syntax guiding the student learning experience. In exploratory syntax, students will carry out simple experiments to prove and clarify the outline given by the teacher. Then, in the application syntax, students will be given conceptual practice questions to apply and also test the concepts that have been obtained. In this stage, students conduct internal discussions with their teams to solve problems given by the teacher. Furthermore, the syntax guides students' learning experiences, where students will discuss solving problems by observing all learning media, be it companion books or the internet, and also exchanging ideas with them.

When these discussion activities take place, students will practice their critical thinking skills even further. Then, the cause of the percentage of critical thinking ability is still low even though it has been given treatment due to time constraints so that the learning experience of students has not been maximally achieved. Meanwhile, the student-centered learning model takes a long time in the process. Therefore, when students are given different practice questions, it will take a long time to complete them because they have to determine further which steps are appropriate to take. So, it can be emphasized again that the cause of the low percentage of critical thinking skills in these two indicators is because students' experience in working on various questions is still lacking, especially at the C5 cognitive level as a result of limited time in learning.

From this explanation, POGIL or PBL learning activities empower students' critical thinking skills more than the control class (TCL). Learning in the experimental class is more conducive to a livelier atmosphere because students are actively involved when compared to the control class. The activeness of students by providing ideas, constructing concepts to conclusions, and evaluating independently becomes a means for students to develop critical thinking skills.

Conclusion

Based on the analysis and discussion, it can be concluded that there is a significant effect or difference in the POGIL experimental group, PBL Experiment, and Control with the application of HOTS questions in it after being given treatment on students' critical thinking skills. Then, a further test was carried out with Post Hoc-

Scheffe where the significance value of the POGIL model test with PBL > 0.05 was 0.098 so it was concluded that there was no significant difference between the two models in improving critical thinking skills. In another sense, both POGIL and PBL models are equally good at increasing students' critical thinking levels. However, when viewed based on the N-Gain score for the POGIL class, which is higher than the others, which is 0.71, it can be explained that the POGIL model is better able to increase the percentage of students' critical thinking skills compared to the PBL model.

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Conflicts of Interest
The authors declare no conflict of interest.

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