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Students' Mathematical Problem-Solving Ability of Class-VIII Through the Geogebra-Assisted POGIL Learning Model

Nabila Alifa Shandhita Putri*, Surya Sari Faradiba, Gusti Firda Khairunnisa
Universitas Islam Malang, Kota Malang, Jawa Timur, Indonesia
e-mail: nabila.shandhita04@gmail.com

Abstract

A This study aims to determine differences in mathematical problem-solving abilities between the experimental class through the Geogebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning model and the control class through conventional learning and to determine mathematical problem-solving abilities after being treated with the POGIL (Process Oriented Guided Inquiry) by Geogebra-assisted. This study used a mixed method with a sequential-explanatory type. The study recruited class VIII of SMPN 2 Prigen. The research sample was class VIII-A (the control class) and class VIII-C (the experimental class). The results showed that (1) there were differences in the mathematical problem-solving abilities of the experimental class through the Geogebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning model and the control class through conventional learning. (2) the mathematical problem-solving abilities of class VIII students of SMPN 2 Prigen using the Geogebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning model are better than using conventional learning models.

Keywords: Mathematical Problem-Solving Ability, POGIL (Process Oriented Guided Inquiry Learning), Geogebra

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INTRODUCTION

Mathematics is critical for students. Studying mathematics may patronize students to systematically think and employ logic in solving problems. These subjects are available at all levels, from kindergarten to university. Permendiknas No. 22 of 2006 states that the purpose of learning mathematics is to understand mathematical concepts; use reasoning; perform mathematical manipulations; solve the problem; communicate ideas to clarify circumstances or problems; and appreciate mathematics's usefulness in life. Thus, problem-solving ability is a critical aspect for students in learning mathematics. Students' problem-solving ability may facilitate them to deal with mathematical problems (Yuliani et al., 2019:79).

Mathematical problem-solving ability is the students' ability to solve and find solutions to a mathematical problem. Every day, we consciously and unconsciously face various problems that require mathematical problem-solving skills. By solving some problems, students learn to develop appropriate problem-solving strategies (Utami & Wutsqa, 2017:167). Moreover, an interview with one of the mathematics teachers at SMPN 2 Prigen, unpacked that students' problem-solving abilities were meager because when they were given dissimilar questions from the sample, the students experienced difficulties, also when they were given story questions in daily-life context, the students also experienced elusive understanding to solve the problems. Andayani & Lathifah (2019:2) support that a lack of problem-solving abilities may lead the students to solve

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teachers' routine or exact questions merely. However, providing opportunities for students to actively involve in the learning process may elevate students' problem-solving abilities (Alanda et al., 2019:25).

Thereby, teachers should be innovative in implementing appropriate learning models and strategies to motivate students in the learning process, generate interest in asking questions, solve real problems, and obtain optimal learning outcomes. The POGIL (Process Oriented Guided Inquiry Learning) learning model is a learner-centered inquiry learning model in active learning, implementing study groups, guided inquiry to develop knowledge, and questions to improve problem-solving ability. The POGIL learning model has several stages: the orientation stage is used to explore students' learning interests related to the material, the exploration stage is used to discuss problems in groups and each group member plays an active role, the concept discovery stage is also used to analyze and find appropriate concepts with their own knowledge, the application stage is used to relate concepts that have been found into new contexts, and the closing stage is used to present the results of group discussions.

In addition, using learning media is fundamental to creating a more attractive learning atmosphere. Learning media may help students to explore knowledge, increase learning motivation, and create more innovative learning (Margarita et al., 2021:229). Geogebra is a free, dynamic multi-platform math software for all levels of education, combining geometry, algebra, tables, graphs, statistics, and calculus in a convenient package (Septian, 2017:181). In the learning process, Geogebra is an abstract problem-solving aid. Geogebra problem visualization provides an accurate picture to help students to solve the encountered problem (Sari et al., 2019:412).

Cubes and blocks are taught in junior high school in the even semester of VIII graders. Cubes and blocks are geometric shapes with flat sides. Cubes and blocks have many applications in everyday life. Recently, there has been no research discussing the ability to solve mathematical problems through the Geogebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning model on cubes and blocks. Wahyuningsih et al. (2019) stated an increase in students' mathematical problem-solving abilities using the POGIL learning model. Moreover, they claimed that the POGIL learning model was more effective than conventional learning models.

Therefore, this study aims to determine differences in mathematical problem-solving abilities between experimental classes through the Geogebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning model and the control class through conventional learning and to determine mathematical problem-solving abilities after being treated with the POGIL learning model (Process Oriented Guided Inquiry Learning) assisted by Geogebra.

RESEARCH METHOD

The current study employs a sequential explanatory mixed methods approach. The design combines quantitative and qualitative research methods sequentially. The quantitative methods were employed in the first stage and followed by qualitative methods in the second stage (Wirsal et al., 2022). In addition, Creswell (2012) explains the stages of a sequential explanatory mixed methods approach as follows:

Moreover, the quasi-experimental with a non-equivalent pretest-posttest control group design was the quantitative design of the study. This design has two groups: the experimental and the control groups. The experimental and control groups will then be compared with organized samples (Rukminingsih et al., 2020:51). The current study population was all VIII graders at SMPN 2 Prigen for the 2022/2023 academic year consisting of 6 classes: VIII A, VIII B, VIII C, VIII D, VIII E, and VIII F. However, the study recruited two classes (VIII A as the control class and class VIII C as the experimental class) as the samples of the study.

The study also exploited the purposive sampling technique. Data collection techniques in quantitative research are test methods in the form of pretest and post-test questions of mathematical problem-solving ability consisting of 4 descriptive questions that have been tested for validity. The test items were consulted and validated by one expert and one practitioner to test the validity of the content. SPSS 24 software was employed to analyze the data. Data analysis techniques were carried out in two stages: the initial data analysis (pretest) and the final data analysis (post-test). Initial data analysis (pretest) was performed to test the pretest data, consisting of a normality test and an average similarity test. In addition, the final data analysis (post-test) was carried out to test the post-test data, consisting of a normality test and hypothesis test through a two t test party.

Furthermore, the study geared a descriptive approach for the qualitative design. The data source was all class VIII students of SMPN 2 Prigen for the 2022/2023 academic year. A purposive sampling technique was employed in this study. The sampling technique considered samples with certain considerations or categories (Sugiyono, 2021:133). Six subjects were recruited based on the post-test results with high, medium, and low ability categories.

Meanwhile, the Geogebra-assisted POGIL learning model was employed as the research object. The qualitative data collection technique portrays the non-test method, applying observation, field notes, and interviews. Observation was used to observe teachers and students in the learning process, while field notes were used to record activities in the learning process. The qualitative data analysis technique was in two stages: the stage before the field and the stage during the field (data reduction, data presentation, and drawing conclusions).

RESULTS AND DISCUSSION

The study was carried out at Prigen 2 Public Middle School for 7 meetings. In the first meeting, the researcher gave a pretest to find out the students' initial abilities before the treatment. In the second to sixth meetings, the treatments were given for the experimental class using the Geogebra-assisted POGIL learning model. Meanwhile, the control class exploited conventional learning. Finally, the researcher gave a post-test in the last meeting. The results were then analyzed, employing SPSS 24.

Initial data analysis (pretest) aims to determine whether the sample comes from a normally distributed population. The pretest normality test for the experimental and control classes used the Kolmogorov-Smirnov test. The normality test in the experimental class was Sig 0,125 > 0,05 and the control class was Sig 0,089 > 0,05, reflecting normal distribution. At the same time, the Independent Samples Test was employed to test the average similarity of the experimental and control classes using. The results of the average similarity test can be seen in Table 1.

Table 1. Results of the Pretest Average Equality Test

		t-test for Equality of Means		
		t	*Df*	*Sig. (2-tailed)*
Mathematical Problem Solving Ability	*Equal variances assumed*	0,477	50	0,635
	Equal variances not assumed	0,477	49,920	0,635

Based on the results of the pretest average similarity test in Table 1, the value was *Sig 2-tailed* = 0,635 $>$ 0,05, so H_0 was accepted, and H_1 was rejected, reflecting no initial significant difference between the experiment and control classes. The final stage of data analysis (post-test) aims to determine whether there are differences in the mathematical problem-solving abilities of students in the experimental class and control classes. The post-test normality test for the experimental and control classes used the Kolmogorov-Smirnov test. The normality test results in the experimental class were *Sig* 0,089 $>$ 0,05, and the control class was *Sig* 0,069 $>$ 0,05, reflecting normal distribution. Meanwhile, Independent Samples Test was conducted to test the hypothesis of a two-party t-test in the experimental and control classes. The results of the hypothesis test through the two-party t-test can be seen in Table 2.

Table 2. Post-test Hypothesis Test Results

		t-test for Equality of Means		
		t	*Df*	*Sig. (2-tailed)*
Mathematical Problem-Solving Ability	*Equal variances assumed*	2,090	50	0,042
	Equal variances not assumed	2,090	47,813	0,042

The hypothesis test in Table 2 showed *Sig 2-tailed* = 0,042. Because the score of *Sig 2-tailed* = 0,042 $<$ 0,05, H_0 was rejected, and H_1 was accepted. The data shows different mathematical problem-solving abilities of students in the experimental class using the Geogebra-assisted POGIL learning model and the control class using conventional learning models.

Qualitative data analysis employed data collection techniques: interviews, observations, and field notes. Observational data and field notes were obtained from classroom observations. During the learning process in the experimental and the control classes, there were two observers: the mathematics teacher at SMP 2 Prigen and a mathematics education colleague. The classification of the successfull observation activities of teachers and students can be seen in Table 3.

Table 3. Classification of Successful Observation of Teacher and Student Activities

Evaluation	**Criteria**
$81\ \% < SR \leq 100\ \%$	Very Good
$61\ \% < SR \leq 80\ \%$	Good
$41\ \% < SR \leq 60\ \%$	Enough
$21\ \% < SR \leq 40\ \%$	Poor
$0\ \% < SR \leq 20\ \%$	Very Poor

Based on the average results of the teacher activity observation sheet, it was found that the percentage of teacher activity in the experimental class was 87.4%, and the percentage of teacher activity in the control class was 86.4%. In short, the teacher's activities during the learning process have been carried out very well in both classes. At the same time, the average result of the student activity observation sheet is known that the percentage of student activity in the experimental class was 85.5%, and the percentage of student activity in the control class was 82.8%, reflecting that the activities of students in both classes during the learning process have been very well done. In addition. The field notes in the experimental class displayed very good data where students were active, enthusiastic, and quite serious when discussing in groups in Geogebra-assisted POGIL learning. The results of field notes in the control class also showed that students were active and serious when discussing in groups in conventional learning.

Based on the results of the students' post-test scores in the experimental and control classes, it can be classified based on Normative Reference Assessment (PAN) to determine subjects with high, medium, and low mathematical problem-solving abilities in the experimental and control classes. The classification of Normative Reference Assessment (PAN) can be seen in Table 4.

Table 4. Classification of Mathematical Problem-Solving Ability Values

Value Range		Classification
Experimental Class	Control Class	
$94 \leq score \leq 100$	$90 \leq score \leq 100$	High
$74 \leq score < 94$	$66 \leq score < 90$	Medium
$0 \leq score < 74$	$0 \leq score < 66$	Low

Based on the classification in table 4, it was obtained that 6 students (23.1%) had high mathematical problem-solving abilities in the experimental class, 16 students (61.5%) had moderate mathematical problem-solving abilities, and 16 students (61.5%) had mathematical problem-solving abilities, and 4 students with low mathematical problem-solving abilities (15.4%). Whereas in the control class, 4 students (15.4%) had high mathematical problem-solving abilities, 14 students (53.9%) had moderate mathematical problem-solving abilities, and 8 students had low mathematical problem-solving abilities (30.8%). Then in each experimental and control class, the researcher chose one subject from each group of students with high, medium, and low mathematical problem-solving abilities to conduct interviews. The data were then analyzed and compared with the students' post-test results. Based on this selection, six subjects were recruited, as seen in Table 5.

Table 5. List of Qualitative Research Subjects

Mathematical Problem-Solving Ability	Research Subjects	
	Experimental Class	Control Class
High	E23	K7
Medium	E9	K4
Low	E18	K3
Total	3	3

Based on the list of research subjects in the experimental class in table 5Based, the data analysis that has been obtained from the results of the post-test with the results of interviews on subjects with high mathematical problem-solving abilities (E23) have fulfilled all four indicators of problem-solving ability: understanding the problem by writing down what known and asked, planning a solution by determining the appropriate strategy/formula, carrying out the solution plan by substituting what is known in the formula correctly, and interpreting the results by checking back and writing the conclusion of the solution. Subjects with moderate mathematical problem-solving ability (E9) have fulfilled three of the four indicators of problem-solving ability: understanding the problem by writing down what is known and asked, implementing a solution plan by substituting what is known in the formula correctly, and interpreting the results by rechecking and writing the conclusion of the solution. Meanwhile, subjects with low mathematical problem-solving abilities (E18) have fulfilled two of the four indicators of problem-solving ability: understanding the problem by writing down what is known and asking and implementing a solution plan by substituting what is known in the formula correctly.

Furthermore, based on the list of research subjects in the control class in table 5, the analysis of the data that has been obtained from the results of the post-test with the results of interviews on subjects with high mathematical problem-solving abilities (K7) has fulfilled the four indicators of problem-solving abilities: understanding the problem by writing down what is known and asked, plan the solution by determining the strategy/formula that is appropriate to the problem, implement the solution plan by substituting what is known in the formula correctly, and interpret the results obtained by rechecking and writing the conclusion of the solution. Subjects with moderate mathematical problem-solving ability (K4) are quite capable of fulfilling three of the four indicators of problem-solving ability: understanding the problem by writing down what is known and asked, implementing a solution plan by substituting what is known in the formula correctly, and interpreting the results obtained by rechecking and writing the conclusion of the solution. Meanwhile, subjects with low mathematical problem-solving ability (K3) can fulfill two of the four indicators of problem-solving ability: understanding the problem by writing down what is known and asked and implementing a solution plan by substituting what is known in the formula correctly. Therefore, the results of data analysis in qualitative research based on observations, field notes, and interview results can be concluded that the mathematical problem-solving abilities of students who use the Geogebra-assisted POGIL learning model are better than the mathematical problem-solving abilities of students who use conventional learning models.

The data displayed that the experimental class is better than the control class in the mathematical problem-solving abilities. Based on the data, the learning model used in the experimental class is the Geogebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning model. The POGIL learning model is a learner-centered inquiry learning model in an active learning that uses study groups, guided inquiry to develop knowledge, and questions to improve the ability to solve a problem. The POGIL learning model has several stages: orientation, exploration, concept discovery, application, and closing. Through these stages, students can collect information, explore, reason and analyze information from the given problems. Besides, students can link the obtained concepts into new contexts and present the results of group discussions. Geogebra may also assist students in visualizing related material in cubes and blocks. GeoGebra is a learning media that can visually help students to understand abstract mathematical material and can help students understand geometric concepts in more detail with a varied and attractive appearance (Simbolon, 2020:1108). In addition, the field notes in the experimental class showcased students' activeness, enthusiasm, and seriousness when discussing in groups on Geogebra-assisted POGIL learning.

CONCLUSION

Based on the quantitative data analysis, reflecting the different abilities in solving mathematics problems between students with Gegebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning and the control group, applying conventional teaching. Furthermore, the results of data analysis in qualitative research based on observations, field notes, and interviews showed that the mathematical problem-solving abilities of students using the Geogebra-assisted POGIL (Process Oriented Guided Inquiry Learning) learning model were better than the mathematical problem-solving abilities of students using conventional learning models.

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