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PROBLEM POSING AND PROBLEM SOLVING WITH SCIENTIFIC APPROACH IN GEOMETRY LEARNING

Research Article

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Abstract

Geometry subject that prosecute students to comprehend abstracts things is one of the causes of students' difficulties in mathematics learning. This study aims to determine the effect of Problem Posing and Problem Solving learning models with the Scientific Approach to students' adaptive reasoning on plane figure materials. It was conducted at the State Junior High School (SMPN) 4 Magetan, Indonesia. It employed quasi-experimental research methods. The populations were the seventh grade students with a total sample of 64 students who were divided into 34 students as experimental 1 class and the other as experimental 2 class. The simple random sampling method was chosen as the sampling technique. Moreover, normality test was the Lilliefors method; homogeneity was the Bartlett test; and t-test for research results analysis. The results revealed that the Problem Posing learning model with the Scientific Approach was better than Problem Solving with the Scientific Approach. It significantly enhanced students' adaptive reasoning on plane figure materials. The Problem Posing learning model with the Scientific Approach provided the needed skills to build knowledge, where students performed the process of observation, clarification, measurement, prediction, and hypotheses. Therefore, the model was appropriate for mathematics learning, especially on plane figure materials to increase students' adaptive reasoning and achievement.

Keywords: problem posing, problem solving, scientific approach, geometry learning, adaptive reasoning

1. Introduction

The branch of science that plays a significant role in the world of education and life is mathematics (Schmitt, 2006). Students can think logically in solving problems through geometry learning (Van de Walle, 1994). Geometry helps people to achieve their goals, makes them easier to think and get solutions in everyday life (Hızarcı, 2004). It also helps them to understand other topics, such as to understand the concepts of division and decimals, find the area of rectangles, squares, and circles, and it is also carried out to teach mathematical operations techniques (Hamdi, 2018). Applying the right concepts and formulas in solving problems, is one indicator of achieving the goals of learning geometry. Efforts that can be made to meet the aims is an increase in adaptive reasoning to build knowledge in the learning process (Riyanto & Siroj, 2011).

The students with good adaptive reasoning can create conclusions rationally, guess and give the answer rules along with calculating their validity mathematically (Kilpatrik, Swafford, & Findell, 2001). Adaptive reasoning is a basic element in understanding a problem topic and building ideas in determining the evidence of the problem because it is the glue that holds all mathematical abilities together, including as a guideline in learning activities. However, the fact shows that most students still experience difficulties in geometry learning (Adolphus, 2011). Learning geometry, especially on plane figure materials require students to comprehend abstracts things, is one of the causes of students' difficulties. Specifically, for the seventh grade of Junior High School at the material of flat structure includes triangles and rectangles that discuss the nature, circumference, and area of the building. Several studies have shown that the level of basic geometrical thinking in secondary education students is below the expected level (Alex & Mammen, 2012). Factors affecting students' difficulty in understanding problems related to the discussion of various types of shapes, one of which is that teachers do not precisely apply learning in class. The teacher becomes the main focus in the learning process, it can be said that the teachers still employ conventional method (Komalasari, 2012). This makes the students play less role to building knowledge that should be obtained and lacking enthusiasm during the learning process. Therefore, innovation and changes in the learning process must be done by the teacher, especially in choosing a learning methods to motivate the students to build their own knowledge to improve adaptive reasoning.

The geometry material in the learning process requires innovation from the teacher to choose and apply proper learning models along with supporting the students. Besides, the model chosen should be able to make students more active and think creatively, especially when facing problems in finding solutions (Kar, 2016). As an effort to realize changes in the learning of geometry, the possible learning model that can be used is Problem Posing and Problem Solving. Problem Posing and Problem Solving are two of the many innovative learning models that focus on the activity of the students in solving problems. On the other hand, Problem Posing and Problem Solving also have differences, Problem Posing requires students to be able to redefine the problems that have been given with the aim of improving the understanding and facilitate students in solving problems (Arikan & Unal, 2015), while Problem Solving more emphasizes on the steps of Solving problems that are logical and systematic. The Problem Solving relies on the competence to formulate problems and ways of conveying learning that supports students to solve problems as learning objectives (Hamdani, 2011). In this 21st century, one of the important parts in mathematics is a skill in Problem Solving, it is also one of those the competencies that are very much-needed (Permata, Kusmayadi & Fitriana, 2018). In the process of solving problems, the students gain experience to apply their knowledge and skill (Prismana, Kusmayadi, & Pramudya, 2018) and it can stimulate students' logical and systematic thinking patterns. The teacher is not only the source of information, but also the students are encouraged to dig up information from prior knowledge. It is expected that the students can solve problems in their lives using knowledge gained after learning mathematics (Ojose, 2011). But in practice, Problem Posing and Problem Solving still has shortcomings, such as the students have not been able to use their knowledge. To overcome the problems, the teacher needs to change the Problem Posing and Problem Solving learning model with an approach that allows students to use their knowledge comprehensively.

The Scientific Approach is one that can be chosen as an approach because it can produce more meaningful learning when it is applied in integrated learning. The scientific learning process is very important for students by learning concepts and providing the needed skills in learning. Besides, it gives more opportunities for students to explore, elaborate, and actualize their abilities (Rusman, 2005). Therefore, learning scientifically involve several activities where the students make the process of observation, clarification, measurement, prediction, and making hypotheses (Balfakih, 2010). The students must also master process skills to elaborate knowledge about the situation in the environment, be scientific to solve the problems that they face every day (Yuselis, Fajri, & Rieno, 2015), and make observations and analyse activities in practice as a way to get learning outcomes (Mwelse & Wanjala, 2014).

Problem Solving and Problem Posing learning models with the Scientific Approach makes students actively use their knowledge and think thoroughly according to scientific principles. Likewise, geometry plays an important role in solving various problems in life. Therefore, the Problem Posing and Problem Solving leaning models with the Scientific Approach are very interesting to study to investigate its effect on geometry material in improving students' achievement, so that it is beneficial for students' lives.

2. Methodology

This research employed quasi-experimental method. It required two variables namely; the learning model as an independent variable which is divided from the Problem Posing learning model with the Scientific Approach to the experimental class 1 and the other as an experimental class 2, and students' adaptive reasoning on geometry as the dependent variable. Adaptive reasoning in this study is adaptive reasoning on the plane figure materials which was measured using descriptive tests for all indicators (Analogy Reasoning, Conditional Reasoning, Categorical Syllogical Reasoning, Classification Reasoning, and Linear Syllogical Reasoning) adaptive reasoning. When it was related to the revised edition of Bloom's Taxonomy Theory, the matter of adaptive reasoning in this study was employed to measure the dimensions of C4 cognitive processes (analyze). Expert judgment was applied to assess whether an instrument had high validity or not. Experts assessed whether the blueprint made by the test developer represents the content and the concept, and assesses the suitability of each test item with the blueprint made. The validity of this adaptive reasoning instrument consisted of the validation of the blueprint and the test items which include the validation of the blueprint and the validation of the test items. This validation was done by filling out, giving comments, and advising for improvement on the validation sheets that had been available by three validators. In addition to validation, an item of difficulty level calculation with the criteria of $0{,}3 \leq P \leq 0{,}7$ and discriminant $r_{pbis} \geq 0{,}30$ was also analyzed. The instrument reliability test was also an instrument that can be said to be reliable if the reliability coefficient is $r_{11} \geq 0{,}70$. In this study, the reliability test employed Cronbach Alpha formula. It was organized at the State Junior High School 4 Magetan, Indonesia. The population was all students in seventh grade in the academic year of 2019/2020. There were 308 students, so the sample consisted of experimental 1 and experimental 2 classes using the simple random sampling method. The samples in this study were 64 students, 32 as the experimental 1 class and 32 as the experimental 2 class. The 64 students were taken randomly as samples; sampling was done without returning, so that each student had the same opportunity to be selected as a sample with a homogeneous population. The research run from November 2019 to February 2020 through three steps. The first step is in December 2019 by preparing and requesting research's permission. Then the second step is from December 2019 to January 2020 by implementing the research and the last step is in February 2020 for obtaining the data. The data in this study were obtained from students' adaptive reasoning test instruments on the geometry material which were carried out before the treatment (pretest) and after the treatment (post-test). To find out if the sample is from the same population, normality and homogeneity tests were done using the Lilliefors and Bartlett tests from students' adaptive reasoning pretest data. The research hypothesis test used the data obtained from the post-test results of students' adaptive reasoning with the t-test. All tests were carried out with a significance level of 5 %.

3. Findings and Discussion

The instruments for the pretest and posttest in the experimental class was tested for the level of difficulty and reliability to obtain several questions that met the criteria for the level of difficulty and reliability with Cronbach Alpha. The data obtained from the results of the students' pretest both in the experimental and control classes were tested to determine the sample from a population that was normally distributed and had a homogeneous variance.

3.1. Normality Test

The normality test in this research was the Lilliefors test with a significance level of 5 %. The results of Lilliefors were presented in the following table.

Table 1. *Result of normality*

Group	L_{obs}	L_{table}	Test Decision	Conclusion
Experimental 1	0,0877	0,0914	H_0 is accepted	Normal
Experimental 2	0,0832	0,0914	H_0 is accepted	Normal

Table 1 showed that the results from the experimental 1 class was 0,877 and the experimental 2 class was 0,832 and L_{table} = 0,0914 on the normality test $|L_{\text{obs}} < L_{table}|$ or $L_{obs} \notin$ DK means H_0 was received. This showed that the students' pretest data on geometry material came from normally distributed populations.

3.2. Homogeneity Test

The homogeneity test in this research was the Bartlett test with a significance level of 5 %. The results of Bartlett were presented in the following table.

Table 2. *Result of homogeneity*

χ^2_{obs}	χ^2_{table}	Test Decision	Conclusion
2,313	5,991	H_0 is accepted	homogeneous

The calculation of homogeneity tests revealed that $\chi^2_{\text{obs}} < \chi^2_{\text{table}}$ which was 2,313 < 5,991 which means that H_0 was accepted and the population had homogeneous variance.

3.3. Univariate Test

Hypotheses test the in the research was conducted using the t-test on students' pretest and post-test geometry material after the prerequisite tests are carried out. The results can be seen in table 3.

Table 3. *Pretest, post-test data and t-test*

Groups	N	Mean		t_{obs}		t_{table}
		Pretest	Posttest	Pretest	Posttest	
Experimental 1	32	77,96	80,46	2.348641	5,108714	-1,998972 or 1,998972
Experimental 2	32	77.09	78.40			

Table 3 showed that the mean of pretest scores in the experimental class were 77,96 and 77,09 for the control class, while the mean of post test scores for the experimental 1 and experimental 2 classes were 80,46 and 78,40 respectively. Furthermore, it was also obtained $t_{\text{obs pretest}}$ = 2.348641 and t_{table} = (-1,998972 or 1,998972) for critical areas $DK = \{t|\text{t} < -1{,}998972 \text{ or } \text{t} > 1{,}998972\}$. So, we got $t_{\text{obs pretest}} \in DK$ and it could be concluded that H_0 was rejected, which means that there were significant differences in adaptive reasoning in the experimental 1 and experimental 2 classes before being given treatment. While the experimental 1 and experimental 2 class post test data showed that the value of $t_{\text{obs posttest}}$ = 5,108714, this means $t_{\text{obs posttest}} \in DK$ so that it could be concluded that H_0 was rejected, which means that there were significant differences in adaptive reasoning in the geometry material of experimental 1 and experimental 2 classes after being given treatment.

Based on the data and the results of the research, the experimental 1 class got a better score in adaptive reasoning than the experimental 2 class after receiving the treatment. The researcher thought that experimental 1 class employed Problem Posing learning models with the Scientific Approach. The increase of students' adaptive reasoning in the experimental 1 class provided a positive impact of modifying the Problem Posing model with the Scientific Approach, especially on geometry material. Compared to the experimental 2 class that is subjected to Problem Solving model with the Scientific Approach, the experimental 1 class has improved better. Several factors cause an increase in students' adaptive reasoning after learning the Problem Posing model with the Scientific Approach were (1) The learning process made the students more active and increases their motivation to learn. This is because the principle of learning is to place students as active subjects and through scientific stages, in the process of learning knowledge students get from the knowledge they have. So, students can build new knowledge and integrate with previously owned knowledge (characteristic of the Scientific Approach: student-centered learning). (2) The students were better able to solve problems systematically and thoroughly. This is because in learning Problem Posing models with the Scientific Approach, they are invited to collect, process, and communicate information obtained from various sources to get conclusions in the form of knowledge (characteristics of the Scientific Approach: developing students' potential and using scientific processes in building knowledge). (3) The students found it easier to solve various levels of difficulty of the questions. This is because the learning process conditions are created so that they feel that learning is a necessity. Besides, it also train students in expressing ideas, and improve students' learning outcomes through cognitive processes and higher-order thinking skills (characteristics of the Scientific Approach: Involving potential cognitive processes in stimulating the development of the intellect). (4) The students tend to be better at developing each talent and skill. This is caused by the freedom given for students to form knowledge through observation, communicate and discuss by forming small groups to shape the character of discipline, responsibility, and care (the characteristics of the Scientific Approach: developing students' character).

The data in the experimental 2 class that was taught using Problem Solving learning models with the Scientific Science Approach showed that there was no significant increase in value. This revealed that there was something missing in the learning process. Furthermore, it can be seen that the students in experimental class 1 in the post-test experienced much higher adaptive reasoning than those in experimental class 2. This was because students in the experimental class 1 were asked to reformulate a new problem that was similar to the problem given, so that they were required to think more extra in understanding the material being taught to formulate new problems that were similar to previous problems.

Based on these explanations, the Problem Posing learning models with Scientific Approach provided a better impact than Problem Solving learning models with Scientific Approach on students' adaptive reasoning, especially in the geometry of plane. This is supported by a research by Abadi, Pujiastuti and Asaat (2017) that the application of Problem Posing learning in learning geometry can make students' adaptive reasoning increase much.

4. Conclusion

The results showed that the students who used the Problem Posing learning model with Scientific Approach experienced an increase in adaptive reasoning significantly. So, it could be concluded that Problem Posing learning model with the Scientific Approach was better than Problem Solving with the Scientific Approach and it significantly enhanced students' adaptive reasoning on plane figure materials. Therefore, the Problem Posing learning model with the Scientific Approach is appropriate to be applied to enhance the adaptive reasoning of students in learning geometry, especially plane figure materials so that the students' learning outcomes can be improved.

5. Conflict of Interest

The authors declare that there is no conflict of interest.

6. Ethics Committee Approval

The authors confirm that the study does not need ethics committee approval according to the research integrity rules in their country.

References

Abadi, M. K., Pujiastuti, H., & Asaat, L. D. (2017). Development of teaching materials based interactive scientific approach towards the concept of social arithmetic for junior high school student. *International Conference on Mathematics and Science Education.* Journal of Physics: Conf. Series 812.

Adolphus, T. (2011). Problem of teaching and learning of geometry in secondary schools in River State, Nigeria. *International Journal of Emerging Science, 1(2),* 143-152.

Alex, J. K., & Mammen, K. J. (2012). A survey of South African grade 10 learners' geometric thinking levels in terms of the Van Hiele theory. *Anthropologist, 14(2),* 123-129.

Arikan, E. E., & Unal, H. (2015). Investigation of problem–solving and problem-posing abilities of seventh grade-students. *Educational Science: Theory & Practice, 15(5),* 1403-1416.

Balfakih, N. M. (2010). The assessment of the UEA's in-service and pre-service Elementary science teachers in the integrated science process skills. *Procedia-Social and Behavioral Science, 2(2),* 3711-3715.

Hamdani. (2011). *Strategi Belajar Mengajar.* Bandung: Pustaka Setia.

Hamdi, S. (2018). Perspectives on the teaching of Geometry: Teaching and learning methods. *Journal of Education and Training, 5(1),* 131-137.

Hizarci, S. (2004). *Euclidean geometry and special education.* Ankara: Teachings Publisher.

Kar, T. (2016). Prospective middle school mathematics teachers' knowledge of linier graphs in context of problem posing. *International Electronic Journal of Elementary Education, 8(4),* 643-658.

Kilpatrik, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics.* Washington: National Academy Press.

Komalasari, K. (2012). the effect of contextual learning in civic education on students' civic skills. *International Journal for Educational Studies, 4(2),* 179-190.

Mwelse, J. K., & Wanjala, M. S. (2014). Effect of problem solving strategy school students' achievement in circle geometry in Emuhaya District of Vihiga County. *Journal of Educations, Arts, and Humanities, 2(2),* 18-26.

Ojose, B. (2011). Mathematics literacy: Are we able to put the mathematics we learn into everyday use? *Journal of Mathematics Education,* 89-100.

Permata, L. D., Kusmayati, T. A., & Fitriana, L. (2018). Mathematical problem solving skills analysis about word problems of linear program using IDEAL problem solver. *Journal of Physics: Conf. Series 1108*.

Prismana, R. D., Kusmayadi, T. A., & Pramudya, I. (2018). Analysis of difficulties in mathematics problem solving based on revised Bloom's taxonomy viewed from high self-efficacy. *Journal of Physics: Conf. Series 1008*.

Riyanto, B., & Siroj, R. A. (2011). Meningkatkan Kemampuan Penalaran dan Prestasi Matematika dengan Pendekatan Konstruktivisme pada Siswa Sekolah Menengah Atas. *Jurnal Pendidikan Matematika, 5(2),* 111-127.

Rusman. (2005). *Model-Model Pembelajaran Mengembangkan Profesionalisme Guru.* Jakarta: PT Raja Grafindo Persada.

Schmitt, J. M. (2006). *Developing geometric reasoning.* Washington DC: GED Mathematics Training Institute.

Van de Walle, J. A. (1994). *Elementary School Mathematics.* New York: LONGMAN.

Yuselis, Fajri, I., & Rieno, S. N. (2015). Pengaruh Pendekatan Saintifik Terhadap Pemahaman Konsep Siswa Pada Pembelajaran Matemaika Di Kelas VII MTs Patra Mandiri Palembang. *Jurnal Pendidikan Matematika JPM RAFA, 1(2)*, 258-287.