PROBLEM BASED LEARNING COMPARED TO DISCOVERY LEARNING IN EFFECTIVENESS OF MATHEMATICS LEARNING OUTCOMES

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ABSTRACT

Mathematics is a subject that is often assumed to be a difficult subject to learn and understand. This is caused by the monotonous learning model and problem solving. This study aims to determine the comparison of problem-based learning and discovery learning models in effectiveness of mathematics learning outcomes by paying attention to the level of student creativity. The type of research used is a quasi-experimental which is applied in mathematics learning to high school students in Bojonegoro as much as 129 people. Data were collected using test techniques, then analyzed by anova test. The results showed that the discovery learning model was more effective in learning mathematics provided that students had high creativity.

Keywords: *Problem-based learning, discovery learning, creativity, mathematics learning outcomes*

INTRODUCTION

The topic of discussion that is often used in mathematics research is the ease of understanding lessons and the improvement of learning outcomes. One of the results of studying mathematics can be seen in the results of the national exam. The results of the national mathematics exam in the national realm show that the results are relatively low, especially the results of the national high school mathematics exams in Bojonegoro which do not meet the average national standard. It is proven in the data shown that it does not meet the standard value of $\geqslant$ 5.5 and the percentage of 9% that meets the standard value in 2018/2019.

Learning outcomes can be improved by paying attention to 2 factors, namely external and internal. External factors include everything that can affect learning from outside the individual such as learning models and learning strategies, while internal factors include everything that affects learning from within such as the level of student ability and student conditions. Learning outcomes are one form of achieving learning objectives. Learning objectives can be achieved by the existence of learning strategies that are tailored to student characteristics and student abilities so that learning material feels comfortable and worthwhile (Haeruman, Rahayu, & Ambarwati, 2017). The implementation of strategies and learning models needs to pay attention to the characteristics and conditions of students so that their implementation is effective. The application of learning models and strategies affects the level of student characteristics as the condition of the students being studied.

The large amount of cognitive load given to mathematics lessons makes learning ineffective for low-ability students because of the management of working memory that is not optimal so that it is difficult to understand the material. Effective learning does not only depend on the

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cognitive load but lies in the formation of learning patterns that can be developed through the preparation of students' cognitive prerequisites. If the learning pattern is not activated, students with low abilities will find it difficult to understand the material. Mathematical prerequisite readiness, namely the recognition of the characteristics of mathematics learning material consisting of understanding language, pictures, number lines, katesius, coordinates, symbols and tables. The language used in mathematics is paraphrasing everyday problems to mathematics or vice versa, paraphrasing mathematics into everyday language (Umbara & Suryadi, 2019). There is also pattern reading, comparison, analysis, synthesis and generalization. Creativity is assumed to be one of the factors that influence the improvement of learning outcomes and the mathematics learning process and further research is needed on this linkage.

As for previous research by Susilowati (2019), Nurwidyastuti (2018), Yustianingsih, Syarifuddin, Yerizon (2017), Putri, Suryani, Jufri (2011) learning mathematics with the Problem Based Learning model can improve problem-solving abilities and can increase students' creative abilities. In other studies that support the Guide Discovery Learning model by Asri, Noer (2019), Purwitasari, Bharata, Coesamin (2019), Trinovita, Susanta, Hanifa (2018), it was found that the Guide Discovery Learning model can improve student learning outcomes in mathematics. learning learning models are able to improve mathematical analogical skills (Rahman & Maarif, 2014). This study became the basis for selecting the two models for students' mathematical understanding with the Problem Based Learning learning model and Guide Discovery Learning as the independent variable and creativity as the moderate variable.

There is other evidence that proves that the Problem Based Learning and Guided Discovery Learning models can improve mathematics learning outcomes. Simamora, Saragih, & Hasratuddin (2019) in their research show that the discovery method can improve the ability to solve mathematical problems. And Rahman & Maarif (2014) stated that with discovery, the analogical ability of mathematics is better than the expository method. Yuliana, Tasari, & Wijayant (2017) in their research show that guided discovery models are effective in learning mathematics in improving mathematics learning outcomes. The application of the problem-based learning model in mathematics learning has better results compared to conventional learning (Mulyanto, Gunarhadi, & Indriayu, 2018). (Argaw, Haile, Ayalew, & Kuma, 2017) state that the problem-based learning model can improve students' math learning outcomes and motivation, and is effectively used in learning. Problem based learning in mathematics learning can increase students' creativity in problem solving (Birgili, 2015).

Learning conditions are also determined by the student's creativity factor in the basis of the mathematics learning process. This is related to the increase in mathematics learning outcomes obtained from encouraging students' creativity and level of thinking. Effective learning conditions will affect the achievement of learning objectives and learning outcomes. The achievement of learning objectives and optimal learning outcomes are obtained from the concepts and material that the teacher implants in students easily adjusted to student characteristics and the need for logic skills and the high level of teacher reasoning in the selection of learning models (Wahyuni & Kurniawan, 2018) The planting of mathematical concepts and material carried out by the teacher is adjusted to the characteristics of the students in the learning conditions. So the characteristics of students are important for the teacher to know before planting concepts and materials.

Students are required to be independent in learning in almost every school but students with low mathematical abilities will find it difficult to achieve competencies because of the demand to master the prerequisite competencies in order to master new competencies. The

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solution needed for this is the creativity of teachers and student guides to learn independently. The second phenomenon, differences in student culture and background resulted in a large gap in the competence and abilities of students in the classroom. The difficulty in learning mathematics experienced by students comes from the lack of care for the school and the teacher in overcoming gaps in learning.

Student creativity is encouraged by the process of providing learning directly or indirectly by the teacher. Student creativity in learning is also felt to determine learning outcomes (Eftafiyana, Nurjanah, Armania, Sugandi, & Fitriani, 2018). The level of creativity of each student is different and has different characteristics. Students with low levels of creativity will have difficulty understanding and solving mathematical problems. As a result, the solutions found are less diverse. This must be known by the teacher from the start and find solutions to increase student creativity. So the teacher is required to provide learning that paraphrases language into mathematics material and vice versa mathematics material into the language of everyday life and uses a model that encourages student creativity.

This study aims to determine which learning models are effective in learning mathematics in order to maximize the achievement of learning outcomes in terms of students' creativity level. The research scope was carried out in the Bojonegoro area for high school students because the criteria for students who did not meet the standard mathematics score $\geqslant$ 5.5 which had only reached 11% of the minimum standard value in the National Exam category. The problems discussed are mathematics learning outcomes in terms of students' creativity levels and the influence of the interaction between learning models and creativity levels on student mathematics learning outcomes.

THEORY

Guided Discovery Learning

The guided discovery learning model is learning with a scientific method pattern to find problem solving by students in groups with steps ranging from stimulation, problem statement / identification, data collection, data processing, verification, to drawing conclusions (Yerizon et al., 2018 in Simamora, Saragih, & Hasratuddin, 2019). Guided discovery is a series of learning activities that involve students in the maximum effort to seek, examine and investigate systematically, critically, and logically so that they can find their own knowledge, attitude, insight and skills as a manifestation of changes in themselves (Yurniwati & Hanum, 2017) . So, the guided discovery learning learning model is a learning model that requires students to obtain their knowledge by maximizing their involvement in all learning processes.

The principles of the guided discovery learning model consist of: (1) the problem to be solved; (2) according to the level of cognitive development of students; (3) the concepts or principles that students should find must be written clearly; (4) must be available on the tools and materials used; (5) the class sequence is arranged in such a way as to facilitate students who are involved in the free flow of thoughts in teaching and learning activities; (6) teachers provide opportunities for students to collect data; (7) the teacher provides the information requested by students (Mulyasa, 2008 in Yurniwati & Hanum, 2017).

The guided discovery learning model used in this study is the involvement of students in finding and collecting information and providing answers according to the design of the problems given by the teacher to achieve learning objectives.

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Problem-Based Learning Model

Problem based learning is learning that uses real-world problems as a learning context for students, starting by exposing students to real or simulated problems. Furthermore, students will realize that they have to develop knowledge or integrate information from various disciplines, develop inquiry and thinking skills, develop independence and confidence to solve problems (Arvianaa, Irwan, & Dewi, 2018).

The operational steps of Problem Based Learning are basic concepts, problem definition, independent learning, knowledge exchange, and assessment. The steps for problem-based learning include observing, gathering information and experimenting, associating or processing information, communicating and asking questions.

Learning Outcomes

The effects that are used as indicators of the assessment of learning methods in different conditions are the result of learning. The real learning outcomes are using a method under certain conditions, while the desired learning outcomes are the selection of methods to be used in accordance with the objectives to be achieved and have an effect on the learning plan decisions, both learning outcomes are manifestations of learning outcomes (Degeng, 1997; Reigeluth (1983); Uno, et al. (2010). Furthermore, Degeng (1997); Reigeluth (1983), Uno, et al. (2010) stated that in general learning outcomes can be classified into three, namely: (1) effectiveness learning, (2) learning efficiency, (3) learning attractiveness.

The test instrument used to measure the cognitive aspects of learning outcomes is the description test. The test instrument is directed to measure students' ability to remember (C1), understand (C2), apply (C3), and analyze (C4).

Creativity Thinking

Creative thinking is a skill that is indispensable for everyone as stated by Luthfiyah Nurlaela (2015). Spontaneous and imaginative thinking patterns or ideas that have the characteristics of artistic results, scientific discoveries, the creation of something new, both new for oneself and for others, constitute creativity.

Several tests were conducted to measure creativity, namely Guilford's divergent thinking ability test, Torrance's creative thinking ability test, creative-productive thinking test, creative-thinking test with sounds and words, and creative thinking test using a knowledge-torrance inventory. Measuring creativity, there are several aspects that are used as measurement indicators, namely fluency, flexibility, authenticity, decomposition, and formulation.

METHOD

This research uses quasi-experimental research because it is possible to control all variables that are assumed to influence treatment and the impact of treatment. Data were analyzed using the independent t sample test. Learning outcomes as the dependent variable, apart from being influenced by the learning model, the level of student creativity, may also be influenced by differences in students 'initial abilities. Therefore, students' abilities need to be controlled. Control is done by using anova 2x2 analysis technique.

The research took place at high school in Bojonegoro and was carried out in the odd semester of the 2019/2020 school year with the research subjects of class XI students of the Science program. The variables are the learning model as the independent variable, creativity as the moderator variable, student competence in geometry material as the dependent variable, and control variables. The influence of internal validity factors on the control variables for this

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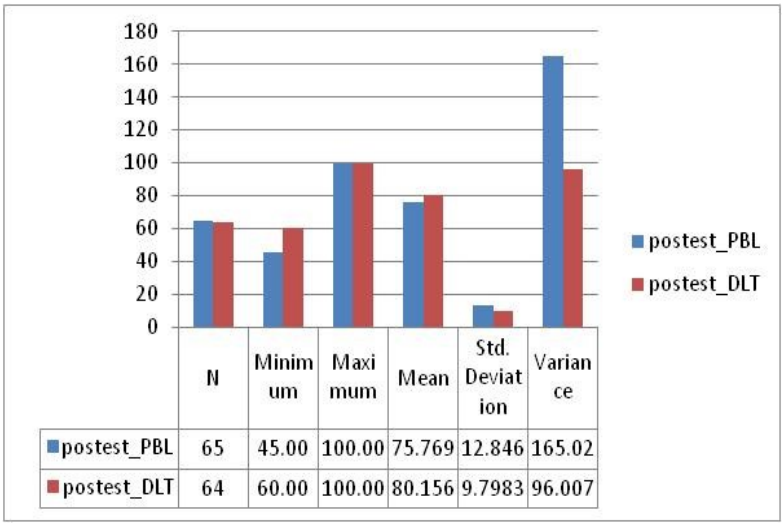
study and control measures, including: (1) historical factors, (2) maturation process, (3) testring process, (4) subject selection, (5) measurement instruments, (6) statistical deterioration, and (7) experimental mortality.

Data were collected using tests that have passed two validities, namely theoretical validity and instrument validity. Then the prerequisite test was carried out using the normality and homogeneity test. The data ended in the independent t sample test to analyze the student's ability data and the ANOVA test to analyze the influence between variables.

RESULT

Data regarding the results of learning mathematics by applying the problem-based learning model obtained the highest score of 100 and the lowest score of 45, the number of students (N) 65, the average score (mean) 75.77, the standard deviation (SD) of 12.846. Data regarding mathematics learning outcomes by applying the guided discovery learning model obtained the highest score of 100 and the lowest score of 60, the number of students (N) 64, the average score (mean) 80.156, the standard deviation (SD) of 9.798. Furthermore, the number of subjects, range, maximum score, minimum score, average score, standard deviation and variance of learning outcomes can be presented in Figure 1 and Figure 2.



	N	Minimum	Maximum	Mean	Std. Deviation	Variance
postest_PBL	65	45.00	100.00	75.769	12.846	165.02
postest_DLT	64	60.00	100.00	80.156	9.7983	96.007

Figure 1. PBL and GDL Learning Outcomes Descriptions Graph

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
postest_PBL	65	45.00	100.00	75.7692	12.84617	165.024
postest_DLT	64	60.00	100.00	80.1563	9.79831	96.007
Valid N (listwise)	64					

Figure 2. Description of PBL and GDL Post-Test Statistics

Mathematics learning outcomes data that have a level of creativity: (1) High, from the subject (N) 67, the highest score is 100 and the lowest score is 55, the average score (mean) is 81.119, the standard deviation (SD) is 9.917. (2) Low of the number of subjects (N) 62, the highest score is 100 and the lowest score is 45, the average score (mean) is 74.516, the standard deviation is 12.371.

Furthermore, data on learning outcomes with different levels of creativity based on the number of subjects, range, maximum score, minimum score, average score, standard deviation and variance are presented in Figure 3.

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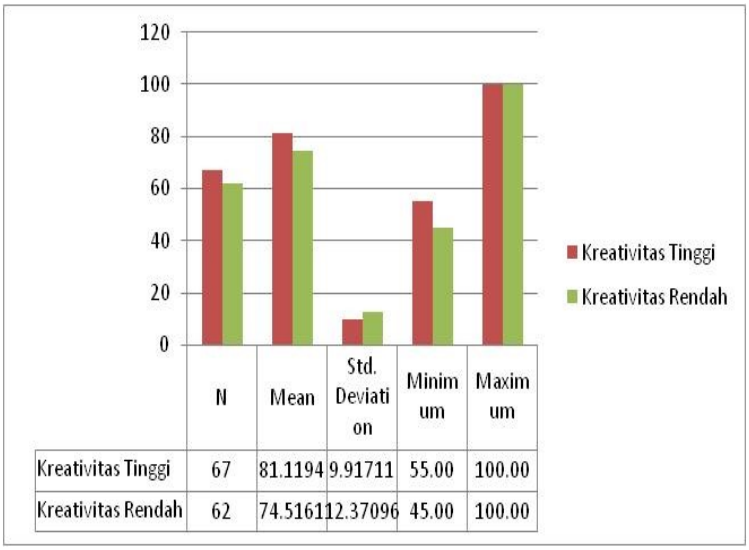

	N	Mean	Std. Deviation	Minimum	Maximum
Kreativitas Tinggi	67	81.1194	9.91711	55.00	100.00
Kreativitas Rendah	62	74.5161	12.37096	45.00	100.00

Figure 3. Graph of Learning Outcomes Description High and Low Creativity Levels

Descriptives

Hasil Belajar

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
tinggi	67	81.1194	9.91711	1.21157	78.7004	83.5384	55.00	100.00
rendah	62	74.5161	12.37096	1.57111	71.3745	77.6578	45.00	100.00
Total	129	77.9457	11.60234	1.02153	75.9245	79.9670	45.00	100.00

Figure 4. Description of Learning Outcomes with High and Low Creativity Levels

Hypothesis testing is carried out on the mathematics learning outcomes test after students take learning with the probem-based learning and discovery learning models, and see the influence of high and low creativity level variables and the effect of their interactions. This test is done to prove the truth of the hypothesis proposed. The hypothesis proposed includes: (1) There is a significant difference in mathematics learning outcomes between students who have a high level of creativity and a low level of creativity, (2) There is a significant interaction effect between the model and the level of creativity on mathematics learning outcomes.

Hypothesis testing is done by analyzing the mathematics learning outcomes test data. After calculating the two-way analysis of variance (ANOVA) technique at a significance level of 0.05 with the help of the SPSS version 16 computer program, the results are presented in table 1.

From the results of the calculation of data on the results of learning mathematics, the price of Fcount = 11,995 with a significance level of 0.001 is obtained. This shows that the significance level $\alpha = 0.001$ is under the significance level of 0.05 (0.001 <0.05). Thus H0 is rejected. This means that there is a significant difference in mathematics learning outcomes between groups of students who have a high level of creativity and a low level of creativity. By looking at the average learning outcomes obtained by groups of students who have a high level of creativity of 81.12, greater than the average learning outcomes of students who have a low level of creativity of 74.52. Thus it can be concluded that the learning outcomes achieved by groups of students who have a high level of creativity are better than students who have a low level of creativity.

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SUMMARY OF CALCULATION RESULTS

Table 1. Two-way Variance Analysis Technique at the Significance Level α = 0.05

Tests of Between-Subjects Effects

Dependent Variable: Hasil Belajar

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2583.777[a]	3	861.259	7.350	.000
Intercept	779951.916	1	779951.916	6656.314	.000
Kreativitas	1405.469	1	1405.469	11.995	.001
Model	679.974	1	679.974	5.803	.017
kreativitas * model	545.005	1	545.005	4.651	.033
Error	14646.843	125	117.175		
Total	800975.000	129			

From the results of calculating the mathematics learning outcomes data to test the hypothesis regarding the effect of the interaction between models and the level of student creativity on mathematics learning outcomes, the Fcount = 4.651 with a significant level α = 0.033 is below the significance level of 0.05 (0.033 <0.05) thus H0 is rejected. This means that there is an interaction effect between the model and the level of student creativity on mathematics learning outcomes.

Based on the calculation of the hypothesis test results obtained above, it can be concluded as follows.

a. There is a significant difference in mathematics learning outcomes between groups of students who study with the problem-based learning and guided discovery learning models.
b. There is a significant difference in mathematics learning outcomes between groups of students who have a high level of creativity and a low level of creativity.

There is an interaction effect between the model and the level of student creativity on mathematics learning outcomes.

DISCUSSION

There is a striking difference from the scores obtained by students with high and low creativity, namely 81.12 and 74.51. This shows that students with high creativity are better at learning logic mathematics than students with low creativity. This is as expressed by Ihsan (2016) that student creativity or a high level of creativity is needed in order to be able to logically solve problems, without the ability to think creatively, students have difficulty developing the ability to imagine which results in a lack of perspective ability of various alternative solutions to problems, especially problems with high complexity. high like math. Wilda et al, (2017) which revealed that the level of student creativity is very much needed in teaching and learning processing, especially in mathematics. Mathematical problems are very varied so that students also have difficulty solving them because the way of solving them is

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monotonous, the learning strategies and directed concepts are given by the teacher and demands for finding the level of student creativity.

This study has results in accordance with previous research, where research has been carried out by Insyasiska et al, (2015), Kharista (2012), Tirtiana (2013), which concluded that the level of student creativity significantly affects student achievement and learning. The research results of Abdurrozak (2016), Awang and Ramli (2018) concluded that the level of creativity has an impact on the acquisition of learning outcomes. Students in the high creativity group get better learning outcomes than those in the low creativity group. The findings of Kuspriyanto and Siagian (2013) suggest that the information received and understood well by students is determined by the level of student creativity in processing each material in the cognitive domain. Teachers who are careful and observant in developing learning strategies and methods in the classroom will increase learning concentration and motivate students to be more creative, so that learning outcomes are expected to increase.

The results of research monitoring in teaching and learning activities show that students who have high creative thinking tend to be more focused, more enthusiastic and motivated to carry out lessons. They have a good belief in expressing opinions, ideas, ideas for problem solving, posing questions, and answering questions. Creative students have great activity in learning, they also have no fear of guilt or cross arguments with other students, and have a greater sense of mutual understanding and respect for other people's differences of opinion.

Based on the observation activities carried out by the researcher, it shows that the ability to think creatively is low by students because during teaching and learning activities they tend to lack attention, lack of concentration, lack of motivation to take mathematics lessons, and lack the courage to express opinions and questions when compared with students who have high levels of attention. higher creativity. In general, students with lower creative thinking abilities are also less active in participating in mathematics lessons.

Students in the high creative thinking ability group when given learning with the guided discovery learning model appear more confident, enthusiastic, active, eager to try to find and find solutions to problems in mathematics that are presented to students, while students in the group who have the low creative thinking category looks passive in problem-solving efforts and lacks enthusiasm, insecurity, fear of guilt, doubt, and a tendency to be less able to collaborate with other students.

Students do not have much creativity because it is not easy to give a boost to their abilities or needs for this. Creative ideas are not that easy in cultivating them originally. Problem solving from various points of view can train creativity and affect creativity (Nasution & Sinaga, 2017). Student creativity can be honed in various ways and one of them can be generated by solving problems. This can be interpreted that cultivating one's creative thinking ability, including convergent and divergent thinking, cannot be carried out spontaneously or suddenly, but it takes students' perceptions and careful habituation to think creatively.

This study reveals that qualitatively the learning outcomes of students who are the subject of group research: (1) the Guide Discovery Learning model with a high level of creativity is high, (2) the Guide Discovery Learning model with a low level of creativity is high, (3) the Problem Based Learning model. with a high level of creativity in the high category, (4) the Problem Based Learning model with a low level of creativity in the sufficient category.

This study reveals that the average score: (1) the learning outcomes of the Guide Discovery Learning model group at a high level of creativity are the same as the learning outcomes of the Guide Discovery Learning model group at low creativity levels, and (2) the learning outcomes of the Problem Based Learning model group at the low level of creativity. high

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creativity differs from the learning outcomes of the Problem Based Learning model group at a low level of creativity. Previous research conducted by other studies on the application of the Guide Discovery Learning and Problem Based Learning models at the level of student creativity showed cognitive abilities had an effect on the mathematics-logic learning process, strengthened by the results of this study in other words this research supported previous research.

The interaction between the model and the level of creativity has a significant effect on learning outcomes. This statement may imply that the effect of implementing the Guide Discovery Learning model is also influenced by the level of student creativity. As Clark and Mayer, 2003; Moreno, 2004 in Jacobsen, Enggen and Kauchak (2009) states that the strategy in the teacher's Guide Discovery Learning model presents students with examples (both concrete and abstract), when trying to find patterns in these examples the teacher guides them, and when students have been able to describe the ideas being taught, the teacher provides a kind of cover and conclusions. Likewise, the application of the Problem Based Learning model affects student learning outcomes. The comparison between learning-teaching by applying the Guide Discovery Learning and Problem Based Learning models reveals that the planning stages for the two approaches are very identical to one another. As with the Guide Discovery Learning model, planning for the Problem Based Learning model also begins by posing a problem, but students 'motivation to bring out creativity has diversity based on students' background knowledge in the two application models, namely students must rely on data on learning resources in the form of reference books. to form the abstraction that is being taught. If these data examples are inadequate, self-study without teacher guidance will be much more difficult if the ability to come up with creative ideas in solving problems. As Woolfolk (2008) states that brainstorming in a group can give rise to creative ideas, but group efforts of this kind tend to be creative if the individuals share their opinions first. In other words, the effect of the application of the model on learning outcomes is influenced by the level of student creativity.

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