The Effect of Puzzle-based Learning Approach on Students' Mathematical Intuitive Thinking Ability

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Abstract. The purpose of this research was to know students' mathematical intuitive thinking ability between students taught with Puzzle-based Learning Approach and those taught using a Scientific Approach. The research was conducted at a senior high school Tangerang Selatan. The method of research used was quasi experiment with posttest-only control group design. The samples were 64 students; 32 students in experimental group and 32 students in controlled group by cluster random sampling technique. Data collection to measure the ability of students' mathematical intuitive thinking used by test instrument. The result of this research showed that the value of sig.= 0,000 was less than signification standard 0,05 on hypothesis test. This indicated that the average of students' mathematical intuitive thinking ability of teaching sequences and series taught using Puzzle-based Learning Approach was higher than those taught with Scientific Approach. This research concludes that learning mathematics using Puzzle-based Learning Approach has an effect on students' mathematical intuitive thinking ability.

Keywords: Puzzle-based Learning Approach, Mathematical Intuitive Thinking, quasi experiment.

1. Introduction

The urgency of mathematics according to Suwarsono in Muniri in daily life is considered not only as a method of arithmetic using formulas and processing of numbers, but also as a logical value in thinking specifically in solving problems, [6].

Based on the role of mathematics, learning in schools is required to create a well-learning climate to support the improvement of students' thinking skills. One effort that can be done is by giving problems to students related to mathematics. Sometimes some students can immediately understand the problem or problem given and at the same time an idea or strategy appears to solve the problem, but there are also students who need stimulus such as aids or learning media as a bridge of thinking to understand and find the best way to determine solutions from that problem. The ability of a person to understand mathematical problems as well as determine the strategy of a problem solving is a mental activity that is supported by intuitive thinking skills or can also be called mathematical intuitive thinking skills.

The aspect of intuitive thinking ability still receives less attention in the practice of learning mathematics in Indonesia. Based on the 2015 PISA results under the auspices of the OECD stated that the ability of Indonesian students to solve questions level 5-6 namely 0.8% is very far from the average of 15.3%, [8]. Cognitive level level 5-6 in PISA questions one of which is the ability to predict a solution to a problem based on prior knowledge that has formed within, [7].

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Based on preliminary research conducted at one of the high schools in Tangerang Selatan, the researcher submitted a mathematical intuitive thinking ability test instrument to 30 students. The results obtained are students' mathematical intuitive thinking ability which is relatively low with a percentage of 37.5%.

Fischbein believes that through the training process, one can develop new intuitions. Thus this view implies that intuition can be learned, acquired, and developed, [12]. Puzzle-based learning approach is a learning that uses puzzles with students compiling their own knowledge based on problems given to improve their thinking ability in solving unstructured problems, [5]. In compiling his knowledge of a given problem, the use of intuition is very necessary and instrumental. Because convergent problems are solved directly, using the ability of the algorithm possessed by prior knowledge requires the ability to think intuitively mathematically.

The use of puzzle-based learning approaches in class tends to direct students to compile their own knowledge with steps that start from understanding the problem, recognizing patterns, registering and eliminating, simplifying, *gedanken*, then ending with simulation and optimization in order to compile mathematical rules, formula, and its own principles.

Based on the problems that have been described, there is a significant relationship between puzzle-based learning in improving students' mathematical intuitive thinking skills. The core of PzBL learning provided is to stimulate students' intuitive mathematical thinking abilities based on unstructured problems and knowledge from previous experiences that have arisen suddenly and tend to be unclear where they came from.

Based on the research background that has been stated, the problem to be investigated will be further studied with the formulation of the problem as follows:

1. How is the mathematical intuitive thinking ability of students who get learning with puzzle-based learning?
2. How is the ability to think intuitively mathematically students who get learning with a scientific approach?
3. Is the ability to think intuitively mathematically students who get learning with puzzle-based learning is higher than students who get learning with a scientific approach?

2. Literature Review

2.1 Mathematical Intuitive Thinking Ability

Thinking is a very influential part in supporting the activities of human life. This causes human activity in regulating life on earth supported by the ability to think. Mathematical thinking, according to Sumarmo, is defined as a way of thinking regarding mathematical processes (doing math) or ways of thinking in completing mathematical tasks, both simple and complex, [11].

Intuitive thinking ability is often used in mathematical problem solving. As revealed by Kustos [9], that intuition can be a reason for a strong understanding in relation to logic rather than against logic. A mathematical statement requires proof, but evidence from a statement often uses intuition to determine patterns in proving the statement. To think intuitively is to think concrete, direct, inductive and rich in non-symbolic ways in representing and processing of information, as well as recognition, [4].

Based on the description above, the ability to think intuitively mathematically which is the basis of this research is the ability of a person to solve mathematical problems based on information stored in memory, linking them to aspects in the form of audio or visual, to

understand and apply them in understanding and resolve the structure of mathematical problems spontaneously, globally, or may emerge suddenly.

2.2. Puzzle-Based Learning

Pedagogically, the concept of puzzle-based learning aims to improve students' general analysis and problem solving skills by using puzzles (unstructured problems) that are educational, interesting and not boring, [5]. Puzzle-Based Learning refers to a basic approach that aims to improve thinking skills, build mentality and accuracy in solving unstructured problems, [10]. The statement is in line with the main purpose of puzzle-based learning expressed by Falkner, which is to build a solid foundation for students to become problem solvers in real life, [2].

3. Research Methods

The research method used a quasi-experimental design that has a control group, but cannot control the external variables that affect the experiment. This study divides the two groups namely the experimental group and the control group. The experimental group was the group that was given the treatment of learning with Puzzle-based Learning while the control group was given the treatment of learning with the Scientific Approach.

The design used was a randomize control group post test only design, which is a randomized design using a control group as a comparison to the experimental group and administering the test at the end of the treatment.

The sample in this research was taken from the population that is all students of class XII one of senior high schools in Tangerang Selatan in the academic year 2018/2019. Samples were taken as many as 2 classes randomly from nine classes using the cluster random sampling technique.

The research instrument used in this study was in the form of six descriptive questions given in the form of a post-test. The research instrument used in this study is a matter of description that has been measured validity, reliability, and tests to find out the different power and difficulty level of questions.

Analysis of the data used is hypothesis testing regarding differences in two population averages. The test used is the t-test. Before testing the hypothesis, the analysis prerequisite test is performed first, namely: normality test and homogeneity test

4. Result And Discussion

4.1. Result

1. Comparison of Mathematical Intuitive Thinking Ability in Experimental and Control Class Students

Comparison of the results of the test results of mathematical intuitive thinking ability students of the experimental class who were taught with a puzzle-based learning approach and the control class taught with a scientific approach can be seen in Table 3 as follows.

Table 1. Descriptive Statistics Mathematical Intuitive Thinking Ability in Experimental and Control Class Students

Class	N	Range	Min	Max	$\bar{X}$	S	Skewness
A	32	30	63	93	78.91	7.512	-.081
B	32	31	38	68	55.53	8.317	.464
Valid N	32						

The table shows that the average value of the experimental class is higher than the control class with an average value of 78.91 in the experimental class and 55.53 in the control class. The maximum value of students in the experimental class is 93, while the minimum value is in the control class is 38. The standard deviation of the experimental class is lower than the control class. This shows that the mathematical intuitive thinking ability of the control class is more diverse than the experimental class. When viewed from the skewness level, the experimental class is negative, which means that most of the experimental class data is above average. The slope of the control class is positive, which means the control class data is below average.

Visually, the difference in the distribution of students' post-test results data for mathematical intuitive thinking ability of the two classes can be seen in the following figure 1:

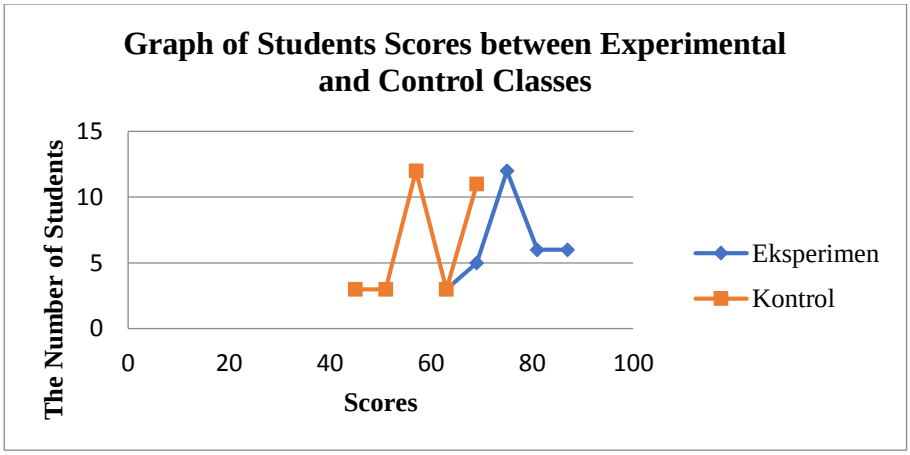

Fig.1. Graph of Frequency Distribution in Experimental and Control Class

Based on these curves, it is seen that the comparison of mathematical intuitive thinking ability values of the experimental class and control class students has a significant difference in the acquisition of the most values, namely the control class in the range of 50-60 and the experimental class in the range of 70-80. The highest score is dominated by the experimental class.

2. Mathematical Intuitive Thinking Ability in Experimental Classes and Control Class Students Based on Indicators

The students' mathematical intuitive thinking abilities are analyzed even more sharply based on the indicators namely catalysis, generalization and deduction. The average mathematical intutive thinking ability in the experimental class and the control class are reviewed based on the indicators presented in the following table.

Table 2. Average Mathematical Intuitive Thinking Ability between Experimental and Control Class Review Based on Indicators

No.	Indicators	Experimental	Control
1	Catalysis	76,17	58,59
2	Generalization	79,69	50,98
3	Deduction	82,81	58,2

Based on the table, on the catalyst indicator, the achievement of the experimental class is superior to the control class. In the generalization indicator, the achievement of the experimental class is far superior to the control class. Furthermore, the achievement of the experimental class on the deduction indicator is also higher than the control class. Judging from the three indicators, the experimental class is always superior to the control class in each indicator of mathematical intuitive thinking ability.

The average indicator of mathematical intuitive thinking ability with the highest level for the experimental class is indicator 3, namely deduction. Meanwhile, the average indicator of mathematical intuitive thinking ability with the highest level for the control class is indicator 1, namely catalysis. It can be seen, the average experimental class was higher in all indicators than the control class.

This research uses quantitative analysis, which is an analytical technique whose analysis process is carried out with mathematical calculations. This is because the results of this study are in the form of numbers on the results of tests of mathematical intuitive thinking abilities. Data taken from the experimental class and the control class are the results of the students' post-test on the subject of Trigonometry Derivation. The data that has been collected is processed and analyzed to answer the problem formulation and research hypothesis. The data processing starts from the normality test to the average difference test of the research class carried out using SPSS software.

Based on the results of the t-test hypothesis test it can be that the price of t = 10,607, df = 62 and p-value = 0,000 <0.05. This shows the rejection of H0 and acceptance of H1. H1 states that the average mathematical intuitive thinking ability of the experimental class taught by the puzzle-based learning approach is higher than the average mathematical intuitive thinking ability of the control class taught by the scientific approach.

4.2 Discussion of Research Results

The results revealed that there were significant differences in mathematical intuitive thinking skills between groups of students who were taught with a puzzle-based learning approach and groups of students who were taught with a scientific approach. When viewed from the acquisition of values on each indicator, the experimental class is superior to the control class in each indicator of mathematical intuitive thinking ability.

Based on the results of the study found that learning with a puzzle-based approach has a positive influence on the development of students' mathematical intuitive thinking abilities that are applied during the learning process. It can be seen from the achievement of the values obtained by students who are taught with a puzzle-based approach and who are taught with a scientific approach to each indicator of mathematical intuitive thinking ability. The intuitive thinking ability of a puzzle-based approach is superior to a scientific approach, because a puzzle-based approach scores on the intuitive thinking ability of each indicator is higher than a scientific approach. This statement is supported by the recapitulation of a puzzle-based approach students who read the questions on average twice, while a scientific approach three times, this supports that the ability to quickly grasp the problem of a puzzle-based approach students is better than a scientific approach.

The results of this study are also supported by research conducted by Boukhcherida in an international journal entitled "Enhancing Tertiary Students" Creativity Thinking Through Educational Puzzles ". The study concluded that puzzle-based learning is able to optimize students' creative thinking abilities that are closely related to intuitive abilities [1]. In addition, the findings of this study are also relevant to research conducted by Lia Kurniawati in the International Journal of "Enhancing Students' Mathematical Intuitive-Reflective Thinking Ability through Problem-Based Learning with Hypnoteaching Method" which concluded that learning with Problem-Based Learning uses the method hypnoteaching can develop mathematical intuitive-reflective thinking skills, [4]. The indicators measured are identify, arrange, evaluate, determine and construct. Intuitive-reflective abilities are closely related to indicators of mathematical intuitive thinking ability. Identification indicators are related to catalysis, where students use their intuition to make sense of the problem in a logical way. Arrange and determine indicators use the ability of students to solve problems and group concepts based on prior knowledge as stated in the generalization indicator. The next indicator is evaluate and construct related to students' thinking ability in concluding and building their own concepts of knowledge based on generalizations from examples or concepts that have been done before. From previous research it can be concluded that problem-based learning or puzzle-based learning can improve mathematical intuitive thinking skills.

Based on the average of each indicator the mathematical intuitive thinking ability of the puzzle-based approach is above 75, while the scientific approach is above 50. Even though the average control class taught with the Scientific Approach is lower than the experimental class, it does not mean this approach does not have a positive influence on Natematic intuitive thinking ability. The combination of puzzle-based learning with a scientific approach can certainly be an alternative choice when learning mathematics to improve students' mathematical intuitive thinking abilities.

5. Conclusion And Recommendation

5.1. Conclusion

1) The mathematical intuitive thinking ability of students in the experimental class which learning is applied puzzle-based learning approach is already high on all indicators. The ability to think intuitively mathematically in the largest experimental class is in indicators of deduction. Other indicators that occupy the second and third positions are generalization and catalysis. It can be said that learning with a puzzled-based learning approach can develop students' mathematical intuitive thinking skills.
2) Mathematical intuitive thinking ability of students in the control class that is applied with conventional learning that is with a scientific approach is still relatively low on

all indicators. The ability to think intuitively mathematically in the largest control class is catalysis but this result is still relatively low and not satisfactory enough. Other indicators that occupy the second and third positions are deduction and generalization.

3) Based on the results of hypothesis testing shows that the average mathematical intuitive thinking ability of experimental class students whose learning is applied with puzzled-based learning is higher than the average of control class students with a scientific approach.

5.2. Recommendation

Based on the findings that the researchers got in this study, there are some suggestions that researchers want to convey in this study, namely:

1) For schools, based on the results of research that the average students' mathematical intuitive thinking ability that is applied with puzzled-based learning is higher than the average mathematical intuitive thinking ability of students who are taught with a scientific approach so that learning with puzzle-based learning can be wrong or suggested alternatives in mathematics learning to be applied to students in developing mathematical intuitive thinking skills.
2) For teachers, learning with puzzle-based learning requires a relatively longer time at the stage of quantifying and eliminating as well as simulation and optimization. Therefore, the application of this learning should be well designed to consider the time allocation needed so that learning can run on time.
3) For students, it is better to be more independent in solving problems when learning the concept of knowledge rather than waiting and relying on the teacher's explanation in presenting the material so that students are more confident and get solid knowledge in each learning process.
4) For other researchers, this study only looked at the effect of applying learning with puzzle-based learning to the ability to think intuitively mathematically on trigonometric derivative material. Therefore, research should also be carried out on the subject and other mathematical thinking abilities. In the selection of problems (puzzle) researchers should provide unique and interesting problems, so students are enthusiastic in solving problems. Researchers are also advised to conduct good time management, so that all stages of puzzle-based learning run optimally.

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