Mathematical Problem-Solving Ability Through Pictorial Riddle-Based Inquiry Model

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Abstract

This study aims to determine the significant differences in students' mathematical problem-solving abilities using the Pictorial Riddle-based Inquiry learning model and conventional learning models. This type of research is quasi-experimental research. The population in this study were students of class XI IPS SMAN 4 Bengkulu City. The sample in the study was taken 2 classes randomly, namely class XI IPS 3 as the experimental class 1 and class XI IPS 5 as the control class. The mathematical problem-solving ability test obtained that there is a significant difference between the mathematical problem-solving abilities taught using the Pictorial Riddle-based Inquiry learning model and the conventional learning model. The inquiry learning model based on Pictorial Riddle provides an average result of mathematical problem-solving ability that is better than conventional learning models.

Keywords: *Code Mixing; Teaching and Learning Process; Qualitative Method*

Introduction

Mathematics is a study material that has abstract objects and is built through a deductive reasoning process, namely the truth of a concept is obtained as a logical result of the previous truth so that the relationship between concepts in mathematics is very strong and clear (Asmara, 2014:1). In learning mathematics to be easily understood by students, the inductive reasoning process can be carried out at the beginning of learning and then followed by a deductive reasoning process to strengthen the understanding that students already have. One of the learning objectives according to Wardhani (2008:8) is solving problems which include the ability to understand problems, design mathematical models, complete models, and interpret the obtained models.

According to Syaiful (2012) problem solving can be interpreted in three different categories. First, problem-solving as a goal. This category focuses on learning how to solve problems. In this case, problem-solving is independent of procedures or methods and the content of mathematics itself. Second,

problem-solving as a process. This category focuses on the methods, procedures, strategies, and heuristics used in problem-solving. Third, problem-solving as a basic skill, one of which concerns the minimum skills that students have in mastering mathematics.

Problem-solving is part of high-level skills in mathematics. This is because students will gain experience in using their knowledge and skills to solve non-routine questions. Agreeing with this statement, Sadiq (2014: 3) defines mathematical problem solving as "the process of applying previously acquired mathematical knowledge into new, unfamiliar situations". As an implication, problem-solving activities can support the development of other mathematical abilities such as communication and mathematical reasoning.

Mathematical problem-solving is a complex cognitive activity, as a process to overcome a problem encountered, and solving it requires a number of strategies (Harahap & Surya, 2017: 45). According to Soedjadi (2000: 36), the mathematical problem-solving ability is a skill for students to be able to use mathematical activities to solve problems in mathematics, problems in other sciences, and problems in everyday life. Meanwhile, Montague (Hidayat & Sariningsih, 2018) says that mathematical problem-solving is a complex cognitive activity accompanied by a number of processes and strategies.

From some of these opinions, it can be concluded that mathematical problem solving is a complex activity carried out to deal with problems encountered and think about how to solve them using a number of strategies, both solving problems in learning mathematics, other learning, and in solving problems of everyday life.

So mathematical problem-solving ability is one of the basic mathematical abilities that must be possessed by every student (Darmani & Renaldi, 2018). By learning to solve problems, students are given many opportunities to connect mathematical ideas and develop conceptual understanding.

Based on observations at SMA Negeri 4 Bengkulu City, mathematics lessons are still considered difficult by students, especially in solving problems that are different from the example. Based on interviews, teacher experiences, and during the internship at the high school, information was obtained that students' mathematical problem-solving abilities were still low. When carrying out internship activities at the high school, it was seen that students had difficulty solving questions given by the teacher if they were different from the examples. When the teacher gives a question that is different from the previous example, students immediately complain because they think the problem is difficult and immediately ask how to solve it. In addition, another cause of the low problem-solving ability of students is that in general mathematics is not liked by students, they only see mathematics as a difficult and boring subject.

Then conducting interviews with the mathematics teacher at the high school they said that after the learning activities and giving examples of questions and exercises that were given in accordance with the sample questions. When given back questions related to the material that has been studied, but with different questions and know it makes students confused to solve the problem because the questions given cannot be solved directly by simply entering what is known into the solution formula. Interviews were conducted with teachers who teach in IPA, IPS, and LANGUAGE classes, all of the answers on average are the same but slightly different from science students, where some students can carry out several completion steps even though they are still wrong.

Likewise with the teacher's teaching experience that if given questions that are different from examples and routine questions, as usual, students will find it difficult to solve the problem. The Pictorial Riddle-based Inquiry Model in this study provides opportunities for students to be able to play an active role in real-world problem-solving activities to the fullest through their abilities.

The inquiry learning model is a learning activity that involves maximally all students' abilities to search for and investigate something (objects, people, or events) systematically, critically, logically, and analytically, so that they can formulate their own findings with confidence (Trianto, 2014: 82). According to Majid (2016: 222), the inquiry learning strategy is a series of learning activities that emphasize critical and analytical thinking processes to seek and find answers to the problems in question. The thinking process itself is usually carried out through questions and answers between teachers and students.

According to Mudrlofir & Rusydiyah (2016: 66), inquiry learning is a learning activity that maximally involves all students' abilities to search for and investigate something (objects, people, or events) systematically, critically, logically, analytically so that they can formulate their own findings with full of confidence. From some of the opinions above, it can be concluded that the inquiry learning model is a teaching and learning activity carried out by involving the abilities of students to the maximum in the process of thinking logically, systematically, analytically so that they can find answers to the problems they face.

According to Eni (2016: 2), the approach using Pictorial Riddle is one of the techniques or methods to develop students' motivation and interest in small and large group situations. Pictures, demonstrations, or real situations can be used to improve students' critical and creative thinking. A riddle is usually an image on a blackboard, poster board, or projected from transparency, then the teacher asks questions related to the riddle. A skilled problem solver cannot be separated from the ability to think systematically, logically, and critically as well as persistence in solving the problems he faces (Cahya & Surya 2017:5).

According to Febriana, et al (2018: 3), the Pictorial Riddle method is a method or technique for developing student activities in small and large group discussions, by presenting problems presented in the form of illustrations. According to Rizkiah et al (2018: 3), the Pictorial Riddle approach is a learning process that uses pictures or demonstrations on a blackboard, poster board, or screen. Then the teacher asks questions related to pictures to foster student learning motivation in small and large group discussions.

From some of the opinions above, it can be concluded that the Pictorial Riddle-based approach is a process of learning and teaching activities carried out using pictures as learning media, then from the picture, the teacher gives questions, and then students think and solve the problems that are drawn. The Pictorial Riddle-based Inquiry learning model is one of the teaching approaches that involve pictorial problems that make students who are given problems think about solving the pictorial problems. This study aims to determine the effect of the Pictorial Riddle-based Inquiry learning model on compulsory mathematics learning for arithmetic sequences and series and the benefits of this research if successful it will add new alternatives to learning.

Methodology

The type of research in this study is quasi-experimental (quasi-experimental). This experiment aims to test the comparative hypothesis with a research design where in the experimental class the Inquiry model is based on Pictorial Riddle and in the control class the conventional learning model. The research was conducted in the even semester 2021/2022 academic year at SMA Negeri 4 Bengkulu City. The population in this study were students of class XI IPS SMA Negeri 4 Bengkulu City. The sample class is taken, class XI IPS 3 which amounted to 30 students as the experimental class, and class XI IPS 5 which amounted to 30 students as the control class. The sampling technique used is random sampling, namely simple random sampling, by randomizing all classes of the population.

The operational definition of this research is (1) an Inquiry learning model based on Pictorial Riddle and conventional which is applied according to the steps/syntax of each learning model. (2)

Mathematical problem-solving ability is the average of the mathematical problem-solving ability test scores obtained by students before and after being given good treatment in the Pictorial Riddle-based and conventional Inquiry learning model.

Research data analysis techniques through several tests, namely:

Analysis Prerequisite Test

a. Data Normality Test

A normality test is needed to test whether the data distribution is normally distributed or not. To test normality, the Kolmogorov-Smirnov test is used. To test the normality of the data, the hypotheses to be tested are as follows:

H_0 : Data distribution is normally distributed
H_1 : Data distribution is not normally distributed

b. Variance Homogeneity Test

The homogeneity test aims to determine whether the variance between groups of samples is homogeneous or not. In this case, the Barleth test was carried out at a significance level of 0.05. The criteria used are if the calculated value $x^2h > x^2t$, table value, then H_0 states the variance of the score is homogeneous is rejected, in other cases, it is accepted

The data that will be taken into consideration is taken from the total score of each question that is done by students. The score is processed using data analysis techniques. The instrument in this study was a set of test questions before and after the implementation of the learning model. To simplify the process of scoring the results of student work, the score for each item is used with the scoring rubric rules. The following are indicators and rubrics for scoring students' mathematical problem-solving abilities.

Table 1. Scoring Guidelines for Mathematical Problem-Solving Ability

Criteria	Response to questions/problems	Score
Understanding the Problem	There are attempts to identify known, stated, but still incorrect elements	1
	Can identify elements that are known, stated to obtain part of the solution but are still incomplete	2
	Complete and correct element identification	3
Planning Completion	Strategies that are made less relevant and lead to wrong answers	1
	The strategy made is right	2
Solve the problem	There is a solution but it's still wrong	1
	There is a solution to the problem, but there are still errors in the calculation	2
	Correct problem solving	3
Doing Checks	The conclusion given is wrong	1
	The conclusion given is correct	2
Description: Score = 0, if there is no response or empty answer for each indicator being assessed		

Source: Adapted from Vermont Math Problem Solving Criteria, Vermont Department of Education.

The test data collection technique is in the form of a set of mathematical problem-solving questions. The initial test (pre-test) aims to determine the student's initial ability before being given treatment and the final test (post-test) aims to determine the ability after being given treatment. The test

questions used are mathematical problem-solving ability test questions whose contents are validated first by experts, namely lecturers and teachers of mathematics subjects.

Result and Discussion

Based on the data before (Pre-Test) and after (Post-Test) treatment was given. Pre-test and Post-Test data were analyzed to see if there were differences in mathematical problem-solving abilities in the two groups. Then, based on the post-test data, it was analyzed which model gave better results. Furthermore, as a condition for using parametric statistics, hypothesis testing was carried out including data normality tests and variance homogeneity tests.

The data of Pre-Test and Post-Test of students' mathematical problem-solving ability obtained descriptive statistics regarding the amount of data (n), the total score ($\sum$), average (x), maximum score, minimum score, and standard deviation (s). It can be seen in table 2 below:

Table 2. Distribution of post-test and post-test results
Students' Mathematical Problem Solving Ability

Value	*Pictorial Riddle-based Inquiry*						Conventional					
	n	Σ	X	S	Min	Max	n	Σ	X	S	Min	Max
Pre-test	30	315	10,2	2,6727	8	15	30	294	9,8	2,6704	6	14
Post-test	30	580	18,71	5,074	8	29	30	491	16,37	4,493	8	26

Based on table 1 above, it can be seen that the total score of the Pre-Test Inquiry class based on Pictorial Riddle is 315 with an average score of 10.2 and the total post-test score is 580 with an average value of 18.71, meaning that the treatment given to students with Inquiry learning model based on Pictorial Riddle experienced an increase in the total score of 265 with an average increase of 8.83. The total pre-test score obtained in the conventional class is 294 with an average value of 9.8 and the total post-test score is 491 with an average value of 16.37, meaning that the treatment given to students with conventional learning models has increased by 197 with an average increase of 6.56.

So it can be concluded that students who received learning using the Pictorial Riddle-based Inquiry learning model experienced much improvement compared to students who received conventional learning models with a comparison of the increase in average scores of 8.83 and 6.56. The standard deviation (s), the Pre-Test data for Pictorial Riddle-based Inquiry class students is 2.6727 with a post-test of 45.074 and the conventional class of pre-test data is 2.6704 with a post-test of 4.493. With a max post-test score of Inquiry based on Pictorial Riddle 29 and a max score of post-test for conventional class 26. This means that the class that gets the Pictorial Riddle-based Inquiry learning model gets a higher score. Based on the description above, it can be said that there are differences in the mathematical problem-solving abilities of students who are taught with the Pictorial Riddle-based Inquiry model and conventional, and the Pictorial Riddle-based Inquiry learning model gives better results than the conventional model. These differences can be seen in Figure 1.
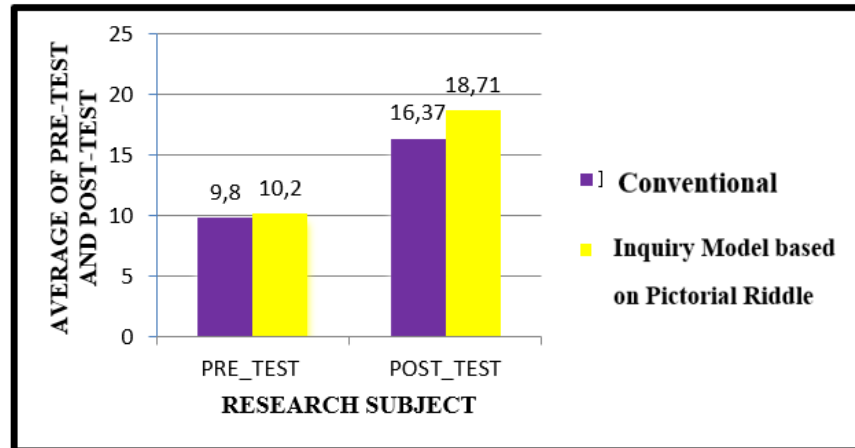
Figure 1. Average of Pre-Test and Post-Test of Mathematical Problem Solving Ability Inquiry Model based on Pictorial Riddle and Conventional

Based on the results of data analysis using descriptive statistics for students' mathematical problem-solving abilities before the application of the Pictorial Riddle-based Inquiry learning model has an average of 10.2. Then for students' mathematical problem-solving ability after the application of the Pictorial Riddle-based Inquiry learning model has an average value of 18.71. The results of inferential statistical analysis (Paired Sample T-test) obtained a significance value of less than 0.05. This means that there is an increase in students' mathematical problem-solving abilities after the application of the Pictorial Riddle-based Inquiry learning model.

This is in accordance with previous research conducted by Hidayati, et al. (2017) in their research stating that there are differences in mathematical problem-solving abilities between experimental class students who are taught with the Pictorial Riddle-based Inquiry model and control class students who are taught using conventional models. The Pictorial Riddle-based Inquiry model is commonly used by previous researchers in physics and biology, but this time the researchers tried to apply the Pictorial Riddle-based Inquiry model to mathematics lessons on the basis of previous research.

Researchers took the Pictorial Riddle-based Inquiry model in this study, based on previous research submitted by Himah, et al (2015) which stated that there was a significant difference with the implementation of the Problem Based Learning (PBL) learning model accompanied by the Pictorial Riddle-based Inquiry method in Physics learning in high school, from the results of this study the researcher hopes that his research can be used as a basis for other researchers but on different learning topics or even in different subjects.

The increase in students' mathematical problem-solving abilities is caused by several factors. One of them is the different learning steps. Problem-based teaching is an effective approach to teaching higher-order thinking processes. This learning helps students to process ready-made information in their minds and construct their own knowledge about the social world and its surroundings. This course is suitable for developing basic and complex knowledge. Pictorial Riddle-based inquiry has the characteristics of student-centered, designed based on pictorial problems containing puzzles that encourage students to build a rich understanding of contextual mathematical concepts through a series of constructive questions. The Pictorial Riddle-based Inquiry learning model is a student-centered learning process, while before the implementation of Pictorial Riddle-based Inquiry, educators still used a teacher-centered learning process. Thus, the improvement of students' mathematical problem solving abilities after the application of the Pictorial Riddle-based Inquiry learning model is a very convincing result.

Conclusion

Based on the data analysis, it can be concluded that (1) there are differences in students' mathematical problem-solving abilities who are taught with the Pictorial Riddle-based Inquiry learning model and the conventional learning model at SMAN 4 Bengkulu City class XI Social Sciences. (2) Inquiry learning model based on Pictorial Riddle has an average mathematical problem-solving ability that is better than conventional learning models. Also, there is an increase in students' mathematical problem-solving abilities after the application of the Problem Based Instruction (PBI) learning model. From the results of this study, the researcher hopes that his research can be used as a basis for other researchers to apply the Pictorial Riddle-based Inquiry model to other materials to find out whether all mathematics materials can improve learning outcomes when using the Pictorial Riddle-based Inquiry model.

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