Junior high school students’ achievement of mathematical problem solving ability and mathematical habit of thinking flexibly using learning Inquiry Co-operation Model (ICM)

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Abstract. This study aims to see the achievement of mathematics problem solving ability and mathematics habit of thinking flexibly using Inquiry Co-operation Model (ICM) learning in the experimental class and the control class. This research is a quasi-research with a post-test only control group design. ICM learning is given to 31 students of the experimental class, while 31 control class students are given direct learning. The population is students of class VIII junior high school students in one of the cities in Sumatera Barat selected through purposive sampling techniques. Students take tests of problem solving ability and fill in the habit of thinking flexibly questionnaire. a) The achievement of students' mathematical problem solving abilities using ICM learning is higher than students who use direct learning; b) achievement of a mathematical habit of thinking flexibly of students who use ICM learning is better than students who use direct learning; c) there is a relationship between mathematical problem solving abilities with a mathematical habit of thinking flexibly. It was concluded that ICM learning can achieve problem solving ability and habit of thinking flexibly.

1. Introduction

One of the abilities students must possess at this time is the ability to solve problems. By having the ability to solve problems, students can use their abilities to solve non-routine problems, namely problems where procedures and steps that are not yet known to students. However, the ability to solve problems can not be owned just like that, but must go through habituation. One of the ways that students can solve problems is through mathematics. Because learning to solve problems or solve problems is the goal of learning mathematics. Problem solving becomes the focus of mathematics in school [1]. Problem solving in mathematics learning can be seen as an approach and a goal that must be achieved. As an approach, problem solving is used to find and understand mathematical material or concepts [2].

However, the reality on the ground shows how students’ problem solving is still low. Based on the results of interviews conducted by researchers on grade VIII teachers in junior high schools in Lima Puluh Kota, West Sumatra Province, information was obtained about students who still need difficulties in solving non-routine problems that demand problem solving ability. This is caused by many factors, including students who can not be determined between the information about the questions or questions, students' lack of understanding in changing sentences about mathematics models, and mistakenly using...
strategies to solve problems and use different ways of solving a problem. While students who get problem solving can solve non-routine problems given.

In dealing with problem solving problems students are expected to be able to identify the elements that are known, asked, and the adequacy of the required elements, formulate problems and plan strategies from everyday situations in mathematics, and implement strategies to solve various problems. Based on the results of researchers' interviews with these teachers, it can be said that the students' problem solving ability is not sufficient to solve the problem.

The above facts are strengthened by the results of other studies by those who say that the low ability to solve problems with trigonometric topic from 37 class X students of Bandung Aloysius High School is due to the difficulty of students to understand the questions, students cannot distinguish between question and answer information or requests the problem, the students' lack of understanding in turning the sentence into a mathematical model, and the incorrect strategy used to solve the problem and use the different way of solving a problem [3]. The low problem solving ability of students in class VIII of junior high school 4 Semarang with quadrilateral topic is also due to the learning model that is used generally positions students as recipients of information in learning activities [4].

Habits of mind has 16 characteristics [5]. One of them is habit of thinking flexibly which can help students in understanding problems in various life contexts. Habit of thinking flexibly is the habit of opening one's thoughts based on the information or data obtained to create alternatives to solving problems with the rules and criteria given [6]. This explains that if students have a habit of thinking flexibly, then in solving problems students have many other ways or alternatives. This reinforces the notion that the importance of habit of thinking flexibly owned by students. The importance of habit of thinking flexibly owned by students that in solving effective mathematical problems requires flexible thinking [7]. A flexible thinker will be confident in using his knowledge, persisting in understanding and solving mathematical problems and able to find other solutions [7].

However, the reality on the ground reveals that the habit of thinking flexibly possessed by students is still low. Flexible thinking students by obtaining an average score of 26.07 from an ideal maximum score of 50 [8]. Based on these findings, the authors get the picture that the low ability of mathematical problem solving ability and habit of thinking flexibly one of them comes from learning that is not yet optimal, so we need a learning that can improve students' mathematical problem solving abilities and develop habits of flexible thinking.

There are many alternative approaches, methods, or learning strategies. Among the many alternatives, which are felt to be effectively applied to be able to improve mathematical problem solving abilities and develop students' habit of thinking flexibly, one of them is the Inquiry Co-operation Model (ICM) learning model. ICM learning is a modification of two learning, namely free inquiry learning and guided inquiry [9]. ICM learning is a learning model that requires students to be actively involved in the learning process in the investigation, discovery, and resolution of problems related to daily life through guidance or direction from the teacher [9].

Inquiry Co-operation Learning model consists of eight stages of the learning process, namely: (1) getting in contact (making contact); (2) locating (localizing); (3) identifying (identifying); (4) advocating (advocating); (5) thinking aloud (thinking hard); (6) reformulating (reformulating); (7) challenging (challenging); and (8) evaluating [9]. The stages of learning are interrelated with each other and cause students to be actively involved in learning in the learning process. The stages of ICM enable students to take steps to solve Polya's problems, namely understanding the problem, planning problem solving, implementing the problem solving plan, and looking back at what has been done. [10].

Based on the description above, researchers feel the need to research to find a picture of the achievement of mathematical problem solving abilities and the habit of thinking flexibly mathematically that obtained ICM learning.

2. Methods
This study uses a quasi-experimental method with the research design is a post-test only control group design that classifies into two classes, namely the experimental class, and the learning class directly on
the material to build flat side space. The sample of this study was 31 students of class VIII 5 and 31 students of VIII 6 in junior high school in Sumatera Barat in the even semester 2020. The instruments in this study were test and non-test instruments, the test instrument consists of 4 questions in the form of descriptions that have been tested before to find out the validity, reliability, level of difficulty, and distinguishing features of each question. The tests are arranged based on indicators of mathematical problem solving ability. The non-test instrument in this study was in the form of a mathematical student habit of thinking flexibly consisting of 20 statements and equipped with 4 answer choices, Very Frequently (VF), Frequently (F), Rarely (R), and Very Rarely (VR). Respondents' answers were measured using a Likert Scale of 1 to 4 for each statement. The habit of thinking questionnaire was flexibly validated by 1 mathematics lecturer, 1 Indonesian language lecturer, and 1 mathematics teacher who focused on construct validity and content validity. All calculations in this study were assisted by SPSS and Microsoft Excel.

3. Result and Discussion

3.1. Result

The results of this study describe and examine the mathematics problem solving ability and habit of thinking flexibly students who use Inquiry Co-operation Model (ICM) learning and who use direct learning and to find out whether or not there is a relationship between mathematical problem solving ability and students' habit of thinking flexibly mathematics.

This study uses a T-test to describe the difference in the average achievement of students' mathematical problem solving abilities using ICM learning and direct learning. The table shows the results of the test of the average score difference in the ability of problem solving.

| Table 1. Test results of the mean difference in scores of problem solving ability |
|---------------------------------|----------------|----------------|----------------|
| T-Test | Sig (2-tailed) | Sig (1-tailed) | Information | Conclusion |
| 4.325 | 0.000 | 0.000 | H₀ is rejected | Higher |

Table 1 shows that the t-test carried out an obtained significance of 0.000. Because this study uses a one-way test, the significance value is divided in two. Based on the results of calculations performed that the Sig (1-tailed) value is less than α = 0.05, so H₀ is rejected. So it can be concluded that the mathematical problem solving ability of students who use ICM learning is higher than the mathematical problem solving ability of students who use direct learning.

Furthermore, the t-test to describe the differences in the average achievement of a mathematical habit of thinking flexibly of students who use ICM learning and direct learning. The table shows the results of the test of the average score difference in the ability of thinking flexibly.

| Table 2. The results of the test of the average score of habit of thinking flexibly questionnaire |
|---------------------------------|----------------|----------------|----------------|
| T-Test | Sig (2-tailed) | Sig (1-tailed) | Information | Conclusion |
| 2.006 | 0.049 | 0.0245 | H₀ is rejected | Better |

Table 2 shows the results of calculations performed obtained that the value of Sig (1-tailed) is less than α = 0.05, so H₀ is rejected. So it can be concluded that the habit of thinking flexibly of students who use ICM learning is better than the habit of thinking flexibly of students who use direct learning. The correlation between mathematical problem-solving abilities and mathematical habit of thinking flexibly, can be traced through the score of mathematical problem solving ability and mathematical habit of thinking flexibly using ICM learning. To see whether there is a correlation between mathematical problem solving abilities with the mathematical habit of thinking flexibly used Pearson correlation. The
The table shows the results of the correlation between mathematical problem solving abilities and mathematical habit of thinking flexibly.

**Table 3.** Correlation results between mathematics problem solving ability and mathematically flexible mathematical habits

| Pearson Correlation | Sig (2-tailed) | Information | Conclusion |
|---------------------|----------------|-------------|------------|
| 0.818               | 0.000          | H$_0$ is rejected | Related |

Table 3 shows that the value of sig. (2-tailed) obtained is 0.000 or sig value <0.05. Based on the testing criteria, it can be concluded that H$_0$ is rejected. The correlation value obtained is 0.818 with a high category with a positive (+) direction. This means that there is a significant relationship between mathematical problem-solving abilities and mathematical habit of flexibly thinking.

### 3.2. Discussion

Based on research results obtained from mathematical problem solving students who use ICM learning higher than the mathematical problem solving abilities of students who use direct learning. This can be seen from the answers of students who answer questions about mathematical problem solving abilities including all indicators of problem solving ability. The following presents one of the problem solving ability test questions along with an answer of ICM learning class students and direct learning in problem solving.

**Question:**

Two right triangular prisms have a base with the size of one side of a right elbow of 5 cm and the longest side of 13 cm, and have a height of 10 cm. If the sides that have the same size from both prisms are squeezed together, a new building will be formed.

a. Write down the elements that are known in the situation.
b. Make a picture after being crushed based on the situation.
c. Based on the picture you made in point b (the picture that after being crushed), what strategy should you use to calculate the surface area of the two coinciding prisms? Then do the completion of the strategy.
d. Re-examine what you have done in points a and b, how do you conclude?

Figure 1 shows an example of an experimental class student's answer. Based on the results of the answers below, students can be seen completing the questions by the steps raised by Polya:
Following is an analysis of the achievement of each mathematical problem solving indicator from the answers presented above.

1. Understand the problem
Understand the problem by identifying the data that is known, which will be asked, the adequacy of the data needed. Based on Figure 1 for the answer point, the question given directs students to understand the problem. Figure 1 shows student's understanding of the given problem, it is proven that students are able to identify elements in two right prisms. So that students feel enough to determine the sides in the image of a right prism.

2. Formulating mathematical problems or composing mathematical models
If indicator 1 has been reached by the student, it means the student can draw two coinciding prisms and determine the length of the sides. So to formulate mathematical problems or compose mathematical models will also be able to be achieved by students. Seen from the answers presented by students. Students are able to make possible images that are formed, students make two images and two alternatives, and students write the length of each side. The right sketch is based on the adequacy of the elements given.

3. Implement the plan by implementing the right strategy to solve the problem
Indicator 3 is not difficult to achieve by students if students are able to correctly identify each element and arrange appropriate mathematical problem solving models. Seen from the answers presented by students. Students are able to apply appropriate strategies to solve problems by determining the surface area of two coinciding prisms. Students determine the surface area of the two drawings that have been sketched correctly and correctly. This is based on drawing and composing the right mathematical model.

4. Looking back
The last indicator in problem solving is an indicator that is not achieved by all students. Some students re-conclude the results of problem solving that has been solved, but there are also students who do not conclude it. In this ICM learning group, there are still some students who do not do it.

Furthermore, Figure 2 is the answer to one of the students in the direct learning class in solving the same problem.

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Figure 2. Answer students who use direct learning
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Following is an analysis of the achievement of each mathematical problem solving indicator from the answers presented above.

1. Understand the problem
Understand the problem by identifying the data that is known, which will be asked, the adequacy of the data needed. Based on Figure 2 for the answer point, the question given directs students to understand the problem. Figure 2 shows student's understanding of the problem given, it is proven students are able to identify elements in two right prisms. So that students feel enough to determine the sides in the image of a right prism.
2. Formulating mathematical problems or composing mathematical models
   Seen from the answers presented by students, they were able to create two coinciding prisms but only made one possible picture. Students do not write the length of each side and the elements of the two prisms. Inaccurate drawing sketches can make it difficult for students to formulate mathematical problems.

3. Implement the plan by implementing the right strategy to solve the problem
   Based on the answers presented by students. The incompleteness in drawing and determining the elements in two prisms coincide with students in solving problems shows that there is a mistake in determining the length of two formed prisms so that the final results obtained are not correct. But strategically the students did right, although it was not right to determine the surface area of the prism.

4. Looking back
   The last indicator in problem solving is an indicator that is not achieved by all students. Some students re-conclude the results of problem solving that have been solved, but there are also students who do not conclude it. Most students do not do it because students consider the last indicator in solving this problem unimportant and there is no score.

   The achievement of students' mathematical problem solving abilities in the experimental group, because all stages of ICM learning have the potential to achieve mathematical problem solving abilities. The stages of ICM learning consisting of 8 stages require students to develop mathematical problem solving abilities. ICM learning is learning that requires students and teachers and students with other students to collaborate, thus enabling students to develop ideas to solve problems. The process of student interaction with teachers and other students who have more abilities, it will form new knowledge and ideas [11].

   Based on the correlation test results obtained amounted to 0.818 high categories with a positive direction (+). That is, there is a mutually influential relationship between the ability to solve problems and the habit of mathematically flexible thinking. Based on this, it can be concluded that students who score high on post-test problem solving abilities also have good habits of flexible thinking. One of the factors needed in solving mathematical problems is a habit of thinking flexibly. The development of a habit of thinking flexibly can help students in creative thinking to find alternatives in solving problems. Habits of mind which one of the indicators habits of thinking flexibly supports students to be more thinking, reflective, and creative in problem solving [12].

   The development of the habit of thinking is flexibly needed in mathematics learning especially in problem solving, where the problems faced by students are non-routine problems. The context of education is thinking flexibly that the main abilities needed to adapt to the new learning environment can use knowledge into new situations so that you can solve problems that are not routine [13].

4. Conclusion
   Based on the results of data analysis and discussion that have been presented previously, it can be concluded that: a) the achievement of students' mathematical problem solving abilities using ICM learning is higher than students who use direct learning; b) achievement of a mathematical habit of thinking flexibly of students who use ICM learning is better than students who use direct learning; c) there is a relationship between mathematical problem solving abilities with a mathematical habit of thinking flexibly. It was concluded that ICM learning can achieve problem solving ability and habit of thinking flexibly.

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