The Effect of Open-Ended Approach Towards Students’ Mathematical Reasoning

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Abstract. This research was examining students' mathematical reasoning by the open-ended approach. This research has a purpose to train students' mathematical reasoning abilities to think logically and know how much is the effect of open-ended approach to students' mathematical reasoning abilities. The subjects of this research are the students of 5th grade in elementary school Gugus I, Buleleng sub-district, Bali. The instrument using mathematical reasoning test which made by the researcher with reference to indicators of mathematical reasoning abilities of P4TK Yogyakarta. This research is a quasi-experiment research with randomized control group pre-test post-test design. The outcomes of the research tell us that in the experimental group, where the students in the experimental group were treated by open-ended approach during the learning process and the students in control group were treated by conventional approach during the learning process. Students' mathematical reasoning in the experimental group was better than students' mathematical reasoning in control group after post-test was given. Both groups had similar performance in the pre-test. Both groups were following common work schedule. Open-ended approach gave positive influences on students' logical thinking abilities.

Keywords: Open-ended approach, Mathematical reasoning, Pre-test Post-test

1. Introduction
Mathematics is one of the basic science that has an important role in the development of science and technology. Science and technology are rapidly demanding quality human resources. To master and create technology in the future, it takes mastery of mathematics from an early age. This is the reason for the conceptual mind and able to solve problems in everyday life. In accordance with the purpose of learning mathematics is to form a person's mindset so that it can think critically, creatively, logically and systematically [4-5].

At a child's age a child enters the ability to think abstractly, reason logically, and draw conclusions from available information. This capability is necessary because it can be used to solve other problems, both math problems and everyday life issues. The reasoning ability is inseparable from the truth of mathematical material when one learns or builds its mathematical knowledge. This means that mathematical material will be more easily understood by the ability of good reasoning. Reasoning can develop if the mastery of the mathematical material is good. That is why the mathematical concept of planting early is needed.

The reasoning is used to think about the properties of a set of mathematical objects and develop the announcements imposed on the object. According to O'daffler [8], mathematical reasoning is part of
mathematical thinking which involves making announcements and drawing valid conclusions about ideas and how those ideas are interrelated. Based on the above statement it is found that reasoning involves several important skills such as investigating patterns, making and testing allegations, and using formal deductive and inductive reasoning to formulate mathematical arguments.

In fact, students 'reasoning ability in Indonesia is still low, based on the report of TIMSS (Trend International Mathematics and Sciences Study) study conducted in 2015 conducted in 49 countries including Indonesia, showed that students' reasoning ability in Indonesia scored 397 out of 618 average scores average TMISS. This is supported by research conducted by [1] which states that of the 10 students who tested, only 3 students who are able to solve the problem of reasoning given, and even then, not completed perfectly.

One of the causes of the poor quality of students' reasoning in mathematics is in classroom learning, teachers are too oriented to procedural and mechanistic things such as teacher-centred learning, mathematical concepts often delivered informatively, and students are trained to complete without a deep understanding. This is because most teachers are ready to transfer their knowledge directly to students, in other words, active teachers while passive students during learning, consequently the process or procedures that have been done by students in solving the problem is less or even not get the teacher's attention. Though it should be realized that the process of problem-solving is the main goal in learning math problems.

Therefore, it is necessary to make efforts to improve the learning of mathematics in schools in order to train students' reasoning skills. One such effort is through the provision of open-ended questions. This statement is based on research conducted by [9] that learning by giving open-ended questions can improve students 'reasoning ability, as well as opinion of Nohba [11] to develop students' ability in reasoning and strategic thinking directed at problem-based and the process of completion given should be open, the final answer to the problem is open, and how to solve it is open.

To achieve the goal of learning maximally, the teacher is not enough to just provide closed questions contained in textbooks that have been used in school. But it is also necessary to provide open-ended questions that can develop students' reasoning abilities through mathematical problems provided by teachers, which have not been included in the student textbooks. And it is expected also if students are given the problem of open-ended then the students will get a number of benefits, in the form of digging the resources needed to make conclusions, plan tasks, choose methods and apply the ability, this is in line with that says by [6] in his research suggests that by providing open-ended questions, it can train the students' reasoning seen from as many as 29 excellent and good categorized students, as well as the diversity of student solutions from open-ended questions.

Based on the exposure of learning approaches related to students' math skills, the researcher is interested in conducting an open-ended research approach, through a study entitled "The Influence of Open-ended Approach to Student's Math Ability" as a form of contribution that writers can do in the development of learning the innovative and the development of students' reasoning abilities.

2. Research Methods
This research is a quantitative research with the experimental method. The design used was quasi-experimental research with pre-test post-test control group design to know the effect of open-ended approach to students' mathematical reasoning. The subjects of this study were 5th-grade students of group 1 in Buleleng sub-district consisting of 6 schools. This research is divided into 3 stages: preparation stage, implementation stage and analyze stage. Data collection techniques in this study using the test. The test is used to look at students' mathematical reasoning abilities after an open-ended approach. Data analysis technique in this research by using a hypothesis test to see the influence of open-ended approach to students' math reasoning ability [2].

3. Result
The results of the test students before and after the implementation of learning with the open-ended approach in class 5 SD group 1 sub-district Buleleng can be seen in the following table.
### Table 1. Distribution of Pretest and Posttest Marks of Control Class and Experiment Class.

| Mark   | Frequency | Mark   | Frequency | Mark   | Frequency | Mark   | Frequency |
|--------|-----------|--------|-----------|--------|-----------|--------|-----------|
| 87 – 98| 2         | 95 – 99| 1         | 87 – 98| 1         | 95 – 99| 3         |
| 75 – 86| 17        | 90 – 94| 1         | 75 – 86| 13        | 90 – 94| 2         |
| 63 – 74| 35        | 85 – 89| 3         | 63 – 74| 26        | 85 – 89| 13        |
| 51 – 62| 18        | 75 – 84| 26        | 51 – 62| 10        | 75 – 84| 28        |
| 39 – 50| 13        | 70 – 74| 10        | 39 – 50| 16        | 70 – 74| 11        |
| 27 – 38| 3         | 65 – 69| 22        | 27 – 38| 3         | 65 – 69| 13        |
| 15 – 26| 2         | 60 – 64| 24        | 15 – 26| 1         | 60 – 64| 10        |
|        |           | 55 – 59| 13        |        |           | 55 – 59| 10        |

Total  90  Total  90  Total  90  Total  90

### Table 2. Results of t-Test Calculation Value of Control Class Reasoning.

| Group          | Pre-test | Post-test | Total |
|----------------|----------|-----------|-------|
| Complete       | 19       | 31        | 90    |
| Incomplete     | 71%      | 34.4%     | 65.6% |

### Table 2. Results of t-Test Calculation Value of Control Class Reasoning.

| Paired Differences | 95% Confidence Interval of the Difference | Sig. (2-tailed) |
|--------------------|------------------------------------------|-----------------|
| Mean               | Std. Error                               | Lower | Upper | t | df |
| Pair 1: Pre-test - Post-test | -11.6591 | 1.2289 | 8 | -4.00249 | 5.244 | 89 | .000 |

If the significance value is <0.05, then $H_0$ is rejected and vice versa if significance value ≥ 0.05, then $H_0$ is accepted. Because of the sig value. = 0.000 <0.05, then $H_0$ is rejected. So, it can be concluded that there is an increase in control class learning outcomes from pretest and posttest. Based on the calculation, the following results of mastery learning control class before and after treatment:

### Table 3. Percentage Completion of Control Class

| Group | Pre-test | Post-test | Total |
|-------|----------|-----------|-------|
| Complete       | 19       | 31        | 90    |
| Incomplete     | 71%      | 34.4%     | 65.6% |

The above table shows that the reasoning ability in the control class learning has increased mastery from previously reaching completeness 21% and after reaching completeness 34.4%.

Based on the results of the test analysis of the improvement of the above reasoning abilities ability, then this hypothesis I can be accepted which states that the learning process using conventional methods can improve the students' reasoning ability in grade 5 Gugus 1 in Buleleng sub-district.

### Table 4. Results of T-Test Calculations the Mark of Mathematical Reasoning in Experiment Class

| Paired Differences | 95% Confidence Interval of the Difference | Sig. (2-tailed) |
|--------------------|------------------------------------------|-----------------|
| Mean               | Std. Error                               | Lower | Upper | t | df |
| Mean Deviation Mean| r                                          | Upper | t | f | d. |

The above table shows that the reasoning ability in the control class learning has increased mastery from previously reaching completeness 21% and after reaching completeness 34.4%.
If the significance value is <0.05, then $H_0$ is rejected and vice versa if significance value ≥ 0.05, then $H_0$ is accepted. Because of the sig value = 0.000 < 0.05, then $H_0$ is rejected. So, it can be concluded that there is an increase in experimental class reasoning ability of pretest and posttest. Based on the calculation, following the completion of experimental class learning before and after treatment:

Table 5. Percentage Completion of Experiment Class

| Group  | Pre-test Complete | Incomplete | Post-test Complete | Incomplete | Total |
|--------|------------------|------------|-------------------|------------|-------|
| Experiment | 14 | 76 | 46 | 44 | 90 |
| Percentages | 16% | 84% | 51% | 49% |

The above table shows that the reasoning ability in experimental class learning has increased mastery from previously reaching completeness 16% and after reaching completeness 51%.

Based on the result of the test analysis of the improvement of the reasoning ability above, then this hypothesis I can be accepted which states that the learning process using the open-ended approach can improve the students' reasoning ability in grade 5 SD group 1 in Buleleng sub-district.

Based on hypothesis test I can be concluded that the learning by using open-ended approach can improve students' mathematical competence is higher than learning using conventional approach.

Table 6. Result of t-Test Calculation Post-test Data Control and Experiment Class

| Levene's Test for Equality of Variances | t-test for Equality of Means | 95% Confidence Interval of the Difference |
|----------------------------------------|-------------------------------|-----------------------------------------|
| F | Sig. | t | df | Sig. (2-tailed) | Mean | Std. Error | Difference | Lower | Upper |
|---|-----|---|----|-----------------|------|------------|------------|-------|-------|
| Nilai | Equal variances assumed | | | | | | |
| 2.299 | .131 | - | 4.023 | 178 | .000 | 5.73333 | 5 | 1.4250 | - | 8.54550 | 2.92117 |
| Nilai | Equal variances not assumed | | | | | | |
| 4.023 | 769 | .000 | 5.73333 | 5 | 1.4250 | - | - | 8.54586 | 2.92081 |

If the significance value is <0.05, then $H_0$ is rejected and vice versa if the significance value is ≥0.05, then $H_0$ is accepted. Since the value of sig = 0.000 < 0.05, then $H_0$ is rejected. This means that there is a significant difference between the mean values of the control class and the experimental class.

Based on hypothesis test II can be concluded that there is a difference between the average control class with the average value of the experimental class. For the average grade of the experimental class is 74.82, while for the average class of control is 69.09 it means that the average of the experiment class is higher than the average control class value.

Table 7. Pre-test - Post-test Control Group Design Test

| Group | R | Pre-test Average mark | Treatment | Post-test average mark |
|-------|---|-----------------------|-----------|------------------------|
| Control class | R | 62.64 | - | 69.09 |
Table 7 shows the effect of learning without using an open-ended approach of 69.09 - 62.64 = 6.36. While the effect of learning using the open-ended approach of 74.82 - 61.11 = 13.71. So, the total effect of giving of learning with the open-ended approach is 13.71 - 6.36 = 7.35. In the control, class increased by 6.36, while in the experimental class increased by 13.71. Thus, the level of effectiveness of learning with the open-ended approach is 7.35.

Based on hypothesis test III it can be concluded that there are differences and improvement of students' mathematics contest between control class and experiment class so that learning using open-ended approach is more effective than conventional learning.

4. Discussion and Conclusion
This research is an experimental research that aims to know that open-ended learning can improve students' mathematical reasoning ability, to know the difference of students' mathematical reasoning ability using open-ended approach with conventional approach, and to know that the open-ended approach is more effective compared with learning using the lecture method on the 5th grade mathematics class elementary school group 1 sub-district of Buleleng.

Before being given treatment, the class of dick and experimental class is given pretest with the aim of knowing each student's initial ability in each class. The result of the research that has been done got the result of the average ability of the average student of the contraction class is 62.64 and the experimental class is 61.11. This shows that the two classes have initial capabilities that are not much different from other words between the experimental class and the control class have the same initial ability. After being given pretest for both classes, then each class is given treatment that is for control class using conventional approach and experiment class using an open-ended approach which is taught by a math teacher.

After being given treatment, the control class and experimental class students are given posttest aimed to determine the students' final ability after being given a treatment. Based on the results of research that has been done shows that learning by using open-ended approach can improve students' math reasoning ability. This can be shown from the results of the calculation using paired sample t-test, the result obtained is the significance value of 0.000 <0.05 which means that there is a significant difference between the average value before treatment (pretest) with the average value after treatment (posttest). Based on the comparison of pretest and posttest values, it is found that the difference in posttest grade of the experimental class is higher than the difference of the control class value of 13.7 for the experimental class of more than 6.36 for the control class. Exhaustiveness of experimental class study by 51% more than mastery of control class equal to 34.4%. then the learning process using the open-ended approach is said to be successful and quality because the results show a mastery of 51% higher than the mastery of the control group.

The result of the posttest score is evidence of applying an open-ended approach more effective than using a conventional approach. Based on the effectiveness level calculation that the application of the open-ended approach obtains a level of effectiveness of 7.35. This is further reinforced by the test result of independent sample t-test, that is with the value of sig. (2 tailed) equal variances = 0.000 <0.05. meaning there is a significant difference between the average value of the experimental class and the control class. After doing the research, the average result for the experimental class is 74.82 and the control class is 69.09. This illustration shows that there is a difference between the control class and the experimental class after treatment is given.

The use of the open-ended approach is one of the approaches that at least can assist students in improving the ability of mathematical reasoning. Based on the results of analysis and testing of data, with reference to the results of previous research, the researchers concluded that the use of open-ended approach can improve learning outcomes and more effectively used than conventional approaches.

This is because learning with the Open-ended approach emphasizes the students' ability to gather information, investigate, and lead to the discovery of concepts without directly plagiarizing the
existing definitions in textbooks. Thus, students become encouraged to be more active in constructing their knowledge in the discussion process so that students better understand the concepts and use them to solve problems. Unlike the case with conventional learning applied in the control group. Learning activities of this conventional learning has helped students to understand the relevance of a mathematical concept. However, in the application of the mathematical concept students are still experiencing difficulties, especially in the application of daily life problems. This is because the lack of intensity of students in finding the concept itself as well as the confusion of students in using mathematical concepts to solve the problems of everyday life, especially on the story. Students are still dependent on the direction and examples given by the teacher. As a result, when students are faced with problems that are different from examples of questions given by teachers, even the problems of daily life students are less biased to explore to connect with the concept already owned.

Learning activities with Open-ended approach is very supportive of discussion activities, considering the prerequisite material, knowing the existing material relationships with the material to be studied, presenting the results of the discussion, being able to find concepts from the discussion, investigating the concept before it is applied, and able to make generalizations appropriately. These activities are activities that can improve students' math skills. In the end, through the application of the Open-ended approach of mathematics learning, students train to develop their maximum mathematical reasoning abilities. The results of this study are supported by several researches [12] mapped that the learning tool-oriented Discovery-Inquiry can improve student learning outcomes and activities.

After the necessary information is collected, then proceed with the stage of Data Processing is the stage to transform the existing knowledge so that students are able to make guesses about the existing problems. The fourth stage requires students

Looking at the results of the analysis and testing of data and the results of previous research, the researcher concludes that students' reasoning ability using open-ended approach is different from the students' mathematical reasoning using conventional approach and it is proven that the use of open-ended learning can improve the students' learning achievement.

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