The Influence of Inquiry Learning Method Aided by Open Ended Worksheet Towards Quantitative Reasoning and Self-Esteem

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Abstract: Problem solving plays an important role in mathematics and should have a prominent role in mathematics education. Some factors that affect students’ problem-solving ability are quantitative reasoning and self-esteem. The general objective of this research aims to compare quantitative reasoning and self-esteem of students who were taught using inquiry learning with open ended worksheet and those who were taught using conventional learning. This research used quasi-experiment approach with randomize posttest-only control group design. The population of this study consisted of 255 seventh grade students in Singaraja. In addition, cluster random sampling was used to get two groups. The experimental group was taught using inquiry learning method with open ended worksheet and the control group was taught using conventional learning. The data was collected using test and non-test technique then analyzed using Manova. The results showed that quantitative reasoning and self-esteem of students who were taught using inquiry learning model with open ended worksheet were better than students who were taught using conventional learning model. Inquiry learning model with open ended worksheet give students more chance to explore their thinking and idea in solving problem. This model contributes in the improvement of students’ capabilities in quantitative reasoning and self-esteem.

1. Introduction

Problem solving plays an important role in mathematics and should have a prominent role in the mathematics education. To solve a mathematical problem, students do not only need to understand the problem, make a strategy, and using the right procedure but students also need to establish the relationship among quantities in the problem [1]. The ability to analyze any situation into a quantitative structure—a network of quantities and quantitative relationship is called quantitative reasoning [2]. Quantitative reasoning is student’s ability as learning process to conceive mathematical situation, constructs quantities in some situation, and then relates, manipulates, and uses those quantities to make a problem situation coherent [3]. Quantitative reasoning provides a means for students to create relationships between quantities which will supports students in modeling phenomena mathematically [3]. Ellis stated that there are some principals to integrate quantitative reasoning in learning process, such as (1) make a problem that encourage students to identify the quantitates that are relevant to solve the problem, (2) give students freedom to choose how they will measure the quantities, (3) make the students verify the result they have archived. By following those principals, students learn to conceptualize, make a logical reason, and operate quantities and
relationships in sensible problem situations [3]. The students who construct robust images of a problem’s context such as quantitative reasoning is better in connecting and producing problem-solving behaviors that support their logical argument and solution [4].

Beside of quantitative reasoning, another factor that affect problem solving ability is self-esteem. Erdal said that self-esteem has a positive correlation with rational problem solving [5]. Rosenberg defines that self-esteem leads to a positive overall assessment of an individual's self [6,7]. It refers to a person’s belief about whether he or she is intelligent and attractive [8]. Self-esteem leads to a feeling of confidence, worthy, strong, useful and needed in the world. Low self-esteem will make someone feel inferior, weak and helpless. Self-esteem is one aspect of attitude that is believed to contribute to student learning outcomes [9]. Self-esteem has a significant prospective impact on work related wellbeing and career success [10]. It is not the reason of someone’s success but it can be a predictor of success [10]. Good self-esteem will correlate with rational thinking, realistic thinking, intuition, creativity, independence, flexibility, ability to deal with change, ability to admit mistakes, do good, and be able to work together [11]. One way to increase someone self-esteem is by accepting and approving what they had make [11]. As in learning field it means to make more opportunities for students to express their idea with their own way. One of the learning methods that can facilitate those objectives is inquiry learning method aided by open ended worksheet.

Students who learned using inquiry learning method will use all of their abilities to investigate and analyze problems that are given logically, critically and systematically so that they can find their own solutions to the problems that are given. Inquiry learning can improve students' reasoning abilities that are closely related to problem solving abilities. But the inquiry learning method still has some drawbacks. The problems in inquiry learning should be formulated by students and the teacher just helps and being a facilitator [12]. Students in this process sometimes experience difficulties in forming the problem so the learning processed sometimes becomes long lasting. Besides in inquiry learning, the problems that will be studied by students are problems that have definite answers [12]. However, problems with only one solution are likely discourage students from exploring diverse idea [13]. Students sometimes do not try to think of other possibilities in the given situation. Also inquiry learning method is a learning method that requires a quite high critical thinking ability. This will sometimes lead to a problem in learning in groups, because sometimes students who think himself smarter would not want to receive any input except those that come from the teacher. This often results in only one student actively working in groups so that other members become reluctant to participate. To overcome these problems an open-ended worksheet was used. An open-ended worksheet is a worksheet that contain open-ended problems. Open-ended problem is a problem that do not only have one solution but many solutions which can make up for these disadvantages because they allow various answers or various approaches [13]. With this worksheet, either the smart or not so smart students can give their ideas to answer the problem. This situation can increase the level of respect among the members of the class [14]. Open ended problems also can improve students’ creative thinking ability and knowledge by forcing students to think about mathematical problems using their knowledge to get an alternative solution [13].

Based on that problem, the objective of this research is to compare quantitative reasoning and self-esteem of students who were taught using inquiry learning method aided with open ended worksheet and those who were taught using conventional learning.

2. Research methods

2.1. Design

This research is a quasi-experimental study that used randomized posttest only control group design. This study involved two groups that received different treatments. The experimental group in this study was a group of students who were taught using inquiry learning method aided by open ended worksheet, while the control group was the students who were taught using conventional learning which is direct learning. The design of the study can be seen in table below.
Table 1. Randomized Posttest-Only Control Group Design

| Group   | Treatment                                    | Post Test               |
|---------|----------------------------------------------|-------------------------|
| Experiment | Inquiry learning method aided by open-ended worksheet | Quantitative reasoning test |
| Control   | direct learning method                        | Self-esteem questionnaire |                          |

2.2. Subject
The population of this study was consisted of 255 7th grade students in SMP Negeri 1 Singaraja. Sampling in this study was done by cluster random sampling technique because random sampling cannot be done considering we use the natural setting of the school environment. We took four classes in this school as sample which was obtained by conducting a draw that then became two groups. Two classes became experiment group and the others become control group.

2.3. Instrument
The Instrument that used to obtain the quantitative reasoning data is an essay test. By using an essay test researcher can analyze whether students can understand the problem, can identify the important information and make connection and relation between the information, and can use the appropriate methods in solving the problems given. The instrument that used to get the self-esteem data is a non-test instrument which is a self-esteem questionnaire. The self-esteem questionnaire used Likert scale to measure students' self-esteem.

Before using these instruments, they were tested in validation and reliability test. After doing the test and the calculation, there are 6 item questions that valid for quantitative reasoning test and the instrument reliability coefficient is 0.65. There are 28 items were valid for self-esteem questionnaire and the instrument reliability coefficient for self-esteem is 0.89. From the established criteria, these items have a high degree of reliability. The indicators of quantitative reasoning and self-esteem can be seen on table 2 and table 3.

Table 2. Indicators of Quantitative Reasoning

| No. | Indicator                                                                 | Description                                                                 |
|-----|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| 1.  | Calculation                                                               | The ability to do calculations correctly                                     |
| 2.  | Representation                                                             | The ability to convert relevant information into mathematical forms (equations, graphs, diagrams, tables |
| 3.  | Interpretation / Description                                              | The ability to explain information described in mathematical forms (equations, graphs, diagrams, tables, and words |
| 4.  | Judgments / Conclusions                                                   | The ability to make judgments and draw appropriate conclusions based on data analysis and consider the limitations of the method |
| 5.  | Applies content knowledge, methods and / or results to new situations     | The ability to make accurate and understandable conclusions about new situations using previously learned information |
| 6.  | Assumptions                                                               | the ability to make important evaluations and assumptions in estimating, modeling, and analyzing data |
Table 3. Indicator of Self-esteem

| No. | Self-esteem aspect | Indicator |
|-----|-------------------|-----------|
| 1.  | Competence        | Have confidence in their abilities in carrying out tasks. Able to respond to some diverse situations and conditions with a positive attitude. Have a commitment to complete the task well |
| 2.  | Self-Worth        | Have a positive outlook on self-appearance Have a positive view of your ability to build social relationships Believing others have a positive outlook on their appearance Believing others have a positive outlook on their ability to build social relationships |

2.4. Data Analyze
The data of this study was analyzed by Manova test at significance level of 5% because this study involved an independent variable and two dependent variables. Before performing Manova test, some prerequisite tests were conducted, namely bivariate normality, variant homogeneity, the homogeneity of the matrix variance/covariance and correlation between the dependent variable [15].

3. Findings and Discussion
3.1. Result
The data of quantitative reasoning and self-esteem students’ that obtained from the posttest can be seen in Table 4.

Table 4. Data of Research Results

| No. | Variable     | Quantitative Reasoning | Self-esteem |
|-----|--------------|-------------------------|-------------|
|     |              | Experiment | Control | Experiment | Control |
| 1.  | N            | 63         | 64      | 63         | 64      |
| 2.  | Mean         | 13.5       | 10.93   | 103.89     | 95.03   |
| 3.  | Standard Deviation | 6.2 | 6.09 | 12.97 | 11.25 |

Based on the table above, it can be seen that the average score of quantitative reasoning and self-esteem of students in the experimental group was higher than the average score of quantitative reasoning and self-esteem of students in the control group.

Before doing Manova test, we had to test the variant homogeneity, bivariate normality, covariance variant matrix homogeneity, and correlation between dependent variables [15]. After all the requirements were met, the Manova test could be done. The results of the research data were analyzed with the help of SPSS software. The result of Manova test could be seen on table below.

Table 5. Results of Analysis with MANOVA

| Effect    | Value | F     | df   | Error df | Sig. |
|-----------|-------|-------|------|----------|------|
| Intercept | Wilks' Lambda | 0.014 | 4.447 | E3 | 2.000 | 124.000 | 0.000 |
| Class     | Wilks' Lambda | 0.879 | 8.555 | 2.000 | 124.000 | 0.000 |
Based on the table above, we obtained the statistical values of Wilks' Lambda had a significance of 0.000 which is less than 0.05 ($p < 0.05$). This result is used as the basis for the decision to accept $H_0$. This means that quantitative reasoning and student self-esteem that is taught by the inquiry learning method aided by open ended worksheet is better than the quantitative reasoning and self-esteem of students who learned by conventional learning.

3.2. Discussion
From the results of the manova test, it can be concluded that quantitative reasoning and self-esteem are significantly influenced by the learning method that was used. The inquiry learning method aided by open ended worksheet facilitates students to be able to investigate and construct students' understanding through open ended problems given by the teacher. Inquiry learning method facilitates students to construct their knowledge by giving students the opportunity to compose what they will learn, how to learn it, and find what they are learning directly. The provision of open-ended worksheets helps students to identify and make relation between quantitative information that provided, and they are also given freedom to determine the right method to find the best answer. By using open-ended problems, students choose their own the approach they use in answering the question.

The step of formulating problem which are open ended problems helps the students to represent and interpret the information contained in the problem that has been given, so that students can understand the problems well. Because open ended problem provides students with many information they sometimes got confuse, but with the formulating steps the students was demanded to write and analyze the exact problem. This make students can understand and has clearer image about the problem. In this process students learned to represent the information and processed it.

The steps of collecting data by using open ended problems in inquiry learning models facilitate students to choose and solve problems that they have formulated previously with their own methods. This step can improve students' self-esteem by making students realize that there are various answers to a problem. Students will become more confident about the methods and solutions they have been produce by themselves. In addition, because they have different solutions and settlement methods, but the answers they produce are true, students will feel more valuable, confident, and equal to other students. They will become more appreciative of themselves because they feel useful and by solving the problem. This is corresponding to research by Al-Abisi who said solving open ended problem can positively affect students' confidence of their abilities [16]. Along with Al-Abisi, Faridah also stated that learning using an open ended approach had a higher students’ problem solving abilities and higher self-confidence than students who were taught using approaches conventional [17]. This step also helps students to use prior knowledge to apply it to new situations. In this step students learn to solve problems using arithmetic, algebra, geometry along with the method that they choose. Learning mathematics using open ended problem can provide freedom to students in conveying ideas and opinion so as to improve students’ mathematical representation ability [18]. This step will also make students recognize the limitations of each mathematical method they have because sometimes they will success and sometimes they failed.

The step testing the hypothesis helps students to count and estimate the answers that is obtained from the data collection steps, restore the mathematical answer into quantitative information, and check if they are make sense. If the answer to the problem is considered unreasonable, then the student will re-analyze the answers they have obtained, check the information they have got, and check whether the method they have used is correct. In addition, in this step students also learn to use the data that was obtained as quantitative evidence to support the opinions or goals of learning. The final step is to formulate conclusions, this step helps students to be able to make judgments and draw conclusions based on the analysis carried out in testing hypothesis step and interpret the answers they have obtained into quantitative information and drawing conclusions from the information. In addition, this step will also assist students to communicate their conclusions written or verbally. In this step students can increase their confidence in the abilities they have because in this step students have
different data, but still get the same conclusions in the end. Both of these steps are making students think critically. This result is relevant with a research from Fatah, et al which states that learning using an open ended approach can improve students' critical thinking skills. [7]

4. Conclusion
Quantitative reasoning and self-esteem of students that learned by inquiry learning method with open ended worksheets are better than quantitative reasoning and self-esteem of students that follow conventional learning method. Learning that is done through learning inquiry methods aided by open ended worksheet creates learning that can attract students’ interest in learning and can encourage students to become active. Through this approach, students are led to actively discover and understand knowledge. A pleasant learning experience and directly involving real objects will facilitate students in understanding in observing the quantitative values contained in the given situation. It also helps students remember the concepts that exist in learning and understand the existing relationships.

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