Implementation of Reflective Thinking Process Approach to Students' Mathematical Critical Thinking

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Abstract. This study aims to measure students' mathematical critical thinking skills after learning by using a reflective thinking process approach. An experimental research method with a quantitative approach was used in this research. The research design used was a One-Shot Case Study with a pre-test. The population in this study was students of Junior high school in central Aceh, meanwhile the sample was students of class VII\textsuperscript{2} of Junior high school in central Aceh with consideration of heterogeneous students' abilities selected by purposive sampling. A mathematical critical thinking test instrument and a student's attitude scale questionnaire were applied for the data collection of this study. The results of the research showed; (1) the improvement of students' mathematical critical thinking skills who get learning using a reflective thinking process approach was better than learning without a reflective thinking approach; (2) the reflective thinking approach had an effect of 53.6\% on increasing students' critical thinking skills; (3) students showed a positive attitude towards learning mathematics, and also towards mathematical critical thinking questions.

1. Introduction

Educational research is a special topic and the most routinely reviewed by practitioners and researchers at various levels of education units. This phenomenon appears one of which is caused by the demand at the education unit level to carry out various innovations and learning improvements to achieve the goal of optimizing the potential of students. The learning carried out must be through a learning approach, observation, data collection, and presentation of results through the use of various learning resources [1].

Improvements in the learning process have become mandatory to improve the quality of education. When the learning process is carried out, each student experiences a thinking process which is one of the most dominant thinking activities. The process of thinking intentionally when students are given a problem until students can solve the problem. The learning process that occurs in schools, especially in every mathematics learning activity, the activities that occur should not only be a process of transferring knowledge from teachers to students, but building interactions that establish joint activities between students, students and teachers, and students with other learning environments [2].

Learning activities create an active learning atmosphere, but they cannot refuse to complications that may arise when students reflect on what they have learned from what they are doing. Therefore, teachers' assistance is needed to train students' mathematical thinking skills, one of which is reflective thinking. The state when people start to think reflectively will appear when experiencing difficulties [3]. Responses from within a person such as being able to explain and
Communicate ideas based on information obtained in symbols or images are often described as a form of reflective thinking process [4].

Mathematics as a form of organization with proof that becomes a deep pattern of thinking and logic. In line with that [5], states that activity in mathematics is a human activity, which can be defined as a form of thinking activity that has a clear pattern, the pattern of logistical evidence is organized, and carefully defined, clear and accurate terminology can be used [6]. Therefore, when a person is faced with an urgent and challenging situation or problem, there will be activities and thought processes which can trigger his thinking to obtain the answers and solutions to overcome the problems that arise in the situation he faces.

Mentally reflective thinking is associated with cognitive processes to master the factors that cause conflict in an atmosphere. Therefore, reflective thinking is a meaningful component of the learning process [7]. The result of this interaction causes a person to actively build or know about something in a situation in order to improve something strategic so that it can proceed in that situation. Thus, this condition reflects on students' improvisation on large-level speaking skills through their encouragement to: (a) relate new knowledge to their previous explanations; (b) think in abstract and concrete terms; and (d) master their own thought processes and learning strategies. Furthermore, critical thinking is brain activity in classifying, organizing, remembering and analyzing information. Critical thinking also includes the ability to read with understanding and be able to identify the required materials among the other materials which are useless [8].

Reflective thinking and students' mathematical critical thinking are mutually supportive and can run simultaneously. Reflective thinking processes can help students and will emerge when they face any difficulties. Thus they solve these difficulties by connecting pre-existing knowledge. With reflective thinking, students can actively participate in feeling meaningful experiences, where these experiences can strengthen the knowledge they have found and information they have got. This provides opportunities for students to use their thinking skills in solving math problems both in education and everyday life.

Critical thinking involves prior knowledge such as dispositional abilities, mathematical reasoning, and cognitive strategies to generalize, prove or express known mathematical situations in away reflective [9]. This critical thinking often occurs in mathematics learning. Critical thinking is the process of testing claims and opinions / arguments and determining which ones are useful or not. Students who are able to think critically can find their thoughts and compare them with facts or the thoughts of others’ [10]. Critical thinking is rational and thinking reflective that depends on what is believed and done. Rational means having beliefs and views that are supported by appropriate, actual, sufficient, and relevant evidence. While reflective means actively and carefully consider all alternatives before making a decision [11].

Mathematical reflective thinking is one of the thinking processes needed in the process of solving mathematical problems. The process of reflective thinking, among others, is the skill of a person who is able to review, without difficulty and to monitor the problem solving process. Reflective thinking becomes the basis of a person determining the next stage of thinking and being the direction of finding a solution to the problem.

According to a number of opinions stated above, it can be stated that someone who can think reflectively is someone who can think critically by being able to solve problems, make decisions, and learn new concepts through reasoning abilities based on evidence and logic that is believed. Thus, to be able to think critically means to be able to maximize reflective thinking openly, clearly, based on facts or evidence, and be logic in providing reasons for the choice of decisions or conclusions drawn.

The learning approach by involving reflective thinking activities in the process is called the reflective thinking process approach. This approach is expected to provide individual responses to new experiences, situations, events, or information. The responses given by each individual during the teaching and learning process will give meaning to the experiences they receive during learning. Thus the learning that occurs does not just happen, but leaves meaningful learning and deep understanding.

The application of mathematics learning using a reflective thinking process approach is expected to foster positive attitudes towards students and mathematics learning, so that with a
positive attitude students can improve their mathematical critical thinking skills. Reflective thinking is a way of thinking about what has just been learned as new knowledge that is more meaningful as a revision of knowledge about the past, and thinking backwards about what has been done in the past. Reflective thinking is a response to an event, activity, or new knowledge. Reflective thinking becomes important to research as the basis of thinking in determining the steps to find mathematical problem solving solutions.

2. Method
This research was an experimental research with a quantitative approach. The research design used was One Shot Case Study with initial test. The population in this study was all eighth grade students of Junior high school in central Aceh. Sampling in this study was carried out using purposive sampling technique. The sample in this study was class VII2 junior high school in central Aceh with consideration of heterogeneous students’ abilities. The instrument used to collect data were about the ability to think critically and the attitude scale was used to see students’ responses to the learning carried out. The results of the test were to find out the application of the reflective approach in learning and its effects on critical thinking skills.

One Shot Case Study design with preliminary tests was used to avoid bias of the research data gathered. Observation of activity and possible shift from the designed research plan could be avoided. For the treatment of one sample group that minimized gaps in activities and facilitate data collection, so that the effect on the treatment could be seen by avoiding unnecessary disturbing factors. The data obtained is analyzed with inferential statistical tests so that the results found can be used as a verdict to draw conclusions in other larger cases. This research shows that reflective approaches contribute to mathematical critical thinking skills.

3. Result and discussion
Discussion of the results of this study is based on the factors observed and found in the study.

3.1. Achievement of students’ mathematical critical thinking ability

| Class                  | Pretest      | Posttest     | Varians | SD  | Average | Varians | SD  |
|------------------------|--------------|--------------|---------|-----|---------|---------|-----|
| Critical Thinking      | 30           | 12.17        | 8       | 16  | 5.04    | 2.24    | 16.10| 11  | 20  | 4.99    | 2.23    |

Table 1 shows that the average score of the initial critical thinking ability of students when the initial test was carried out was a score smaller than the final test. The average score obtained is 12.17 for the initial test and 16.10 for the final test. This difference shows that there is an effect after the learning is carried out with a reflective approach. For the distribution, critical thinking skills in the initial and final tests are almost the same which can be seen in the standard deviation values of 2.24 and 2.23. This relatively small standard deviation value shows that the scores of each student are not too different and have a small range.

Average Differences in Mathematical Critical Thinking Ability

Calculations were carried out with the help of SPSS 16 at the significance level. The test criteria is to reject $H_0$ if Asymp.Sig.(1-tailed) < 0.05. For more details, see Table 2 below.
Table 2. Test average differences in mathematical critical thinking ability

| Aspects of Ability | Test Type | t   | Df  | Asymp.Sig. (2-tailed) | Asymp.Sig. (1-tailed) | conclusion | description |
|--------------------|-----------|-----|-----|-----------------------|-----------------------|------------|-------------|
| Mathematical critical thinking | Pretest   | -   | 58  | 0.000                 | 0.000                 | H₀ rejected | There is a difference |
|                     | Posttest  | 6.803|      |                       |                       |            |              |

Based on the test = 0.05, \( t_{(1-\alpha)} dk = 58 \) and one sample t-test *independent* on critical thinking skills, the significance is 0.000. Because Asymp.sig = 0.000 < 0.05, then H₀ is rejected, thus ensuring that students' critical thinking skills after learning with a reflective approach are better than without a reflective approach. It also shows that the learning approach with reflective thinking process has a significant effect and contributes to the improvement of students' mathematical critical thinking skills. Results like this are with Jerome Bruner who says if in a learning process students are directed to the structure and concepts of concepts and relationships made from the subject being taught, then the mathematics learning process will be more successful than usual [12].

3.2. Increasing students' mathematical critical thinking skills

The sample of this research was the improvement of critical thinking skill that was obtained by comparing the scores of the initial and final tests in order to find out gain score before and after learning in the class. The increase is calculated using the Hake normalized gain formula [13]:

\[
g = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\text{maks}} - S_{\text{pre}}}
\]

The calculation results are then interpreted using the following classification

| N-Gain criteria | Interpretasi |
|-----------------|--------------|
| \( g \geq 0.7 \) | Low          |
| \( 0.3 \leq g < 0.7 \) | Medium       |
| \( g < 0.3 \) | Low          |

From the calculations, the n-gain score is 0.33 which can be interpreted as an increase in critical thinking skills after the use of a reflective thinking approach is in the medium category.

3.3. The effect of using reflective approaches on increasing students' critical thinking ability

The reflective approach on learning shows an increase in students' critical thinking skills. This increase means that there is an effect of using a reflective approach on learning. The effect will be shown in the value of the coefficient of determination obtained in the following statistical tests.

| Table 4. Coefficient determination |
|-----------------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|---|----------|-------------------|---------------------------|
| 1     | .732²| .536     | .520              | 1.556                     |

In the tests carried out, the R Square value was 0.536, which means that learning carried out with a reflective approach had an effect of 53.6% on increasing critical thinking skills. While 46.4% of the effect on increasing critical thinking skills caused by various other factors.

The Develop stage aims to modify and develop the design of the lesson plan that has been compiled and tested. The design was validated and tested for the second time. The Develop stage was carried out repeatedly three times. After obtaining the third modification of the designed lesson plan, the instrument would not undergo further changes, and it was suitable for use in Anchored Instruction with the use of interactive media.
3.4. Description of Students' Attitudes

Students in the experimental class were given a questionnaire to find out how their attitudes and interests were towards the learning that had been carried out. This questionnaire was given after the implementation series was fully implemented.

Calculation of scores on student attitudes begins by calculating the average for each statement, both positive and negative statements. The data obtained were then processed with the help of the Method Successive Interval (MSI), then proceed by comparing the neutral score with the student attitude score. Students have a negative attitude if the average score is greater than their attitude score, and vice versa students have a positive attitude if the average score is less than their attitude score. In the following Table 5 will be presented a recapitulation of the average student attitudes towards the learning process.

| No | Indicator                                                                 | Average of Student Attitude | Score Neutral | Attitude of Students |
|----|---------------------------------------------------------------------------|-----------------------------|---------------|----------------------|
| 1  | Students feel happy to learn mathematics                                   | 72.71 %                     | 56.15 %       | Good                 |
| 2  | Students show seriousness and interest in participating in the mathematics learning process | 79.61 %                     | 56.15 %       | Good                 |
| 3  | Students show a sense of pleasure towards group learning with a reflective thinking process approach | 74.32 %                     | 56.15 %       | Good                 |
| 4  | Students show a sense of the role of presenting Student Activity Sheets (SAS) | 73.11 %                     | 56.15 %       | Good                 |
| 5  | Students feel the role of learning with a reflective thinking process approach | 70.93%                      | 56.15 %       | Good                 |
| 6  | Students feel motivated and pleasure towards mathematical connection skills questions | 67.14 %                     | 56.15 %       | Good                 |
| 7  | Students feel motivated and pleasure towards critical thinking skills questions | 74.76 %                     | 56.15 %       | Good                 |

Based on observations conducted during the learning process and based on students’ responses, in general, students said that the learning process that had been carried out with this reflective thinking process approach was very good, they gave positive responses. This of course could not be separated from the role of the teacher in the learning design that had been implemented as well as presenting and packaging the learning so that it could provide satisfactory results.

When the observations were administered, the students seemed very interested in participating in mathematics learning. Students were also very active in asking questions, learning both with their groups and during class discussions and they were also energetic in expressing opinions. This, directly or indirectly, could certainly lead to growing, enhancing and developing critical abilities. Spontaneously, students became more critical in dealing with the problems presented and slowly they got used to trying to build mathematical abilities as well.

Students have gained the achievement of the ability to think critically after learning the approach of thinking reflectively in 4 meetings. Before the material was given, test early conducted at the first meeting in order to measure the students’ achievement of the ability to think critically. It was done without applying the approach of thinking reflective. After learning with reflective thinking approach, a final test was given to measure students’ achievement after learning. The results of the final tests obtained information that learning with the approach of thinking reflective was more contribute in improving the students’ achievement, especially the the ability to think critically in mathematics.

The results of tests showed a significant difference of students’ achievement in the ability to think critically with the approach of thinking reflective and without the approach of thinking reflective. This difference showed the quality of learning with a reflective thinking approach was...
better. The improvement of study result and ability to think critically was also higher. The results of students’ achievement and improvement reflected a positive effect of learning with a reflective approach, especially their critical thinking skills.

4. Conclusion and recommendation
Based on the research and reviews above, it can be concluded that: (1) The improvement of critical thinking skills of students who get learning using a reflective approach is better than learning without a reflective approach; (2) The reflective thinking approach has an effect of 53.6% on increasing students’ critical thinking skills. (3) Students show a positive attitude towards learning mathematics, and also towards critical thinking questions. In general, students feel more comfortable and interested in learning as they are given the freedom to express all the knowledge they already have and students feel challenged to find their own problems solutions. This condition shows that learning mathematics with a reflective thinking process approach not only can improve students’ critical thinking skills, but this approach can also make a positive impression of students on mathematics lessons and learning.

Although in this study the results obtained were quite good, but this research still needs to be investigated more deeply so that the results obtained are wider. The following are some recommendations that the authors can convey in this research report: (1) The implementation of this approach takes a long time, therefore teachers are expected to be able to plan carefully and develop more extensive learning with a reflective thinking process approach; (2) Students' critical thinking skills are expected to be further developed by conducting other research that can improve students’ critical thinking skills. Give students non-routine questions so that the thinking process can improve cognitive abilities even better; (3) It is necessary to carry out further research at different levels and places with other subject matter that is broader and for a longer time and is expected to be able to examine other aspects that have not been studied.

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