Improving students’ creative mathematical reasoning ability students through adversity quotient and argument driven inquiry learning

W Hidayat¹, Wahyudin¹ and S Prabawanto¹
¹Universitas Pendidikan Indonesia, Indonesia
E-mail: wahyu@stkipsiliwangi.ac.id

Abstract. This study aimed to investigate the role factors of Adversity Quotient (AQ) and Argument-Driven Inquiry (ADI) instruction in improving mathematical creative reasoning ability from students’ who is a candidate for a math teacher. The study was designed in the form of experiments with a pretest-posttest control group design that aims to examine the role of Adversity Quotient (AQ) and Argument-Driven Inquiry (ADI) learning on improving students' mathematical creative reasoning abilities. The population in this research was the student of mathematics teacher candidate in Cimahi City, while the sample of this research was 90 students of the candidate of the teacher of mathematics specified purposively then determined randomly which belong to experiment class and control class. Based on the results and discussion, it was concluded that: (1) Improvement the ability of mathematical creative reasoning of students’ who was a candidate for a math teacher who received Argument-Driven Inquiry (ADI) instruction is better than those who received direct instruction is reviewed based on the whole; (2) There was no different improvement the ability of mathematical creative reasoning of students’ who is a candidate for a math teacher who received Argument-Driven Inquiry (ADI) instruction and direct instruction was reviewed based on the type of Adversity Quotient (Quitter / AQ Low, Champer / AQ Medium, and the Climber / AQ High); (3) Learning factors and type of Adversity Quotient (AQ) affected the improvement of students' mathematical creative reasoning ability. In addition, there was no interaction effect between learning and AQ together in developing of students’ mathematical creative reasoning ability; (4) mathematical creative reasoning ability of students’ who is a candidate for math teacher had not been achieved optimally on the indicators novelty.

1. Introduction
Mathematics learning teaches people to solve problems by paying attention to a procedure or process that prioritizes pedagogic aspects through a scientific approach so that learners can better understand meaningfully through the process of observing, asking, trying, reasoning, presenting and creating [1]. Development of learning mathematics should shape the mindset of learners that can be measured by the ability. One of the abilities that can form the mindset is the ability of mathematical reasoning. Mathematical reasoning is a process of concluding a problem-solving from a given problem [2,3]. The mathematical creative reasoning is one of the reasoning processes that a person undertakes in solving problems through non-routine procedures [4,5].

One of the success factors in learning mathematics is Adversity Quotient (AQ). AQ is a person's persistence in facing obstacles to achieve success. AQ is expected to make a strong motivation so that it can better support his desire in achieving success to solve the problems encountered. AQ can also be said to be a person's fighting power to solve the problems he is facing [6,7].
Currently, there are still learners who have difficulty in doing reasoning process because the problem solving is still based on the algorithm memorized or routinely done by the teacher. This is because there are still reliable mathematics teachers, but not accompanied by a good conceptual understanding [8,9,10,11].

Achievement and improvement of the ability of mathematical reasoning and AQ of a person cannot be separated from meaningful learning process [12,13]. The learning model is supposed to optimize the improvement of mathematical creative reasoning ability and AQ is Argument-Driven Inquiry ADI), because ADI learning emphasizes the provision of challenging mathematical tasks based on the level of difficulty so that the achievement and improvement of mathematical creative reasoning and AQ of prospective teachers can be better [14,15,16].

Based on that, problems and objectives in this research are to know and examine about: (a) Improving students' mathematical creative reasoning abilities who are candidates for mathematics teachers who get Argument-Driven Inquiry (ADI) learning with those who have direct instruction reviewed based on the whole; (b) Improving students’ mathematical creative reasoning abilities who are candidates for mathematics teachers who get Argument-Driven Inquiry (ADI) learning with those who have direct instruction reviewed by Adversity Quotient (Quitter, Champer, and Climber); (c) Is there any interaction effect between learning factors and types of Adversity Quotient (Quitter, Champer, and Climber) in developing improvement of students’ mathematical creative reasoning ability; (d) How is the achievement of students’ in mathematical creative reasoning abilities.

2. Methods
The study was designed in the form of experiments with a pretest-posttest control group design that aims to examine the role of Adversity Quotient (AQ) and Argument-Driven Inquiry (ADI) learning on improving students’ mathematical creative reasoning abilities. Population in this research is the student of mathematics teacher candidate in Kota Cimahi, while the sample of this research is 90 students of the candidate of the teacher of mathematics specified purposively then determined randomly which belong to experiment class and control class. The test of mathematical creative reasoning abilities in this study is based on the characteristics of mathematical creative reasoning ability and good test preparation guidelines. Data were analyzed by using Two-Way Annova statistic test to see the difference and interaction effect between learning and type of Adversity Quotient (Quitter, Champer, and Climber) in generating improved students' mathematical creative reasoning ability.

To find out how much improvement of students’ creative reasoning ability before and after learning activity, a normalized gain score analysis was calculated using the following formula:

\[ g = \frac{\text{postest score} - \text{pretest score}}{\text{maximum ideal score} - \text{pretest score}} \]

Normalized gain score levels are grouped into three categories:

- \[ 0,70 < (g) \] : High
- \[ 0,30 \leq (g) \leq 0,70 \] : Medium
- \[ (g) < 0,30 \] : Low

Finding out grouping of AQ types is based on the following categories:

- \[ 144 < \text{(AQ)} \] : Climber
- \[ 95 \leq \text{(AQ)} \leq 144 \] : Champer
- \[ \text{(AQ)} < 95 \] : Quitter

3. Results and Discussion
3.1. Results
Findings on students' mathematical creative reasoning abilities based on learning and Adversity Quotient types are presented in Table 1.
Table 1. Gain of mathematical creative reasoning ability based on learning factors and types of AQ

| Type of Adversity Quotient | The Increase of Mathematical creative reasoning ability |
|---------------------------|--------------------------------------------------------|
|                           | ADI Class (n = 45)     | Direct Learning Class (n = 45) |
|                           | Mean  | SD    | Mean  | SD    |
| Climber                  | 0.78  | 0.04  | 0.63  | 0.15  |
| Champer                  | 0.72  | 0.09  | 0.59  | 0.14  |
| Quitter                  | 0.62  | 0.10  | 0.57  | 0.10  |
| Total                    | 0.71  | 0.10  | 0.59  | 0.13  |

Notes: Ideal Score 1.00

Based on the above description, it can be seen that the mathematical creative reasoning ability of students learning through ADI learning is better than those learned through direct learning, whether reviewed as a whole or by type AQ (Climber, Champer, and Quitter). However, improvements for ADI class AQ (Climber and Champer) types are classified into a high category, while ADI class on type AQ (Quitter) and direct learning class on AQ type (Climber, Champer, and Quitter) are classified. In addition, if reviewed based on factors that affect the increase of the ability of mathematical creative reasoning, then based on the description in Table 1 shows that the learning factors and the AQ type affect the development of creative reasoning ability of mathematics students.

To support the description of the students' mathematical creative reasoning abilities that have been described above, then test data analysis about students' mathematical creative reasoning ability through the statistical test of average difference. After the normality test of the data distribution of students' mathematical creative reasoning ability, it is obtained that the data is normally distributed. Based on these findings, the above-average difference test was performed using Two-Way ANOVA test presented in Table 2.

Table 2. Summary of Two-Way ANOVA test the increase of students’ mathematical creative reasoning ability based on learning factors and type of AQ

| Sources               | JK   | Dk | RJK   | F_count | Sig  |
|-----------------------|------|----|-------|---------|------|
| Learning Approach (A) | 0.119| 1  | 0.119 | 8.937   | 0.004|
| Type of AQ (B)        | 0.065| 2  | 0.032 | 2.435   | 0.094|
| A x B                 | 0.055| 2  | 0.028 | 2.079   | 0.131|
| Inter                 | 1.116| 84 | 0.013 |         |      |

(output SPSS. 23)

In relation to the learning factors presented in Table 2, the sig = 0.004; It can be concluded that there is a significant difference between improving students' creative reasoning abilities that learn to use Argument-Driven Inquiry learning with those who learn to use direct learning at 5% significance level. Based on Table 2 also obtained the value of sig for the factor of AQ to creative reasoning ability of 0.094; It can be concluded that there is no difference in improving the students' creative reasoning abilities that learn to use Argument-Driven Inquiry learning with those who learn to use direct learning at 5% significance level.

In addition, Table 2 also found that there is no significant interaction effect between the learning approach (ADI and Direct) with Type AQ (Climber, Champer, and Quitter) in generating improved students' mathematical creative reasoning at 5% significance level (sig = 0.131).
3.2. Discussion

Based on the results of research can be seen that basically the student candidate math teacher has been able to perform a good reasoning process based on completion through a process that contains in it a logical statement and can be maintained truth. This is because mathematical reasoning is a process of concluding problem solving based on logical statements derived from a given proposition and testing the assumptions of a particular problem [3,17].

After analyzed in depth about the results of research, the students' reasoning process is the result of heterogonous thinking. It can be seen that the problem-solving process done by students still tends to imitative reasoning [4,5,11].

In addition, although most students solve the problem with the ability of imitative reasoning, but not a few students who have good creative reasoning ability. This is because students can solve problems based on novelty aspect, plausible and mathematical foundation.

Student's mathematical creative reasoning skill based on Adversity Quotient (AQ) grouping is seen that students who have AQ Quitter have difficulty and often give up easily in solving problems. But for students who have AQ Camper and Climber, the students tend to be careful and try to re-examine the given solution, so the solution is considered to be a true job. It can be interpreted that AQ is one of the factors supporting the success of students in facing difficulties encountered in the problem-solving process [18,19,20].

In relation to the learning factor, Argument-Driven Inquiry (ADI) has a positive influence on the achievement of mathematical creative reasoning ability because ADI learning contains four important aspects that can improve students' mathematical creative reasoning ability: 1) construct and produce argumentation ability in support of mathematical explanation; 2) the ability to use mathematical explanations in problem solving; 3) participate in the discussion process; 4) write the conclusions based on his own opinions as well as input from the opinions of others. This is also because the process of effective interaction between educators and learners in constructing knowledge is a critical determinant of the success of the learning process [16].

Based on the findings in the field, the achievement of students' mathematical creative reasoning abilities is presented in Table 3.

**Table 3. The achievement of mathematical creative reasoning ability**

| Indicators of Mathematical Creative Reasoning | Type of AQ | ADI Class | Direct Learning Class |
|-----------------------------------------------|------------|-----------|----------------------|
| Novelty                                       | Climber    | 66%       | 61%                  |
|                                               | Champer    | 53%       | 51%                  |
|                                               | Quitter    | 51%       | 52%                  |
|                                               | Total      | 58%       | 55%                  |
| Plausible                                     | Climber    | 82%       | 80%                  |
|                                               | Champer    | 78%       | 76%                  |
|                                               | Quitter    | 73%       | 75%                  |
|                                               | Total      | 79%       | 77%                  |
| Mathematical Fondation                        | Climber    | 88%       | 86%                  |
|                                               | Champer    | 85%       | 84%                  |
|                                               | Quitter    | 84%       | 81%                  |
|                                               | Total      | 86%       | 85%                  |
The findings in Table 3 can be interpreted that the achievement of mastering students' mathematical creative reasoning ability has not been optimally achieved on the novelty indicator. Based on the observation, the problem is that students are not used to solve mathematical problems by making new solutions, but they are used to the usual completion steps in their daily problem-solving.

4. Conclusion

Based on the results and discussion, then obtained the following conclusions: (1) Improvement the ability of mathematical creative reasoning of students’ who is a candidate for math teacher who received Argument-Driven Inquiry (ADI) instruction is better than those who received direct instruction is reviewed based on the whole; (2) There is no different improvement the ability of mathematical creative reasoning of students’ who is a candidate for math teacher who received Argument-Driven Inquiry (ADI) instruction and direct instruction is reviewed based on the type of Adversity Quotient (Quitter / AQ Low, Champer / AQ Medium, and the Climber / AQ High); (3) Learning factors and type of Adversity Quotient (AQ) affect the improvement of students’ mathematical creative reasoning ability students’. In addition, there is no interaction effect between learning and AQ together in developing of students’ mathematical creative reasoning ability; (4) mathematical creative reasoning ability of students’ who is a candidate for math teacher has not been achieved optimally on the indicators novelty.

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